











FINAL
Environmental Impact Statement

Update of the Water Control Manual for the Apalachicola-Chattahoochee-Flint River Basin in Alabama, Florida, and Georgia and a Water Supply Storage Assessment

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Abbreviations and Acronyms

aad-mgd	average annual day-million gallons per day
ac	acre
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
ACF	Apalachicola-Chattahoochee-Flint River
ACFS	ACF Stakeholders
ACT	Alabama-Coosa-Tallapoosa
ADAPT	Alabama Drought Assessment and Planning Team
ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
AMEA	Alabama Municipal Electric Authority
ANERR	Apalachicola National Estuarine Research Reserve
ANSI	American National Standards Institute
AOR	area of responsibility
APC	Alabama Power Company
AQCR	Air Quality Control Regions
ARC	Atlanta Regional Commission
ARPA	Archaeological Resources Protection Act
AWAWG	Alabama Water Agencies Working Group
BA	biological assessment
BI	basin inflow
BO	biological opinion
C	Celsius
CAA	Clean Air Act
CCMWA	Cobb County-Marietta Water Authority
CCPC	Crisp County Power Commission
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
cm	centimeter
CMIP5	Coupled Model Intercomparison Project, Phase 5

CO	carbon monoxide
CO_2	carbon dioxide
CRMS	Chattahoochee River Management System
CRNRA	Chattahoochee River National Recreation Area
CRS	Congressional Research Service
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DA	Department of the Army
dB	decibels
dBA	a-weighted decibels
DC	District of Columbia
DCA	Department of Community Affairs
DDCWSA	Douglasville-Douglas County Water and Sewer Authority
DEP	Department of Environmental Protection
DIG	Drought Impact Group
DMR	discharge monitoring report
DNL	day-night sound level
DO	dissolved oxygen
DOE	Department of Energy
DR	Division Regulation
DWMP	District Water Management Plan
EA	environmental assessment
EC	engineering circular
ECB	engineering and construction bulletin
EFH	essential fish habitat
EIS	environmental impact statement
EM	engineering manual
EO	executive order
EOPs	Environmental Operating Principles
EPA	U.S. Environmental Protection Agency
ER	engineer regulation
ESA	Endangered Species Act
F	Fahrenheit
F.S.	Florida Statutes
FCMP	Florida Coastal Management Program

FDACS	Florida Department of Agriculture and Consumer Services
FERC	Federal Energy Regulatory Commission
ft	feet, foot
ft/day	feet per day
ft/mi	feet per mile
FWCA	Fish and Wildlife Coordination Act
FWCAR	Fish and Wildlife Coordination Act Report
FWOPC	Future without Project Condition
GADNR	Georgia Department of Natural Resources
GAEPD	Georgia Environmental Protection Division
GCM	general circulation model
GDM	general design memorandum
GEFA	Georgia Environmental Finance Authority
GGMN	Georgia Groundwater Monitoring Network
GHG	greenhouse gas
GIS	geographical information system
GIWW	Gulf Intracoastal Waterway
GLUT	Georgia Land Use Trends
GPC	Georgia Power Company
gpcd	gallons per capita per day
gpd	gallons per day
gpf	gallons per flush
gpm	gallons per minute
GSA	Geological Survey of Alabama
GWh	gigawatt-hour
GWIN	Georgia Water Information Network
GWIPS	groundwater information and project support
GWQMN	Ground Water Quality Monitoring Network
GWSP	Governor's Water Supply Program (Georgia)
HEC	Hydrologic Engineering Center
HEC-5Q	Hydrologic Engineering Center water quality model
HEC-ResSim	Hydrologic Engineering Center-Reservoir System Simulation
HFC	hydrofluorocarbon
HPMP	historic property management plan
Hz	hertz

IIL	initial impact level
in/yr	inches per year
IOAA	Independent Offices Appropriations Act
IOP	Interim Operations Plan
IPCC	Intergovernmental Panel on Climate Change
IWR	Institute for Water Resources
JSOC	joint statement of commitment
kW	kilowatt
lbs/ac-ft	pounds per acre-foot
LLNL	Lawrence Livermore National Laboratory
L_{eq}	equivalent sound level
m	meter
M&I	municipal and industrial
MAAWRMS	Metropolitan Atlanta Area Water Resources Management Study
mg/L	milligrams per liter
mi	mile
mL	milliliter
mm	millimeter
MNGWPD	Metropolitan North Georgia Water Planning District
MOA	memorandum of agreement
MS4	municipal separate storm sewer system
µg/L	microgram per liter
MW	megawatt
MWh	megawatt-hour
N_2O	nitrous oxide
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAWQA	national water quality assessment
NED	National Economic Development
NEPA	National Environmental Policy Act
NERC	North American Electrical Reliability Council
NERR	National Estuarine Research Reserve
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act

NO_x	nitrogen oxide
NOA	notice of availability
NOAA	National Oceanic and Atmospheric Administration
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWFWMD	Northwest Florida Water Management District
NWR	National Wildlife Refuge
O.C.G.A.	Official Code of Georgia Annotated
O_3	ozone
OWR	Office of Water Resources (Alabama)
P.L.	Public Law
P&G	Principles and Guidelines
PAA	Proposed Action Alternative
PAC	post-authorization change report
PAL	planning aid letter
PCB	polychlorinated biphenyl
PET	potential evapotranspiration
PFC	perfluorocarbon
PM	particulate matter
ppt	parts per thousand
ppb	parts per billion
RBI	revised basin inflow
RDC	regional developmental center
RFPM	Reservoir Fisheries Performance Measure
RHA	River and Harbor Act
RIL	recreation impact level
RIOP	Revised Interim Operations Plan
RM	river mile
ROD	record of decision
ROI	region of influence
RONA	record of non-applicability
RPM	reasonable and prudent measure

RVA	range of variability approach
SADR	South Atlantic Division regulation
SeFPC	Southeastern Federal Power Customers, Inc.
SEPA	Southeastern Power Administration
SERC	SERC Reliability Corporation
SET	Science & Engineering Technology
SF_6	sulfur hexafluoride
SFMRWSA	South Fulton Municipal Regional Water and Sewer Authority
SLF	State Line Flow
SO_2	sulfur dioxide
SOP	standard operating procedure
sq mi	square mile
STATSGO	State Soil Geographic
SWMP	strategic water management plan (NWFWMD)
SWMP	sustainable water management plan (ACFS)
SWP	statewide water management plan
TEN	Technical Excellence Network
TMDL	total maximum daily load
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VIC	variable infiltration capacity (model)
VISA	very intense study area
WAL	water access limited level
WCIP	water conservation implementation plan
WCM	water control manual
WDCP	water development and conservation plan
WRD	Wildlife Resources Division
WSA	Water Supply Act
WSSA	water supply storage assessment
WSTF	Water Supply Task Force
yr	year

EXECUTIVE SUMMARY

This environmental impact statement (EIS) evaluates proposals by the U.S. Army Corps of Engineers (USACE) to adopt an updated *Master Water Control Manual, Apalachicola-Chattahoochee-Flint River (ACF) Basin, Alabama, Florida, Georgia* (Master WCM or Master Manual); including a water supply storage assessment (WSSA) addressing reallocation of storage in Lake Sidney Lanier (Lake Lanier). The WSSA addresses a request from Georgia for reallocation of storage in Lake Lanier to satisfy future water supply needs of certain north Georgia communities. The Apalachicola-Chattahoochee-Flint River (ACF) Basin comprises 19,573 square miles in Alabama, Florida, and Georgia. USACE operates five reservoir projects in the basin: Buford Dam and Lake Lanier; West Point Dam and Lake; Walter F. George Lock and Dam and Lake; George W. Andrews Lock and Dam and Lake George W. Andrews; and Jim Woodruff Lock and Dam and Lake Seminole.

Federal legislation authorizing project purposes in the ACF Basin was originally enacted in the mid-1940s. Section 2 of the River and Harbor Act (RHA) of 1945 (Public Law [P.L.] 79-14) approved the plan for developing flood control, hydroelectric power generation, water supply, and navigation on the ACF Basin rivers in Florida and Georgia. Those purposes are often referred to as "expressly authorized project purposes." A modification to the 1945 general plan was authorized by section 1 of the RHA of 1946 (P.L. 79-525) to include Buford multipurpose reservoir (Lake Lanier), the Fort Benning Lock and Dam, and the Upper Columbia and Jim Woodruff multipurpose developments. The project's navigation feature was to be provided by dredging, channel contraction works, construction of a series of locks and dams, and flow regulation by the upstream reservoirs. The 1946 amendment provided that, in the Apalachicola River portion of the project, "…local interests furnish free of cost to the U.S., as and when required, all rights-of-way, spoil-disposal areas, easements and other lands required for the provision and maintenance of a navigation channel in the Apalachicola River…".

Other operational objectives derive from authorities that generally apply to all USACE reservoirs such as fish and wildlife conservation (Fish and Wildlife Coordination Act [FWCA] of 1958 [P.L. 85-624] and Endangered Species Act [ESA] of 1973 [P.L. 93-205]), recreation (Flood Control Act of 1944 [P.L. 78-534]), water quality (Water Pollution Control Act Amendments of 1972 [P.L. 92-500]), and water supply[1] (Water Supply Act[2] [WSA] of 1958 [P.L. 85-500]). Thus, USACE operates and manages the ACF Basin projects as one system to meet the following authorized purposes: flood risk management, hydropower, navigation, fish and wildlife conservation, recreation, water quality, and water supply.

All of USACE projects are on the Chattahoochee River arm of the ACF Basin except for the Jim Woodruff Lock and Dam, which is immediately downstream of the confluence of the Chattahoochee and Flint rivers and marks the upstream extent of the Apalachicola River. Buford Dam, West Point Dam, and Walter F. George Lock and Dam each form a reservoir (i.e., Lake Lanier, West Point Lake, and Walter F. George Lake, respectively) with a combined conservation storage capacity (relative to the top of each reservoir's full summer pool) of about 1.6 million acre-feet (ac-ft). Jim Woodruff Lock and Dam is operated as a run-of-river project and has very limited storage (referred to as pondage) available to

[1] In updating the WCMs, USACE will consider the authority under Public Law 84-841, enacted July 30, 1956 (the 1956 Act) (see discussion in section 2.1.1.2.1) to contract for 11,200 acre-feet (ac-ft) of storage with Gwinnett County.

[2] The Water Supply Act (WSA) of 1958 stipulates that congressional authorization is required for any reallocation of storage in completed reservoirs that would seriously affect the purposes for which the project was authorized or that would involve major structural or operational changes.

support project purposes. George W. Andrews Lock and Dam is also a run-of-river project principally for navigation with no conservation storage. In addition to the five USACE projects, nine nonfederal reservoir projects are on the mainstems of the Chattahoochee and Flint rivers in the ACF Basin. Those nonfederal projects are operated by the Georgia Power Company and Crisp County Power Commission. Figure ES-1 depicts the project locations in the ACF Basin and Table ES-1 provides pertinent data on the reservoir projects in the basin.

PURPOSE AND NEED

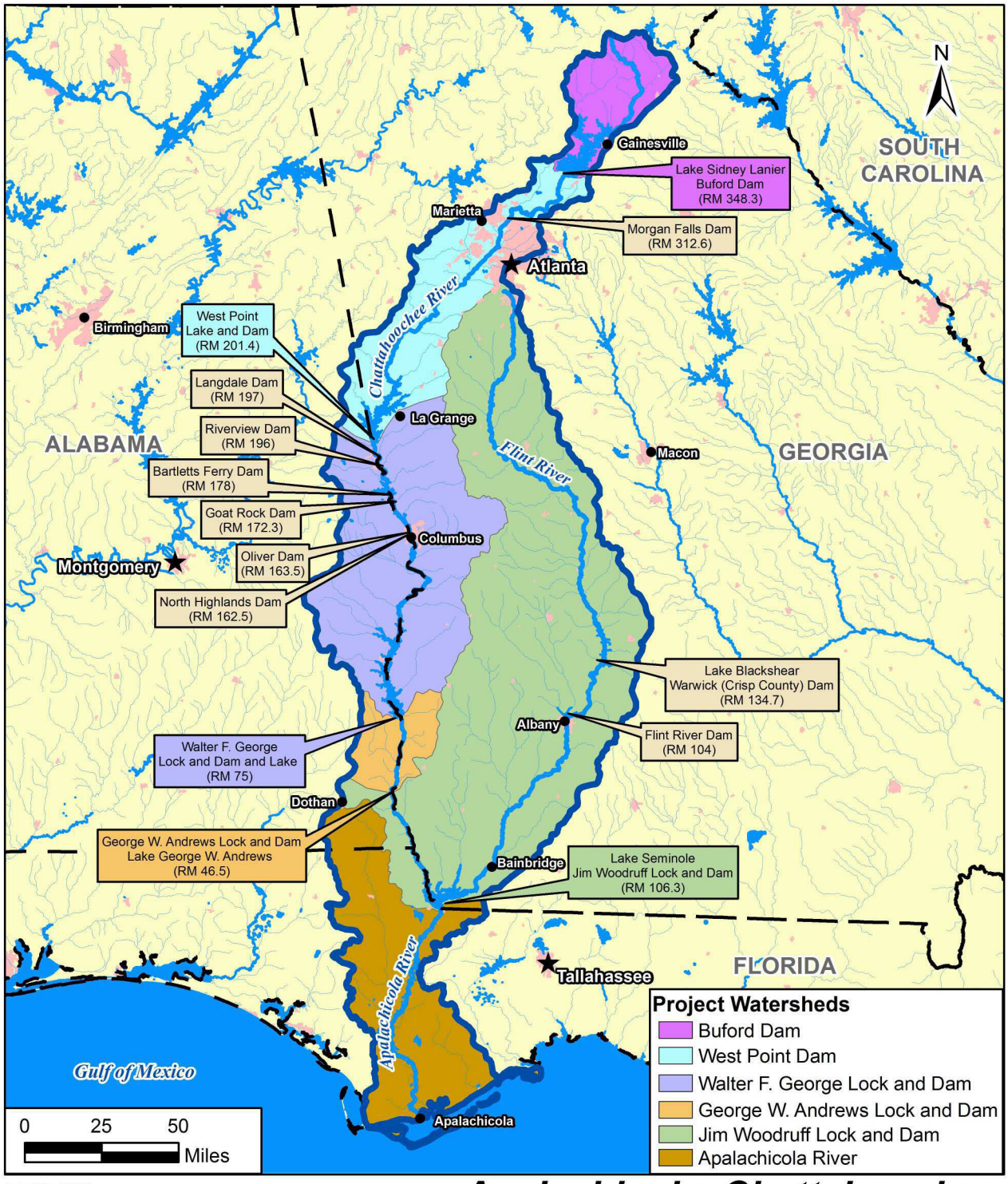
Section 7 of the Flood Control Act of 1944 provides that:

> It shall be the duty of the Secretary of the Army to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations.... (Title 33 of the *United States Code* [U.S.C.] section 709).

The Master WCM for the ACF Basin dates to 1958 and does not include water control manuals (WCMs) for the Buford Dam, West Point Dam, Walter F. George Lock and Dam, or George W. Andrews Lock and Dam project, all of which were completed later. The individual reservoir project WCMs were completed as the projects were completed and placed in operation. The last technical updates to the documents were made at various times, extending as far back as the 1970s and 1980s; primarily administrative updates were approved in the 1990s. USACE has continued to operate essentially in accordance with the status quo reflected in the 1989 draft Master WCM update, with minor adjustments as subsequent experience and circumstances have dictated.

The proposed action updates the Master WCM and individual project WCMs for the ACF Basin as directed by Secretary of the Army Pete Geren on January 30, 2008. Specifically, the purpose and need for the federal action is to determine how USACE projects in the ACF Basin should be operated for their authorized purposes, in light of current conditions and applicable law, and to implement those operations through updated water control plans and manuals. The proposed action will result in an updated Master WCM and individual project WCMs that comply with existing USACE regulations and reflect operations under existing congressional authorizations, taking into account changes in basin hydrology and demands from years of growth and development, new/rehabilitated structural features, legal developments, and environmental issues.

On May 16, 2000, the Governor of Georgia submitted a formal request to the Assistant Secretary of the Army (Civil Works) to adjust the operation of Lake Lanier, and to enter into agreements with the State, or water supply providers, to accommodate increases in water supply withdrawals from Lake Lanier and downstream at Atlanta over the next 30 years. The Assistant Secretary of the Army (Civil Works) in 2002 denied Georgia's request. The 2011 decision of the 11th Circuit Court of Appeals ordered USACE to reconsider whether it has the legal authority to operate the Buford Project to accommodate Georgia's request. USACE provided a legal opinion on remand, concluding that it has sufficient authority under applicable law to accommodate that request, but noting that any decision to take action on Georgia's request would require a separate analysis. On January 11, 2013, the Governor of Georgia provided updated demographic and water demand data to confirm the continued need for 705 million gallons per day (mgd) to meet Georgia's water needs from Lake Lanier and the Chattahoochee River to approximately the year 2040 rather than 2030, as specified in the 2000 request. This request was considered in the draft EIS published in October 2015. On December 4, 2015, the Georgia Environmental Protection Division (GAEPD), on behalf of the State of Georgia, provided updated demographic and



Apalachicola, Chattahoochee, and Flint Rivers Basin Map

Figure ES-1

Table ES-1.
Reservoirs on Mainstem ACF Basin Rivers

Basin/River/Project Name	Owner/State/ Yr Initially Completed	Drainage Area (sq mi)	Reservoir Size (ac)	Total Storage (ac-ft)[a]	Conservation Storage Summer Elev (ac-ft)	Power Capacity (kW)	Normal (summer) lake elev (ft)	Authorized Purposes for USACE-owned Projects[b]
Chattahoochee River		*8,708*						
Buford Dam/Lake Sidney Lanier	USACE/GA/1957	1,034	38,425	2,551,064	1,074,645	127,000	1,071	FRM, HP, NAV, FW, REC, WQ, WS[c]
Morgan Falls Dam/Bull Sluice Lake	GPC/GA/1903	1,360	580	2,450	0	16,800	866	
West Point Dam and Lake	USACE/GA/1975	3,440	25,864	774,798	306,131	87,000	635	FRM, HP, NAV, FW, REC, WQ
Langdale Dam and Lake	GPC/GA/1860	3,640	152	NA[d]	0	1,040	547.7	
Riverview Dam and Lake	GPC/GA/1902	3,661	75	NA[d]	0	480	530.5	
Bartletts Ferry Dam/Lake Harding	GPC/GA/1926	4,240	5,850	181,000	0	173,000	521	
Goat Rock Dam and Lake	GPC/GA/1912	4,510	1,050	11,000	0	38,600	404	
Oliver Dam/Lake Oliver	GPC/GA/1959	4,630	2,150	32,000	0	60,000	337	
North Highlands Dam and Lake	GPC/GA/1900	4,630	131	1,500	0	29,600	269	
Walter F. George Lock and Dam and Lake	USACE/GA/1963	7,460	41,800	884,572	232,800	168,000	190	HP, NAV, FW, REC, WQ
George W. Andrews Lock and Dam/Lake George W. Andrews	USACE/GA/1963	8,210	1,540	18,180	0	None	102	NAV, FW, REC, WQ
Flint River		*8,456*						
Warwick Dam/Lake Blackshear	Crisp Co./ GA/1930	3,770	8,700	144,000	0	15,200	237	
Flint River Dam/Lake Worth	GPC/GA/1920	5,290	1,400	NA[d]	0	5,400	182.3	
Apalachicola River		*2,409*	*(Total ACF Basin – 19,573 sq mi)*					
Jim Woodruff Lock and Dam/ Lake Seminole	USACE/FL/1954	17,164	37,500	367,318	0	43,350	77	HP, NAV, FW, REC, WQ

Notes:
ac = acres; ac-ft = acre-feet; ft = feet; kW = kilowatts; sq mi = square miles.

[a.] Measured at top of storage for flood risk management.

[b.] As used in this table, the term *authorized purposes* includes purposes expressly identified in the project authorizing documents; incidental benefits recognized in projection authorizations; and objectives that result from other authorities, such as general authorities contained in congressional legislation, for which USACE operates each listed project as of 2009. FRM = flood risk management; FW = fish and wildlife conservation; HP = hydroelectric power generation; NAV = navigation; REC = recreation; WQ = water quality; WS = municipal & industrial water supply; GPC = Georgia Power Company.

[c.] USACE operates the Buford Dam/Lake Sidney Lanier project in a manner that accommodates water supply withdrawals from Lake Lanier and from the Chattahoochee River downstream of Buford Dam.

[d.] NA = not available.

water demand data (referred to as Georgia's 2015 request) that reduced Georgia's needs from 297 mgd to 242 mgd from Lake Lanier and from 408 mgd to 355–379 mgd downstream through the year 2050 rather than 2040, as specified in the 2013 request. Georgia's 2015 request includes 20 mgd for relocation[3] contracts, 214 mgd for Forsyth, Gwinnett, and Hall counties, and 8 mgd for Habersham, Lumpkin and White counties. A water supply need for Dawson County had been included in Georgia's 2013 request, but the updated demographic and water demand data indicated that no unmet need is expected to exist in Dawson County in 2050. Because updating the water control plans and manuals requires making a decision on Georgia's water supply request, this final EIS considered, along with operations for all authorized purposes, an expanded range of water supply options associated with the Buford Dam/Lake Lanier project, including current levels of water supply withdrawals and additional amounts that Georgia requested from Lake Lanier and downstream at Metro Atlanta in 2015.

SCOPE OF THE EIS

This EIS identifies, documents, and evaluates the environmental effects of operating USACE projects in the ACF Basin under alternative management regimes that could reasonably be expected to accomplish the purpose and need of the proposed federal action. The scope of the proposed federal action described in the EIS for the Master WCM update was refined as a result of the July 2009 federal district court order in the case *In re Tri-State Water Rights Litigation*. In 2012, the scope of the federal action was further refined because of the June 2011 ruling of the U.S. Court of Appeals for the 11th Circuit, which vacated the 2009 district court order in the case and directed USACE to determine its legal authority to operate Buford Dam and Lake Lanier to accommodate water supply withdrawals. USACE's chief counsel issued a legal opinion in June 2012 concluding that USACE has the legal authority to accommodate both current and increased levels of water supply withdrawals from Lake Lanier and downstream at Atlanta, in light of several different statutory authorities and based on preliminary analysis of impacts to other authorized purposes. Therefore, along with operations for all authorized project purposes, this EIS will consider an expanded range of water supply options associated with the Buford Dam/Lake Lanier project, including current levels of water supply withdrawals and additional amounts that Georgia has requested from Lake Lanier and downstream at Atlanta.

The EIS is intended to inform decision makers and the public of the likely environmental consequences of the Proposed Action Alternative (PAA) and other alternatives. The range of actions, alternatives, and effects considered in this EIS are driven by the requirements set forth by Congress and USACE policies for project operation. This EIS considers operational changes within existing congressional authorities, as determined by recent court rulings, and delegated discretionary authorities. Potential changes to ACF Basin water control operations that would not support authorized purposes of the projects, would require substantial structural modifications, or would otherwise exceed current USACE authority are not consistent with the purpose and need for the WCM update and are not considered further in the EIS.

[3] Relocation contracts are provided as compensation for inundation of existing water intakes at the time of project construction. All withdrawal amounts are shown in gross withdrawals, the only contract that utilizes a net withdrawal figure is the relocation contract for the City of Gainesville due to the specific terms of the contract. Presently, Gainesville withdraws 18 mgd and returns 10 mgd, resulting in a net withdrawal of 8 mgd. The total gross withdrawal under relocation contracts for Gainesville and Buford is 20 mgd.

PUBLIC INVOLVEMENT

Public participation is an important element of the National Environmental Policy Act of 1969 (NEPA) process and is guided by both Council on Environmental Quality (CEQ) and USACE regulations for implementing NEPA. In accordance with those regulations, USACE process for the Master WCM update includes five specific opportunities for public participation: (1) notice of intent (NOI) to prepare an EIS, (2) scoping, (3) independent external peer review, (4) public review of the draft EIS, (5) public meeting(s) in conjunction with the draft EIS, and (6) review of the final EIS. The NOI and public scoping, public review of the draft EIS, and public meetings in conjunction with the draft EIS have been completed as summarized below. The remaining opportunity for public input is the review of the final EIS.

Notice of Intent and Scoping

In February 2008, USACE published an NOI in the *Federal Register* declaring its intent to prepare an EIS for the proposed action. Supplemental NOIs were published to announce additional information for the public scoping process.

A supplement to the initial NOI was published in September 2008 requesting scoping input from agencies and the public and announcing the dates and locations of public scoping meetings. USACE's scoping objectives were to identify public and agency concerns; define the environmental issues and alternatives to be examined in the EIS; identify related issues that originate from separate legislation, regulations, or executive orders (EOs); identify relevant state and local agency requirements; and identify available sources of data, studies, or tools that could provide information valuable in preparing the EIS. The scoping meetings were held in October 2008 at five locations throughout the ACF Basin. A total of 1,018 stakeholders participated in the five public scoping meetings. USACE published a final scoping report in January 2009.

In November 2009, an NOI was published to announce the reopening of public scoping in response to the memorandum and order issued in July 2009 by the United States District Court for the Middle District of Florida in the case *In re Tri-State Water Rights Litigation*. The ruling included a severely limited interpretation of USACE's authority to provide water supply benefits through its operation of the Lake Lanier project and introduced new information and circumstances that affected some of the determinations reflected in the January 2009 final scoping report. USACE published an updated final scoping report in March 2010.

A subsequent NOI was published in the *Federal Register* in October 2012 to reopen public scoping in light of the June 2011 decision of the United States Court of Appeals for the 11th Circuit and the associated June 2012 legal opinion of USACE's chief counsel regarding authority to accommodate municipal and industrial (M&I) water supply from the Buford Dam and Lake Lanier project. USACE revised the scope of the EIS and Master WCM update to include consideration of the following: operations that are within its existing authority under the RHA of 1946, taking into account the 2011 11th Circuit Court of Appeals opinion and USACE 2012 legal opinion; the authority under the 1956 Act to contract for 11,200 ac-ft of withdrawals (10 mgd); and Georgia's 2000 water supply request (updated in January 2013). USACE published an updated final scoping report in March 2013.

Scoping Comments and USACE Analysis of Scoping Comments

The public scoping effort (2008, 2009, and 2012) for updates to the Master WCM resulted in a total of 3,600 comments from over 960 individuals, organizations, and agencies. All the comments from scoping were reviewed, analyzed, and organized into categories based on the nature of the comments.

The greatest number of comments (1,228) was related to water management recommendations, which include the seven authorized project purposes and USACE ability to balance needs throughout the ACF Basin. Other comments in that category addressed potential alternatives for consideration (or potential mitigation measures); demand projections as they relate to downstream and future water supply needs; and water conservation. Issues and concerns regarding socioeconomics and the tie between water levels, recreation, and regional economics received the second-largest number of comments (706). Most of the comments received in this category pertained to the adverse socioeconomic impacts that have occurred in the northern portions of the ACF Basin due to extremely low water levels in Lake Lanier and low or inconsistent water levels in West Point Lake during periods of drought and drought recovery.

The scoping comments expressed by the three states are consistent with their respective positions over the litigation history as summarized in the EIS as well as their subsequent comments on the draft EIS. Although there is a more in-depth analysis in the EIS, a few key issues identified by the states and stakeholders in the states are summarized in the following sentences. The state of Florida disagreed with the process and models used by the USACE; aside from these procedural and technical matters, Florida also sought additional flows into the Apalachicola River and Apalachicola Bay. The state of Alabama also took issue with the process and models. In addition to the stated procedural and technical concerns, Alabama also wanted assurances that specific minimum flows would be met or exceeded at all times for industrial interests in Alabama. Both Florida and Alabama wanted to limit Metro Atlanta's withdrawals from Lake Lanier and the Chattahoochee River, including requirements for greater water conservation measures and limits on consumptive use. The state of Georgia wanted water supply contracts at Lake Lanier and increased water supply withdrawals from the Chattahoochee River downstream of Buford Dam, both to meet projected future water demands for Metro Atlanta, as well as more conservative use of storage in the ACF Basin reservoirs, which would benefit pool levels for recreation and water supply at Lake Lanier and West Point Lake.

Stakeholder comments were helpful in identifying water resources/water management problems as well as measures (or alternatives) the public wished to have considered as the Master WCM is updated. Considering the purpose and need for this EIS, USACE developed eight screening criteria to guide information gathering, to help identify solutions, and to formulate alternatives. The screening criteria helped to define the scope of proposed updates to the Master WCM, identify relevant public/agency issues and concerns to be addressed in the EIS, and guide the consideration of input received from agencies and the public, as well as suggestions from USACE project team. Any proposed measure (or alternative) considered in the update process for the Master WCM should:

- Meet the purpose and need of the proposed federal action
- Address one or more of the congressionally authorized project purposes
- Maintain at least the current level of flood risk management
- Be consistent with the contemporary water resources needs of the basin to the extent practicable
- Support the operation of the projects in the ACF Basin as a system
- Not increase the risk to public safety in the facility or downstream of the project
- Not exceed the physical limitations or pose risks to the structural integrity of the projects
- Not violate USACE responsibilities under the ESA

Draft and Final EIS

The draft EIS was filed with the U.S. Environmental Protection Agency (EPA) by letter dated September 23, 2015. The EPA notice of availability (NOA) of the draft EIS for public review and comment was published in the *Federal Register* on October 2, 2015, initiating a 60-day comment period ending on

December 1, 2015. In response to multiple requests for extension of the comment period, USACE extended the comment period by an additional 45 days, ending on January 15, 2016, and providing a total public comment period of 105 days. Agencies, organizations, and individuals were invited to review and comment on the document with respect to its completeness and on the proposed action, the alternatives, and the adequacy of the analysis. During the comment period, USACE also held a series of five public meetings, using an open-house format, in cities across the ACF Basin to present information, answer questions, and receive comments on the draft EIS.

As provided for in CEQ regulations, USACE considered all comments provided by the public and agencies on the draft EIS. The final EIS addresses all comments received during the draft EIS public review period and incorporates appropriate changes derived from the draft EIS comments. Also, the State of Georgia provided additional information in December 2015 (during the draft EIS comment period) reflecting population projections revised downward for Metro Atlanta and, accordingly, future water demand projections also revised downward. Key revisions and updates incorporated into the final EIS are summarized below:

- All sections of the EIS, and the EIS appendices, where appropriate, include technical and administrative corrections and updates based on agency and public comments, independent external peer review comments, and relevant additional information obtained since the draft EIS was published.
- Section 4 was updated to more fully describe and clarify: (1) the two-phased plan formulation process to determine the alternatives evaluated in detail in section 6; (2) how modeling was used in both phases of the plan formulation process to assess and narrow the array of alternatives considered in detail and to provide a technical foundation for the assessment of impacts of the alternatives considered in detail; (3) the screening process for potential water management measures; and (4) consideration of an alternative offered by the ACF Stakeholders (ACFS) organization.
- Section 5 was updated to incorporate additional information provided by the State of Georgia in December 2015 regarding: (1) future water supply needs for communities withdrawing or expected to withdraw from Lake Lanier; (2) future water supply needs for communities withdrawing from the Chattahoochee River downstream of Buford Dam; and (3) expected return rates associated with lake and river withdrawals. The water supply needs considered in the final EIS were revised downward and extend over a longer planning horizon (from 2040 to 2050) than included in the previous 2013 request from Georgia, which was used in the formulation of alternatives presented in the draft EIS. Further, the final EIS eliminated Glades Reservoir as a reasonably foreseeable source of future water supply when the GAEPD rescinded the *need certification* for the reservoir in early 2016. This additional information resulted in several new alternatives (including a new PAA), all of which are within the range of the alternatives evaluated in the draft EIS.
- Section 6 was updated to address the additional alternatives (including the new PAA) that were developed in consideration of the additional water supply information from Georgia addressed in the update to section 5 of the EIS. The updated analysis of the alternatives was based on additional HEC-ResSim and HEC-5Q modeling that incorporated the revised water supply information. All pertinent subsections within section 6 were updated accordingly.

The final EIS is being made available for a 30-day review before any final decision is made by USACE.

Record of Decision

No sooner than 30 days after filing the final EIS with EPA and publication of the NOA for the final EIS in the *Federal Register*, USACE will prepare a record of decision (ROD) that will state the decision in regard to updating the Master WCM and the individual project WCMs, summarize alternatives that were

considered and relevant factors that were balanced in making the decision, and identify means that have been adopted to mitigate adverse effects.

APPLICABLE USACE GUIDANCE

The following USACE regulations and manuals apply to operation of the ACF Basin projects and management by use of WCMs and have been applied in the Master WCM update process:

- Engineer Regulation (ER) 1110-2-240, *Water Control Management* (May 30. 2016) (also published as Title 33 of the *Code of Federal Regulations* [CFR] section 222.5).
- ER 1110-2-1150, *Engineering and Design for Civil Works Projects* (August 31, 1999).
- ER 1110-2-1941, *Drought Contingency Plans* (September 15, 1981).
- ER 1110-2-8154, *Water Quality and Environmental Management for Corps Civil Works Projects* (May 31, 1995).
- ER 1110-2-8156, *Preparation of Water Control Manuals* (August 31, 1995).
- Engineer Manual 1110-2-3600, *Management of Water Control Systems* (November 30, 1987).
- ER 1105-2-100, *Planning Guidance Notebook* (April 22, 2000).
- *The Water Supply Handbook* (Revised IWR Report 96-PS-4).

WCMs are guidance documents that assist federal water managers in operating individual and multiple interdependent USACE reservoirs on the same river system. They provide technical, historical, hydrological, geographic, demographic, policy, and other information that guides the proper management of reservoirs during times of high water, low water, and normal conditions. The manuals contain water control plans for each of USACE's reservoirs in the basin system and specify how the various reservoir projects will be operated as a balanced system. The manuals also contain drought operations plans and action zones to assist federal water managers in knowing when to reduce or increase reservoir releases and conserve storage in USACE reservoirs. The manuals further ensure the safety of dams during extreme conditions such as floods.

In addition to the above guidance, USACE established Environmental Operating Principles (EOPs) in 2002 to guide and ensure that USACE mission activities include totally integrated sustainable environmental practices. These seven principles were reviewed, updated, and reissued in August 2012. The EOPs are applicable to the Master WCM update and were fully considered in the update process, as described in the EIS.

RELEVANT STATUTES AND EXECUTIVE ORDERS

The EIS has been prepared to comply with the requirements of the NEPA, as amended (42 U.S.C. 4321−4347); the CEQ's *Regulations for Implementing the Procedural Provisions of the NEPA* (40 CFR 1500–1508); and ER 200-2-2, *Environmental Quality—Procedures for Implementing NEPA* (also published as 33 CFR 230). In addressing environmental considerations, the Army is guided by other relevant statutes (and their implementing regulations) and EOs that established standards and provide guidance on environmental and natural resources management and planning. Those relevant requirements, as well as USACE actions taken to ensure compliance with those requirements, are fully addressed in the EIS. Full compliance with all pertinent requirements will be attained upon completion and coordination of the final EIS and signing of the ROD.

BACKGROUND ON ATLANTA WATER SUPPLY NEEDS

The Metropolitan Atlanta Area Water Resources Management Study (MAAWRMS), authorized by a resolution of the United States Senate adopted March 2, 1972, and initiated in 1973, focused on developing a plan for assuring a long-term water supply for Metro Atlanta. The final MAAWRMS report in 1981 recommended construction of a reregulation dam approximately 6.3 miles downstream of Buford Dam for the purpose of reregulating peak power releases from the dam and providing a minimum flow to meet 2010 average summer water supply demands of 487 mgd, plus 750 cubic feet per second (cfs) for water quality purposes. Although the final report was never officially transmitted to Congress, construction of the reregulation dam was authorized in the Water Resources Development Act of 1986 (P. L. 99-662), subject to approval of a general design memorandum (GDM) and with project costs shared 25 percent federal and 75 percent nonfederal. The draft GDM, when submitted to the South Atlantic Division in March 1988, confirmed that the reregulation dam still had the greatest net benefits of the four plans investigated, but only by a small margin. Due to the closeness of the net benefits in the plans for a reregulation dam and for reallocation of storage in Lake Lanier, a more detailed evaluation of the hydropower impacts was conducted. In October 1988, the plan for reallocation of reservoir storage was designated the National Economic Development (NED) plan and recommended for implementation.

In March 1989, USACE initiated a post-authorization change (PAC) report to implement the findings of the GDM for the reregulation dam. The PAC was conducted under the authority of the WSA of 1958 which provides that storage can be included for present and future municipal or industrial water supply in USACE projects, and section 216 of the Flood Control Act of 1970, which allows USACE to review the operation of completed USACE projects and recommend project modifications. The evaluation confirmed that the reallocation of storage in Lake Lanier should be designated the NED plan (the plan that would provide the greatest overall net benefits). Reallocation of storage was recommended for implementation in the draft reallocation and PAC report and a draft environmental assessment, completed in October 1989. The PAC report recommended reallocation of 206,839 ac-ft of storage in Lake Lanier to supply water for M&I purposes to address the future water needs for Metro Atlanta to 2010.

During the 1970s and 1980s, as the MAAWRMS and related activities were underway, USACE worked with the Atlanta Regional Commission and local water authorities to develop interim water withdrawal contracts to address the growing water demands in Metro Atlanta, both around Lake Lanier and downstream of Buford Dam and, including pertinent adjustments in releases at Buford Dam to accommodate increased withdrawals. The EIS includes a detailed summary of these activities.

NEGOTIATIONS AND LITIGATION

Upon completion of the draft PAC report in 1989, USACE efforts to update the Master WCM and address water supply storage reallocation issues associated with Buford Dam and Lake Lanier, in conjunction with multiple agencies and stakeholders, have been the subject of litigation, studies, and negotiations as summarized in the EIS. Since 2011, the Master WCM update has proceeded in accordance with the most recent court rulings:

- The U.S. Court of Appeals for the 11th Circuit issued an opinion on June 28, 2011, that reversed the judgment of the federal district court for the Middle District of Florida on phase I of the consolidated ACF litigation and concluded that the authorizing documents for the Buford Dam project include water supply as an authorized purpose. The case was remanded to the district court with instructions to remand to USACE for further proceedings. As to the merits, the court held that the majority of plaintiffs' claims in the ACF were not final agency actions and therefore not subject to judicial review.

- On January 24, 2013, the federal district court for the Middle District of Florida vacated its Phase II ruling of the consolidated ACF litigation on the grounds that USACE and the U.S. Fish and Wildlife Service (USFWS) reinitiated consultation while the appeal was pending, thus rendering the appeal moot and making it proper to vacate the underlying order.

As of publication of the final EIS, there is no active litigation regarding operation of USACE projects in the ACF Basin. On November 3, 2014, Florida was given permission to file an original motion for leave to file a bill of complaint against Georgia seeking an equitable apportionment of the waters of the ACF Basin and appropriate injunctive relief against Georgia to sustain an adequate flow of fresh water into the Apalachicola Region. The U.S. Supreme Court on November 19, 2014, named a special master to review and propose a ruling to the court. On Oct. 31, 2016, the Special Master began the trial between Florida and Georgia on the issue of equitable apportionment of the waters of the ACF Basin. At this point it is unclear how long the trial will take and when the Special Master will issue his recommendation. USACE is not a party to this litigation and it is unclear whether the outcome will affect the USACE-proposed operations that are the subject of this final EIS. USACE is following this litigation closely, and any outcome will be reviewed and analyzed by USACE and the Department of Justice. Following that review, USACE will take appropriate action.

ALTERNATIVE FORMULATION

The Master WCM update process involved formulation and evaluation of water management alternatives to refine project operations to more effectively meet authorized project purposes. As part of this process, USACE considered, along with operations for all authorized purposes, an expanded range of water supply options associated with the Buford Dam and Lake Lanier project, including current levels of water supply withdrawals and additional amounts that Georgia, in 2015, requested from Lake Lanier and downstream of Buford Dam at Atlanta. To respond to Georgia's 2015 request, a WSSA was prepared following USACE guidance for reports on reallocation of reservoir storage. USACE used a 6-step planning process described in ER 1105-2-100. This process is a structured approach to problem solving that provides a rational framework for sound decision making. Iterations of the six steps were conducted as necessary to formulate efficient, effective, complete, and acceptable plans.

The Master WCM update process addressed in the EIS involved a 2-phased approach. The focus of the first phase was to consider revisions and updates to current water management practices for the five USACE reservoirs in the ACF Basin, with specific consideration given to methods of more effectively operating the projects as a system. A variety of water management measures were developed, screened, and subsequently combined into several different sets of measures to form distinct water management alternatives. For analytical purposes, the evaluation of water management alternatives in this phase assumed that the water supply withdrawals from Lake Lanier would be limited to the 20 mgd currently authorized to be withdrawn by the cities of Buford and Gainesville under the relocation contracts and releases from Buford Dam would be made in accordance with the *Chattahoochee River Management System* (CRMS) to support water supply withdrawals from the Chattahoochee River in Metro Atlanta limited to the amounts withdrawn in 2007 (277 mgd). Water supply providers contributed return flows to Lake Lanier and downstream, and those returns were also taken into account. Withdrawals elsewhere within the basin were similarly limited to the amounts withdrawn in 2007. These assumptions facilitated the comparison of the performance of the water management alternatives using a consistent baseline condition that is relatively independent of the influence of the water supply withdrawals from Lake Lanier under the expired contracts. Additionally, this approach established a baseline for determining the severity of effects on other project purposes of reallocating storage in Lake Lanier for water supply as required by the WSA of 1958. The result of this formulation phase was the identification of a proposed water management alternative. In the second phase of alternative formulation, measures for considering whether and how to accommodate current and future water supply demand—up to and including

Georgia's 2015 request for water supply from Lake Lanier and from the Chattahoochee River downstream of Buford Dam—were identified, screened, and then combined to form water supply options. For this phase, Water Management Alternative 1 (current operations) and Water Management Alternative 7 were combined with water supply options to form alternatives that were evaluated and compared. The result of this formulation phase was the identification of a PAA to improve water management and address water supply needs in the ACF Basin.

WATER MANAGEMENT ALTERNATIVE FORMULATION

On the basis of operational experience gained under the draft 1989 Master WCM, a number of challenges were identified. These challenges included the basis for the configuration and operational criteria associated with *action zones* within the conservation storage of the reservoirs; certain operational criteria associated with the May 2012 Revised Interim Operations Plan (RIOP); the relationship of sustained hydropower operations to operations for endangered and threatened species; and dependability of navigation on the Apalachicola River. Additional information on these challenges is in the EIS.

After identifying those water management challenges and problems, USACE developed several objectives for the Master WCM update and the WSSA to address the issues as follows:

- Define action zones on a scientific basis that eliminates disproportionate impact on reservoirs and address current system needs.
- Develop and implement a basinwide USACE reservoir drought operation plan.
- Reduce or eliminate the chances of prematurely returning to drought operations and reducing flows below Jim Woodruff Lock and Dam below 5,000 cfs.
- Reduce or eliminate the adverse effect of system operations on federally listed threatened and endangered species.
- Improve system performance to achieve congressionally authorized project purposes.
- Increase the reliability of navigation on the ACF system.

USACE identified numerous management measures for possible consideration in the updated Master WCM, based on public scoping comments and USACE experience with ACF project operations. A measure can be defined as a feature or activity that can be implemented at a specific geographic site to address one or more of the objectives. The measures considered in updating the Master WCM included variations for revising reservoir drawdown and refill periods, reshaping action zones, and balancing zone drawdown proportionally among projects; revising hydroelectric power generation; revising drought operations and environmental flows; and developing navigation-specific operations. USACE considered each measure individually and determined whether it passed the eight screening criteria. Measures failing to pass the screening criteria were not carried forward for further evaluation (i.e., eliminated from further consideration). Initial screening of measures is discussed in greater detail in the final EIS. Measures carried forward for further evaluation were refined, if required, and then combined to form basinwide alternatives that address one or more of the objectives identified above.

USACE used the Hydrologic Engineering Center-Reservoir System Simulation (HEC-ResSim) model to simulate ACF operations for Water Management Alternative 1 (current operations) and the six other water management alternatives over a 73-year (-yr) hydrologic period of record (1939–2011). USACE used an iterative process to identify the various measures that would be further developed, analyzed, and refined toward the goal of developing an updated Master WCM. The process relied extensively on

modeling using the latest version of HEC-ResSim.[4] The software incorporates characteristics of the basin and individual reservoirs, including physical constraints (e.g., spillway capacities, area-discharge curves, flows associated with hydroelectric power generation, and such) and operational procedures (e.g., action zones, balancing, and the like). As the HEC-ResSim model for the ACF Basin was refined and initial baseline model runs were conducted, USACE presented two workshops to familiarize stakeholders with the model and its capabilities.

Water Management Measures Eliminated and Retained for Consideration (First Screening)

Water management measures that did not pass the screening criteria or were found to be outside the scope of the EIS were eliminated from consideration. USACE strives to operate the reservoirs of the ACF Basin in a balanced manner to meet all of their project purposes. Therefore, any measure proposed during public scoping that recommended prioritization of project purposes was not carried forward for further consideration. Because navigation is one of the congressionally authorized purposes in the ACF Basin, any recommendations to eliminate navigation as a project purpose were not considered. Management measures that suggest use of flood storage for purposes other than flood storage were not considered. Recommendations for studies to determine the allocation of water among Alabama, Florida, and Georgia were also not carried forward for further consideration. USACE did not carry forward management measures that change minimum releases or minimum flows, ensuring other entities meet their future federal compliance requirements. USACE recognizes existing minimum flow requirements in the system but is not authorized to operate its projects to meet requirements for which others parties are responsible. Setting minimum flow targets to ensure compliance with water quality standards is the responsibility of states, not USACE. Changes to the existing head at dams in the ACF Basin could increase the risk to the structural integrity of the projects. Therefore, measures that would change the existing head limits for projects in the ACF Basin were eliminated from consideration. Management measures that suggest structural modifications to the ACF project or other USACE projects do not meet the purpose and need of this EIS. Accordingly, suggestions such as repairing and reversing channel degradation in the Apalachicola River or halting or limiting the current diversion of fresh water caused by the Chipola Cutoff were not carried forward for further consideration. Separate authorities that could be pursued to address some of those issues include section 216 of the River and Harbor and Flood Control Act of 1970 (*Review of Completed Projects*); section 1135 of the Water Resources Development Act (WRDA) 1986, as amended (*Project Modifications for Improvement of the Environment*); and section 206 of WRDA 1996, as amended (*Small Aquatic Ecosystem Restoration Projects*). The latter two authorities have specific limits on federal funds that can be expended on each project ($10 million). In addition, the USACE major rehabilitation program for major components of existing infrastructure projects provides an avenue for necessary project rehabilitation, including limited opportunities to incorporate features within the scope of the project that might provide environmental benefits.

Potential water management measures that passed the screening criteria were considered in the formulation of water management alternatives. The following provides a general description of the water management measures retained, each of which was considered individually and refined iteratively.

[4] The USACE Hydrologic Engineering Center (HEC) developed the software that is now the standard for USACE reservoir operations modeling. ResSim Version 3.2 was used for analyses documented in the draft EIS and a new version (3.3) was used in the final EIS.

Revised Guide Curves and Action Zones

USACE considered redefining guide curves and action zones at USACE projects in the ACF Basin. A guide curve is the seasonally variable desired pool elevation in a reservoir, and is normally defined as the elevation at the top of the conservation storage. Action zones are partitions of a reservoir's conservation storage, as defined in the reservoir water control plan, to guide reservoir managers in meeting project purposes under a wide variety of hydrologic conditions. In the 1989 draft ACF WCM, four action zones were first defined for Lake Lanier, West Point Lake, and Walter F. George Lake storage projects in the ACF Basin. The action zones were originally developed by USACE based on past experience in water management, considering the time of year, the relationship of historic pool levels and water releases, operational limits for conservation storage, and recreational impact levels. Each of the four action zones has a set of specific operational rules or guidelines that govern water management operations for the reservoir when the pool elevation lies within that zone. The following specific guide curve/action zone measures were considered: maintain existing guide curves; modify guide curves at West Point Lake and Walter F. George Lake; and modify action zones at Lake Lanier, West Point Lake, and Walter F. George Lake.

Drought Operations

Under current drought operations, a minimum release from Jim Woodruff Dam is specified and the other minimum release and maximum fall rate provisions of the May 2012 RIOP are temporarily suspended until composite conservation storage within the basin is replenished to a level that can support them. *Composite conservation storage* equals the cumulative daily conservation storage values by action zone for the ACF Basin reservoirs (Lake Lanier, West Point Lake, and Walter F. George Lake). Composite conservation storage and the associated zones are discussed in more detail in sections 2 and 4 of the EIS. Under the current drought plan, the minimum discharge is determined in relation to composite conservation storage. The drought plan is *triggered* when composite conservation storage falls below the bottom of Zone 3 into Zone 4. At that time, all the composite conservation storage zones 1–3 provisions are suspended and management decisions are based on the provisions of the drought plan. While composite conservation storage is in Zone 4, the minimum release from Jim Woodruff Lock and Dam is 5,000 cfs and any BI above 5,000 cfs can be stored. Below composite conservation storage Zone 4 is the Drought Zone (roughly equivalent to the inactive storage in Lake Lanier, West Point Lake, and Walter F. George Lake plus Zone 4 storage in Lake Lanier). When composite conservation storage falls into the Drought Zone, the minimum release from Jim Woodruff Dam is 4,500 cfs and any BI above 4,500 cfs can be stored. When transitioning from a minimum release of 5,000 to 4,500 cfs, maximum fall rates are limited to 0.25 ft/day. The 4,500 cfs minimum release is maintained until composite conservation storage returns to a level above the top of the Drought Zone, at which time the 5,000 cfs minimum release is reinstated. In accordance with the May 2012 RIOP, the drought plan provisions remain in place until the composite conservation storage reaches a level above the top of Zone 2 (i.e., within Zone 1). At that time, the drought plan provisions are suspended and all other provisions for normal operations are reinstated.

Revised drought operations would incorporate two potential revisions into the drought plan. Under revised operations, the drought plan would be triggered when composite conservation storage falls below the bottom of Zone 2 into Zone 3. The drought plan provisions would remain in place until composite conservation storage reaches a level above the top of Zone 2 (i.e., within Zone 1). If recovery conditions are not achieved in February (after February 1), drought plan provisions will not be suspended until April 1, unless the level of composite conservation storage reaches the top of Zone 1 (i.e., all federal reservoirs are full) before March 1.

Minimum Flows at Peachtree Creek

Three measures have been considered regarding minimum flows at Peachtree Creek: current operations (maintain continuous net minimum flow of 750 cfs for water quality purposes); revised minimum flow

(reduce continuous minimum flow to 650 cfs from November through April); and monthly varying flow (specify a variable minimum flow for each month depending on the reservoir composite conservation storage zone).

Hydropower

Four specific measures were considered for operations of hydroelectric power generation: current schedules at Buford Dam, West Point Dam, and Walter F. George Lock and Dam; modified schedules at Buford Dam, West Point Dam, and Walter F. George Lock and Dam (variable schedule in Zone 1); reduced hydroelectric power under drought operations; and modified schedules with reduced hydroelectric power under drought operations.

Navigation

The lack of dredging and routine maintenance has led to inadequate depths in the Apalachicola River navigation channel, and commercial navigation is possible only seasonally when flows in the river are naturally high, with flow support for navigation suspended during drier times of the year. Specific navigation operations occur on a case-by-case basis, with limited releases for navigation being made for special shipments when a determination can be made that other project purposes will not be significantly affected and any fluctuations in reservoir levels or river stages will be minimal. Measures considered by USACE for navigation included continuing the current operations in support of navigation; periodic navigation based upon the number of opportunities during the year when sufficient flows would be available to provide channel depths of 7 feet (ft) or 9 ft; defined navigation seasons such as December–May, January–April, and January–May; a defined navigation season, which would specify the navigation season as 4 months in duration or, when sufficient water is available, 5 months; and year-round navigation. Use of the waterway under any water management alternative that would improve navigation reliability would likely be shipment-specific and opportunistic, and not subject to traditional navigation benefit estimation techniques.

Fish and Wildlife Conservation

Current operations considered in developing alternatives for the updated Master WCM included lake and river fish spawn standard operating procedures; lockage for fish passage at Jim Woodruff Lock and Dam; and the May 2012 RIOP for federally listed threatened and endangered species.

Other measures that were considered included small pulses or nonhydroelectric power peaking in the Chattahoochee River below Buford Dam and West Point Dam; lockage for fish passage at George W. Andrews Lock and Dam and Walter F. George Lock and Dam similar to that which currently occurs at Jim Woodruff Lock and Dam; a request by USFWS to cycle Walter F. George Lake between the highest levels (190 ft) in late winter/early spring to the lowest levels (185 ft) in late summer to accommodate Eufaula National Wildlife Refuge (NWR) operations; revisions to federally listed threatened and endangered species operations (revised ramping rate [maximum fall rate], revised percent of BI stored, suspend ramping during prolonged low flow, revised seasonal flow targets, pulse flows, monthly flow targets, daily flow targets).

Basin Inflow

BI is currently defined as the amount of water that would flow by Jim Woodruff Dam during a given time period if all of USACE reservoirs maintained a constant water surface elevation during that period. BI is not the natural or unimpaired flow of the basin at the site of Jim Woodruff Dam, because it reflects the influences of reservoir evaporative losses, interbasin water transfers, and consumptive water uses (e.g., M&I water supply and agricultural irrigation). Two alternative methods for computing BI were considered. One alternative method of calculating BI, referred to as *revised basin inflow (RBI) method 1*,

adds depletions to the BI calculation. RBI is not true BI, but it is intended to estimate inflow that would have resulted in the absence of reservoirs and withdrawals for M&I and agricultural water supply demands. A second alternative method of computing BI (*RBI method 2*) would track observed flow in the Apalachicola River at Chattahoochee, Florida, and add considerations of storage change in Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole. Positive storage change represents a net increase in total composite conservation storage, and negative change represents a net decrease.

Water Supply

For analytical purposes, USACE used the following water supply withdrawal assumptions to evaluate and compare the water management alternatives for ACF system operations: currently authorized water supply withdrawals from, and returns to, Lake Lanier (20 mgd water withdrawals under relocation contracts with cities of Buford and Gainesville, with a 50-percent return rate) and releases from Buford Dam in accordance with the CRMS to support current withdrawals by Metro Atlanta water providers (277 mgd) with an 82-percent return rate to the Chattahoochee River.

Water Management Measures Considered and Eliminated from Detailed Evaluation (Second Screening)

The measures identified above were considered for each USACE reservoir in the ACF Basin and the basin as a whole, and a preliminary evaluation was performed. Based on this preliminary evaluation and screening process, a number of the potential measures related to modified guide curves and action zones, hydropower operations, navigation, BI computation, and fish and wildlife conservation were eliminated from detailed evaluation as described in more detail in the EIS.

When commenting on the draft EIS, ACF Stakeholders (ACFS) provided a copy of the ACFS Sustainable Water Management Plan (ACFS SWMP) for consideration. The ACFS is a nonprofit organization whose membership is comprised of a diverse group of cities, counties, industries, businesses, fishermen, farmers, historic/cultural, environmental, conservation, and recreation groups from Alabama, Florida, and Georgia working together to foster equitable water-sharing solutions among stakeholders in the ACF Basin that balance economic, ecological, and social values, while ensuring sustainability for current and future generations. At the time the ACFS SWMP was published, many of the technical details and assumptions associated with the modeling in support of the ACFS SWMP were embargoed as a result of nondisclosure agreements for each of the ACFS members. ACFS comments on the draft EIS did not provide any of those details. Therefore, USACE gleaned all available technical information from the 2015 ACFS SWMP report. As evaluated by USACE, the ACFS SWMP would violate several of the screening criteria for the Master WCM update process. Additionally, due to the lack of technical details and assumptions associated with the modeling in support of the ACFS SWMP, it is impossible to determine if the ACFS SWMP would meet the purpose and need of this EIS, the degree to which authorized project purposes would be met, or whether the USACE responsibilities under the ESA would be met. For these reasons, the ACFS SWMP was not considered any further.

WATER MANAGEMENT MEASURES COMBINED INTO WATER MANAGEMENT ALTERNATIVES

Table ES-2 presents the measures remaining for consideration following the preliminary evaluation and screening process. It also depicts various combinations of the water management measures to establish an array of seven discreet water management alternatives, including no action (representing current water management operations).

Table ES-2.
Summary of Water Management Alternatives

Water Management Measure			Water Management Alternatives						
			1	2	3	4	5	6	7
Guide Curves	Maintain existing guide curve		X	X	X	X	X	X	X
Action Zones	Maintain existing action zones		X						
	Revised Level 1 action zones			X	X	X	X	X	X
Drought Operations	Drought operations trigger[a]		Zone 4	Zone 4	Zone 4		Zone 4	Zone 4	Zone 3
	Drought zone operations		X	X	X	X	X		X
	Drought operations suspension trigger[a]		Zone 1	Zone 1	Zone 1		Zone 1	Zone 3	Zone 1
Peachtree Creek Minimum Flows	Current (750 cfs)		X						
	Seasonal flow 750 cfs/650 cfs			X	X	X	X		X
	Monthly (USFWS) determination by zone							X	
Hydropower Generation	Current generation schedule		X					X	
	Modified generation schedule with drought operations			X	X	X	X		X
Navigation	Current-no navigation operations		X						
	4/5 month			X		X	X	X	X
	Year-round				X				
Basin Inflow	Current computational method		X	X	X			X	X
	Revised Method 1					X			
	Revised Method 2						X		
Fish and Wildlife Conservation	Current fish spawn and passage		X	X	X	X	X	X	X
Listed Species Management	RIOP May 2012		X						
	Ramping Rate	Current ramping rate[b]	X	X	X		X	X	X
		Revised ramping rate				X			
		Suspend during prolonged low flow		X	X		X	X	X
		Suspend in drought		X	X			X	X
	Flow Target	Current (seasonal)[b]	X	X	X				X
		Revised seasonal flow target					X		
		Monthly flow target						X	
		Daily flow target (historic exceedance)				X			
	Pulse flow						X		
Water Supply	Water supply operations: 20 mgd for relocation contracts and 277 mgd downstream withdrawal by Metro Atlanta[c]		X	X	X	X	X	X	X

Notes:

[a.] Based upon composite conservation storage zones (cumulative conservation storage [by zone] for USACE ACF reservoirs [Lanier, West Point, and Walter F. George]).

[b.] Component of the May 2012 RIOP.

[c.] For the purpose of comparing alternatives, currently authorized water supply withdrawals from Lake Lanier and downstream at Atlanta were factored into each water management alternative. Those authorized, currently occurring, annual average amounts are 20 mgd from Lake Lanier and 277 mgd at Atlanta.

ANALYSIS AND COMPARISON OF WATER MANAGEMENT ALTERNATIVES

For the final EIS, modeling in support of the phases 1 and 2 of the alternative formulation and analysis, as described above, was adjusted as follows:

- an updated version of HEC-ResSim was used;
- Georgia's revised and reduced 2015 water supply request was modeled;
- Glades and Bear Creek reservoirs were deleted from the model network in response to public comments and new information (Bear Creek Reservoir was proposed near the Chattahoochee River in south Fulton County downstream from Metro Atlanta with a pending DA permit application under Section 404 of the Clean Water Act at the time of the draft EIS. The permit application was withdrawn in September 2015); and
- an updated elevation-storage-area relationship for Buford reservoir which reflects the most recent survey of the reservoir pool was used.

IDENTIFICATION OF PROPOSED WATER MANAGEMENT ALTERNATIVE

To assist in identifying the water management alternative that best satisfied the objectives for the Master WCM update, USACE developed a process for ranking the performance of the alternatives based on HEC-ResSim modeling results. Based on the values of various performance measures, the alternatives were ranked from 1 (best performance) to 7 (worst performance). As shown in Table ES-3, which summarizes the results of the ranking of water management alternatives, the water management alternative that best balances the authorized project purposes is Water Management Alternative 7 and is the Proposed Water Management Alternative.

The ranking process used to evaluate the performance of the water management alternatives considered each project purpose to be equally important and did not employ any unequal *weighting* of project purposes. The ACF Basin projects must be operated to meet all project purposes under a wide range of hydrological conditions, and the relative importance of the purposes could vary somewhat as conditions vary. In lieu of weighting project purposes in the evaluation process, USACE formulated an array of water management alternatives that emphasized operation for one or more project purposes with a lesser emphasis (or lower priority) on others.

Table ES-3.
Composite Ranking of Water Management Alternatives

	Composite ranking						
Water Management Alternative	**Navigation**	**Hydropower**	**Recreation**	**Fish & Wildlife**	**Water Supply**	**Sum of Rankings**	**Composite Ranking**
Alternative 1	**5**	**1**	**1**	**5**	**3**	**15**	**3**
Alternative 2	**1**	**5**	**3**	**2**	**2**	**13**	**2**
Alternative 3	**1**	**6**	**5**	**7**	**5**	**24**	**6**
Alternative 4	**6**	**7**	**6**	**4**	**6**	**29**	**7**
Alternative 5	**7**	**2**	**3**	**6**	**3**	**21**	**5**
Alternative 6	**1**	**4**	**7**	**1**	**7**	**20**	**4**
Alternative 7	**1**	**1**	**2**	**3**	**1**	**8**	**1**

DEVELOPMENT AND DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

In the first phase of the plan formulation process for the Master WCM update, water management measures were developed, screened, and subsequently combined into water management alternatives. These water management alternatives were evaluated and ranked based on performance metrics aligned with the ACF project purposes. As a result, Water Management Alternative 7 was identified as the Proposed Water Management Alternative. The second phase of alternative formulation developed and screened water supply options to address the current and future water supply demand, up to and including the Georgia 2015 request for water supply from Lake Lanier and for withdrawers in Metro Atlanta downstream of Buford Dam. This process identified an array of water supply options that were combined with either Water Management Alternative 1 or Water Management Alternative 7 (the Proposed Water Management Alternative) to form combined ACF water management/water supply alternatives (Metro Atlanta) for detailed evaluation and impact analysis.

USACE developed the following objectives for the WSSA to address the identified water supply issues:

- Improve system operation to provide for Georgia's current and 2050 water supply demand downstream of Buford Dam.
- Determine whether, and in what amount, to reallocate storage in Lake Lanier to support additional environmentally sustainable withdrawals for M&I water supply while ensuring sufficient water is available to meet other ACF authorized project purposes.

Potential water supply measures that did not pass the previously described screening criteria or that recommended addressing other water supply needs not included in Georgia's 2015 request were eliminated and not carried forward for further consideration.

Based on the June 2011 11th Circuit Court of Appeals ruling and USACE legal opinion of June 25, 2012, USACE has conducted a WSSA for a potential storage reallocation to accommodate current levels of withdrawal for water supply from Lake Lanier as well as increased levels of withdrawals from the lake as specified in Georgia's 2015 request. As discussed in the draft EIS, the Board of Commissioners, Hall County, Georgia, had applied for a Department of the Army permit for work regulated under section 404 of the Clean Water Act (CWA) for a proposed water supply reservoir project (Glades Reservoir) in Hall County to operate as part of a public water supply system. Even though the DA permit process for the proposed project had not been completed, Glades Reservoir was considered in the draft EIS together with other water supply measures to address Georgia's 2013 request. GAEPD has since rescinded the certification of need for Glades Reservoir and has stated that Glades will not be constructed and operated for water supply during the 2015 request horizon (2050) because it is no longer needed for this purpose.[5] Subsequently, Hall County withdrew their DA permit application. Accordingly, the information in the final EIS regarding Glades Reservoir is presented for informational purposes only as it relates to alternatives considered in the draft EIS.

The following management measures to address Georgia's 2015 request for M&I water supply from Lake Lanier were developed and screened to determine their viability for detailed consideration: conservation and water use efficiency programs (including potable water reuse), groundwater supplies, desalination and pumping to service areas, new nonfederal reservoirs, existing surface water sources (other than Lake Lanier), reallocation of Lake Lanier flood risk management storage, reallocation from inactive storage in Lake Lanier, the proposed Glades Reservoir, reallocation of Lake Lanier conservation storage (with and without Glades Reservoir), and conservation.

[5] GAEPD letter dated January 29, 2016, page 10 of 31(see ACF238 in appendix C) and exhibit H thereto.

Because Hall County has withdrawn their DA permit application, Glades Reservoir is no longer reasonably foreseeable and, therefore, was not considered in the final EIS as a potential measure for satisfying a portion of Georgia's 2015 water supply request. For comparative purposes only, however, the PAA from the draft EIS, which assumed that Glades Reservoir would provide a portion of Georgia's 2040 need for water supply, has been retained in the final EIS. Reallocation of Lake Lanier conservation storage was determined to be the most viable and cost-effective measure to meet the water supply need identified by Georgia. The other potential measures were not pursued further because they (1) would not satisfy the identified need for water supply, (2) would not be cost effective, and/or (3) would involve other more significant consequences.

Responding to Georgia's request involved considering not only the quantity of water requested but also the rates at which treated wastewater would be returned to Lake Lanier and downstream of Buford Dam. The current return rate of water withdrawn from Lake Lanier is 29 percent. The overall return rate assumed in Georgia's 2015 request was 43 percent based on additional information provided by the Metropolitan North Georgia Water Planning District.

The withdrawal values and return rate assumptions for the different water supply options considered for detailed analysis are shown in Table ES-4 and described more fully in the EIS. Options A–H were considered in the draft EIS. Some of those water supply options, however, are no longer valid in accordance with Georgia's 2015 request. As a result, water supply options B–G, highlighted in Table ES-4, have been eliminated from further discussion in the final EIS. Option A, which represents a continuation of withdrawals from Lake Lanier that are currently occurring without water storage agreements, has been retained. Option H has been retained only for comparison with other water supply options considered in the final EIS. New water supply options I–M have been added to represent differing amounts of water supply potentially coming from Lake Lanier. Option J (future without project condition) represents the condition expected to exist in the future in the absence of a reallocation of storage in Lake Lanier. The alternatives described in this section combine either Water Management Alternative 1 or the Proposed Water Management Alternative (Water Management Alternative 7) with water supply options A, B, H, I, J, K, L, or M, as shown in Table ES-4. The combined water management/water supply alternatives are identified by the number of the water management alternative followed by the letter designating the water supply option included therein.

Table ES-4.
Water Supply Options Considered

Water Supply Option [a]	Lake Lanier Relocation (mgd)	Lake Lanier Withdrawal (mgd)	Lake Lanier total Withdrawals (mgd)	Lake Lanier Returns (mgd/% returned)	Glades Reservoir Withdrawals (mgd)	Glades Reservoir Returns (mgd/% returned)	Net Withdrawal from Lake Lanier and Glades Reservoir (mgd)	Storage Required to Support Reallocation (ac-ft)	River Withdrawals (mgd)	River Returns (mgd/% returned)
A – No action	20	108	128	37/29%	0	0	91	123,057	277	227/82%
B – Relocation only	20	0	20	10/50%	0	0	10	n/a	277	227/82%
C – Future without project condition (w/ Glades pumping)	20	0	20	10/50%	40	20/50%	30	n/a	408	335/82%
D – GA 2013 request	20	277	297	163*/55%	0	0	134	318,126	408	384/94%
E – GA 2013 request w/ Glades pumping	20	237	257	141/55%	40	22/55%	134	272,187	408	384/94%
F – GA 2013, projected return volume for 2035	20	277	297	91/30.6%	0	0	206	318,126	408	335/82%
G – GA 2013 max treatment facility capacity	20	277	297	128/43%	0	0	169	_ [b]	408	477/117%
H – Projected return volume for 2035 w/ Glades pumping	20	165	185	75/40.4%	40	16/40.4%	134	188,003	408	384/94%
I – 225-mgd lake withdrawal, GA 2015 request downstream	20	205	225	91/40.4%	0	0	134	233,580	379	361/95%
J – Future without project condition—revised	20	0	20	10/50%	0	0	10	n/a	379	361/95%

Water Supply Option [a]	Lake Lanier Relocation (mgd)	Lake Lanier Withdrawal (mgd)	Lake Lanier total Withdrawals (mgd)	Lake Lanier Returns (mgd/% returned)	Glades Reservoir Withdrawals (mgd)	Glades Reservoir Returns (mgd/% returned)	Net Withdrawal from Lake Lanier and Glades Reservoir (mgd)	Storage Required to Support Reallocation (ac-ft)	River Withdrawals (mgd)	River Returns (mgd/% returned)
K – GA 2015 Request	20	222	242	104/43%	0	0	137.4	254,170	379	361/95%
L – Current lake withdrawals, GA 2015 request downstream	20	108	128	37/29%	0	0	91	123.057	379	361/95%
M – Option H for Lanier w/o Glades, GA 2015 request downstream	20	165	185	40.4%	0	0	110.3	188.003	379	361/95%

Notes:

[a.] Water supply options shaded gray have not been considered in the final EIS.

[b.] Storage for this water supply option was not computed because the option was not carried forward for further consideration, as explained in section 5.1.4.1.1.

Table ES-5 shows the combination of water management plans and water supply options considered as alternatives.

Alternative (Alt) 1A (Alt1A)—the No Action Alternative (NAA), Alt1L, Alt7A, Alt7B, Alt7J and Alt7L would meet neither or only one of the two water supply objectives identified above. Thus, none of those alternatives were selected as the PAA. Alt7H, which is based on Georgia's 2013 request, is presented for comparison purposes only and was not selected as the PAA in the final EIS. Alt7I and Alt7M would meet the water management objective but only a portion of the water supply objectives.

Alt7K would satisfy the water management objectives and both of the water supply objectives. Compared to the NAA, the PAA results in some slightly adverse to adverse effects to lake levels and land use at Lake Lanier and Walter F. George Lake, and slightly beneficial effects on lake levels at West Point Lake. Effects on flow conditions below Buford Dam would be slightly beneficial and below Morgan Falls Dam and below Walter F. George Dam the effects would be slightly adverse. Some water quality parameters would have slightly adverse to substantially adverse effects. More conservative *drought operations*, including additional operational restrictions, would occur more frequently under the PAA; however, those operations would likely prevent more severe drought conditions from occurring than under the NAA. Effects on navigation are substantially beneficial. The impacts to hydroelectric power generation would be negligible by the PAA. Recreation would experience slightly adverse effects at Lake Lanier and Walter F. George Lake and slightly beneficial effects at West Point Lake. These effects of the PAA are similar to the effects of Alt7I and Alt7M both of which would provide less water supply and yet have the same effects as the PAA. The PAA has the least overall adverse effects on lake levels, stream flow conditions, water quality, and other natural resource and socioeconomic resource considerations of all the alternatives that fully or partially met both the water management and water supply objectives. Alt7K was selected as the PAA. USACE found that the PAA would have the following notable affects compared to the NAA:

- Varying degrees of changes to authorized project purposes and project operations:
  - Substantially net beneficial changes compared to the NAA to municipal and industrial water supply with no change to agricultural water supply or water supply intake structure operations ($54,315,000 average annual benefits for reallocation of storage in Lake Lanier).
  - Substantially net beneficial changes compared to the NAA to navigation conditions in the Apalachicola River (provides 7-ft channel 42.5 percent of the time during January-May over the 73-year period of record).
  - Negligible/no changes overall compared to the NAA to recreation (reduction in average annual benefits of $202,900 (-0.15%). Changes to the visitation varies from project to project within the ACF system.
  - Negligible/no changes compared to the NAA to hydropower (reduction in average annual benefits of $915,000 (-0.52 percent)).
  - Negligible/no changes to flood risk management effectiveness within the ACF system.
  - Varying changes to lake levels with adverse changes compared to the NAA occurring at Walter F. George Lake.
  - Varying changes to flow conditions downstream of Buford Dam with slightly adverse changes compared to the NAA occurring at Morgan Falls Dam (a non-federal project) to Peachtree Creek and Walter F. George Lock and Dam to Jim Woodruff Lock and Dam.
- Drought operations under the PAA would have a slightly beneficial overall effect from a system operations perspective compared to the NAA. The PAA would take a more proactive approach to conserving reservoir storage as drier conditions develop in the basin than continued operations under the NAA, while continuing to meet downstream commitments and needs.

- Varying degrees of adverse changes to water quality parameters.
  - Slightly adverse changes compared to the NAA in dissolved oxygen with a decrease by nearly 0.5 mg/L in the reach from Atlanta to West Point Lake and by 0.1 mg/L in Lake Lanier.
  - Substantially adverse changes compared to the NAA in total phosphorus with an increase by 0.01 mg/L from Buford Dam to Atlanta and in West Point Lake. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the total phosphorus and nitrogen loads in the river. Under limited circumstances, the wastewater return loads would result in substantial adverse changes compared to the NAA to water quality. Water quality standards violations may similarly be expected in the headwaters of both West Point and Walter F. George lakes. Any modifications to Georgia wastewater return loads would be subject to appropriate requirements under the State of Georgia's National Pollutant Discharge Elimination System permitting procedures.
  - Adverse changes compared to the NAA in total nitrogen with an increase by as much as 0.82 mg/L from Atlanta to West Point Lake.
  - Negligible/no changes compared to the NAA would be expected to water temperature or chlorophyll *a*.
- Varying degrees of adverse changes to fish and wildlife conservation. Substantially adverse changes are a result of the indirect impacts to water quality.
  - Substantially adverse changes compared to the NAA to riverine fish and aquatic resources due to adverse water quality impacts from Atlanta into West Point Lake.
  - Negligible/no changes compared to the NAA would be expected to vegetation, wildlife, reservoir fish and aquatic resources, and estuarine species or to fish hatcheries and the Eufaula National Wildlife Refuge.
  - Negligible/no changes compared to the NAA would be expected to oyster industry in Apalachicola Bay.
  - Varying degrees of changes to protected species. In accordance with ESA section 7, the USFWS issued a Biological Opinion dated September 14, 2016, determining that the PAA would not jeopardize the continued existence of any federally listed species or adversely modify designated critical habitat:
    - Slightly adverse changes compared to the NAA would be expected to Gulf Sturgeon.
    - A mix of slightly beneficial to adverse changes compared to the NAA would be expected on various USFWS defined metrics for assessing impacts to mussels. Slightly beneficial changes would occur in the median number of days per year with flows less than 10,000 cfs, median number of consecutive days per year with flows less than 10,000 cfs, and maximum number of consecutive days per year with flows between 5,000 cfs and 10,000 cfs. Adverse changes would occur in the frequency of daily stage changes (a 5 percent increase from the NAA) and frequency of daily stage changes when releases at Woodruff Dam are < 10,000 cfs (a 10 percent higher than the NAA).
    - Beneficial changes to shoal bass recruitment with an increased age-3 abundance from 5.6 under the NAA to 9.0 in the PAA.

Table ES-5.
Summary of Considered Alternatives (Water Management / Water Supply)

Water Management Measures			Water Management / Water Supply Alternatives									
			Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Guide Curves	Maintain existing guide curve		X	X	X	X	X	X	X	X	X	X
Action Zones	Maintain existing action zones		X	X								
	Revised Level 1 action zones				X	X	X	X	X	X	X	X
Drought Operations	Drought operations trigger[a]		Zone 4	Zone 4	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3
	Drought zone operations		X	X	X	X	X	X	X	X	X	X
	Drought operations suspension trigger[a]		Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1
Peachtree Creek Minimum Flows	Current (750 cfs)		X	X								
	Seasonal flow (750 cfs / 650 cfs)				X	X	X	X	X	X	X	X
Hydropower Generation	Current generation schedule		X	X								
	Modified generation schedule with drought operations				X	X	X	X	X	X	X	X
Navigation	Current-no navigation operations		X	X								
	4/5 month				X	X	X	X	X	X	X	X
Basin Inflow	Current computational method		X	X	X	X	X	X	X	X	X	X
Fish and Wildlife Conservation	Current fish spawn and passage		X	X	X	X	X	X	X	X	X	X
Listed Species Management	RIOP May 2012		X	X								
	Ramping Rate	Current rate[b]	X	X	X	X	X	X	X	X	X	X
		Suspend during prolonged low flow		X	X	X	X	X	X	X	X	X
		Suspend in drought[a]	X	X	X	X	X	X	X	X	X	X
	Current (seasonal) minimum flow provision[b]		X	X	X	X	X	X	X	X	X	X

Water Management Measures		Water Management / Water Supply Alternatives									
		Alt1A (NAA)	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**Alt7K (PAA)**	**Alt7L**	**Alt7M**
Water Supply Options (EIS Table 5.1-1)[c]	A – No action	L=128 D=277		L=128 D=277							
	B – Relocation contracts only (in Lake Lanier)				L=20 D=277						
	H – GA 2013 (projected return volume for 2035 w/ Glades Reservoir pumping)					L=185 G=40 D=408					
	I – 225-mgd lake withdrawal, GA 2015 request downstream						L=225 D=379				
	J – Future without project condition							L=20 D=379			
	K – GA 2015 request								L=242 D=379		
	L – Current lake withdrawals, GA 2015 request downstream		L=128 D=379							L=128 D=379	
	M – Option H for Lanier w/o Glades, GA 2015 request downstream										L=185 D=379

Notes:

[a.] Based upon composite conservation storage zones (cumulative conservation storage [by zone] for USACE ACF reservoirs [Lanier, West Point, and Walter F. George]).

[b.] Component of the May 2012 RIOP.

[c.] Numbers indicate withdrawals in mgd from Lake Lanier (L), Glades Reservoir (G), and the Chattahoochee River downstream (D) of Buford Dam.

ENVIRONMENTAL CONSEQUENCES

The final EIS evaluates the environmental and socioeconomic effects of the alternatives, potential for cumulative effects, and potential mitigation measures and their potential impacts. Seven resource areas are evaluated. For purposes of evaluating alternative operational plans for the Master WCM update, a 73-yr hydrologic period of record (1939–2011) was used to run simulations using the HEC-ResSim model.

The water quality effects associated with the alternatives in the ACF Basin were analyzed with the HEC-5Q model developed by the USACE Hydrologic Engineering Center (HEC). For the simulation of water quality conditions under the various alternatives, HEC-5Q inputs included in-stream flows, tributary flows and water quality data, withdrawals, reservoir operations, and other point and nonpoint source flows and quality loads to the system. The HEC-5Q model was linked with the HEC-ResSim model. The NAA and nine alternatives—Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, Alt7K (the PAA), Alt7L, and Alt7M—were simulated in HEC-ResSim and HEC-5Q. Table ES-6 and the following sections summarize the principal conclusions drawn from the analyses. The following terms characterize or define the various levels of impact presented in the impact matrix:

- Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
- Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.
- Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.
- Adverse—Any adverse impact is clearly detectable and would have an appreciable effect.
- Beneficial—Any beneficial impact is clearly detectable and would have an appreciable effect.
- Substantially adverse—Any adverse impact would result in a highly noticeable effect.
- Substantially beneficial—Any beneficial impact would result in a highly noticeable effect.

The general assessment of environmental consequences in the impact matrix for each natural and socioeconomic resource area is supported in the EIS with more detailed information and analysis, both qualitative and quantitative. While Table ES-6 presents a qualitative assessment for all the alternatives with respect to all the natural, socioeconomic, and cultural resource areas, the subsequent paragraphs highlight key environmental consequences for the PAA compared to the NAA.

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

Table ES-6.
Summary of Effects

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Water Quantity										
Lake levels										
Lake Lanier	Baseline	Slightly adverse	Slightly beneficial	Beneficial	Slightly adverse	Slightly adverse	Beneficial	Slightly adverse	Slightly beneficial	Slightly adverse
West Point Lake	Baseline	Slightly beneficial	Slightly beneficial	Beneficial	Slightly beneficial	Slightly beneficial	Beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lake	Baseline	Negligible/No change	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Lake George W. Andrews	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Nonfederal Reservoirs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Flow conditions downstream of Buford Dam										
Buford Dam to Bull Sluice Lake (Morgan Falls Dam)	Baseline	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Morgan Falls Dam to Peachtree Creek	Baseline	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Peachtree Creek to West Point Lake	Baseline	Slightly beneficial	Slightly adverse	Slightly beneficial	Negligible/No change	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change	Negligible/No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lock and Dam to Jim Woodruff Lock and Dam	Baseline	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Drought operations										
ACF Basin	Baseline	Slightly adverse	Beneficial	Beneficial	Slightly beneficial	Slightly beneficial	Beneficial	Slightly beneficial	Beneficial	Beneficial

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Navigation flow targets/channel availability										
7.0-feet (ft)	Baseline	Negligible/No change	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial
9.0-ft	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Water supply intake structure operation										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Buford Dam to West Point Dam	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Elsewhere in the ACF Basin	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Water Quality										
Water temperature										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Buford Dam to Atlanta	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Atlanta to West Point Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
West Point Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Dissolved oxygen										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Slightly beneficial	Slightly adverse	Negligible/No change	Slightly beneficial	Slightly adverse	Negligible/No change	Negligible/No change
Buford Dam to Atlanta	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Atlanta to West Point Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
West Point Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Total phosphorus										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Buford Dam to Atlanta	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change
Atlanta to West Point Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse
West Point Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse
West Point Dam to Walter F. George Lake	Baseline	Substantially adverse	Negligible/No change	Negligible/No change	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse
Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Total nitrogen										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Negligible/No change	Slightly adverse
Buford Dam to Atlanta	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse
Atlanta to West Point Lake	Baseline	Adverse	Negligible/No change	Negligible/No change	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
West Point Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Adverse	Slightly adverse	Slightly adverse	Adverse	Slightly adverse	Slightly adverse
West Point Dam to Walter F. George Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Walter F. George Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Negligible/No change	Slightly adverse	Negligible/No change	Slightly adverse
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Chlorophyll a										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Buford Dam to Atlanta	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Atlanta to West Point Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
West Point Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Geology and Soils										
Lake Lanier	Baseline	Negligible/ No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
West Point Lake	Baseline	Negligible/ No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lake	Baseline	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Lake George W. Andrews	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Nonfederal Reservoirs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Land Use										
Buford Dam/Lake Lanier	Baseline	Slightly adverse	Slightly beneficial	Beneficial	Slightly adverse	Slightly adverse	Beneficial	Slightly adverse	Slightly beneficial	Slightly adverse
West Point Dam and Lake	Baseline	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lock and Dam and Lake	Baseline	Negligible/No change	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
George W. Andrews Lock and Dam/ Lake George W. Andrews	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Jim Woodruff Lock and Dam/ Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Nonfederal Reservoirs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Biological Resources										
Vegetation and wildlife resources										
Chattahoochee River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Flint River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Riverine fish and aquatic resources										
Buford Dam to Atlanta	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Atlanta to West Point Lake	Baseline	Slightly adverse	Negligible/No change	Slightly adverse	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse	Adverse	Substantially adverse
West Point Dam to Walter F. George Lake	Baseline	Substantially adverse	Negligible/No change	Negligible/No change	Slightly adverse	Slightly adverse	Substantially adverse	Substantially adverse	Substantially adverse	Substantially adverse
Walter F. George Lock and Dam to Lake Seminole	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Slightly adverse	Negligible/No change	Slightly adverse
Apalachicola River	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Reservoir fish and aquatic resources										
Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Slightly beneficial	Slightly beneficial
West Point Lake	Baseline	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change
Walter F. George Lake	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake George W. Andrews	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lake Seminole	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Nonfederal reservoirs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Estuarine fish and aquatic resources										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Protected Species—Gulf sturgeon										
Change in median annual Gulf sturgeon spawning habitat from that available under the NAA (18.17 ac)	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Frequency (% of days) of Gulf sturgeon spawning habitat availability (ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft) on each day Mar 1–May 31 at the two sites that support spawning	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Frequency (% of yrs) of Gulf sturgeon spawning habitat availability (max ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft for at least 30 consecutive days each yr) Mar 1–May 31 at the two sites that support spawning	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Daily fall rates with respect to exposure of Gulf sturgeon eggs and larvae	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Max # of consecutive days per yr < 16,000 cfs	Baseline	Negligible/No change	Negligible/No change	Slightly beneficial	Negligible/No change	Slightly beneficial	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change
Departures from average water temperatures Mar 1–May 31	Baseline	Negligible/No change	Negligible/No change	Slightly adverse	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Protected Species—Mussels										
Interannual frequency (% of yrs) of flow rates < 5,000–10,000 cfs	Baseline	Negligible/No change	Slightly adverse	Negligible/No change	Slightly adverse	Slightly adverse	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse
Median # of days/yr with flows < 10,000 cfs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Slightly beneficial	Slightly beneficial	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change
Median # of consecutive days/yr with flows < 10,000 cfs	Baseline	Negligible/No change	Negligible/No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Maximum # of days/yr flows are < 5,000–10,000 cfs	Baseline	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Slightly beneficial	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

Negligible/No change - Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change. **Slightly adverse -** Any adverse impact is perceptible and measurable, but would not have an appreciable effect. **Slightly beneficial -** Any beneficial impact is perceptible and measurable, but would not have an appreciable effect. **Adverse -** Any adverse impact is clearly detectable and would have an appreciable effect. **Beneficial -** Any beneficial impact is clearly detectable and would have an appreciable effect. **Substantially adverse -** Any adverse impact would result in a highly noticeable effect. **Substantially beneficial -** Any beneficial impact would result in a highly noticeable effect.

	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Maximum # of consecutive days/yr flows are < 5,000–10,000 cfs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Lowest daily flow/yr	Baseline	Negligible/No change	Slightly adverse	Negligible/No change	Slightly adverse	Slightly adverse	Negligible/No change	Slightly adverse	Slightly adverse	Slightly adverse
Frequency (# of days) of daily stage changes (ft/day)	Baseline	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Frequency (% of days) of daily stage changes (ft/day) when releases at Woodruff Dam are < 10,000 cfs	Baseline	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Median fall rates when discharge < 10,000 cfs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Maximum fall rates when discharge < 10,000 cfs	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Shoal bass recruitment										
	Baseline	Slightly beneficial	Beneficial	Beneficial	Beneficial	Substantially beneficial	Beneficial	Beneficial	Substantially beneficial	Beneficial
Eufaula National Wildlife Refuge										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Fish hatcheries										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Socioeconomic Resources										
Municipal and industrial water supply										
From Lake Lanier	Baseline	Negligible/No change	Negligible/No change	Substantially adverse	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial
From Metro Atlanta, downstream of Buford Dam	Baseline	Substantially beneficial	Negligible/No change	Negligible/No change	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial
Navigation Channel										
7-ft	Baseline	Negligible/No change	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial	Substantially beneficial
9-ft	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

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	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Hydroelectric power generation										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Agricultural water supply										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Oyster Industry in Apalachicola Bay										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Flood risk management										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Recreation										
Lake Lanier	Baseline	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly adverse
West Point Lake	Baseline	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lake	Baseline	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Riverine Recreation in the Chattahoochee River National Recreation Area										
Buford Dam to Bull Sluice Lake (Buford Dam gage)	Baseline	Negligible/No change	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Morgan Falls Dam to Peachtree Creek (Atlanta gage)	Baseline	Negligible/No change	Negligible/No change	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Environmental justice										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Protection of children										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

Legend

Substantially Adverse	Adverse	Slightly Adverse	Negligible/No Change	Slightly Beneficial	Beneficial	Substantially Beneficial

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	Alt1A (NAA)	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K (PAA)	Alt7L	Alt7M
Aesthetic Resources										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Cultural Resources										
	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Other Resource Areas										
Air quality	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Noise	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Traffic and transportation (nonnavigation)	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change
Hazardous, toxic, and radioactive waste (HTRW)	Baseline	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change	Negligible/No change

[1] Assessment based on reservoir fisheries metric for spawning habitat.

[2] Source: USFWS letter dated July 19, 2013, figures 1, 2, and 3

Notes:

Impacts descriptions in the Alternatives Impacts Comparison Matrix are drawn from evaluations of the post processing outcomes the no action simulation. The no action simulation is the NEPA baseline.

Water Quantity, Lake Level Conditions for George W. Andrews Lake, Lake Seminole and non-USACE lakes exhibit Negligible/No change because they are 'run of river' reservoirs that are not affected by changes in storage.

Stream flow conditions: The matrix analysis focused strictly on quantities of flow, and did not address any implications of reduced or increased flow conditions. The implications of reduced or increased flow conditions are addressed elsewhere in the matrix.

Land Use: The loss of water supply is acknowledged to have some effect on land use. However, whether effects are beneficial or adverse cannot be determined due to the lack of quantitative data.

Biological Resources, Terrestrial Community, Vegetation: Effects were assessed by reviewing changes in floodplain inundation and potential effects on the vegetative community.

Biological Resources, Fish and Aquatic Resources: River flows in April and May were assessed because increased river flows during the spawning period are assumed to be beneficial to the majority of riverine species.

Biological Resources, Fish and Aquatic Resources: This evaluation is drawn from the USFWS metric described in the Planning Aid Letter.

*Protected Species, Mussels: Represent an estimate of the area underneath the U.S. FWS performance curve(s). The area underneath the curve(s) represents a measure of the affect of a specific flow dependent variable on mussels.

Conclusions in this matrix are based upon the best information available at the time of the matrix's preparation and are subject to change if new information becomes available.

The PAA would be implemented in full compliance with a wide range of relevant federal environmental laws, regulations, and executive orders. NEPA compliance will be attained upon completion of the state and agency review of the final EIS and approval of the Record of Decision. The final Fish and Wildlife Coordination Act Report was transmitted to USACE on September 14, 2016 by the USFWS, and USACE has considered and addressed USFWS recommendations in the final EIS. The USFWS issued a final Biological Opinion on September 14, 2016 to complete Endangered Species Act section 7 consultation with USACE for the PAA. USACE submitted a revised determination of federal consistency with the Florida Coastal Management Program for the PAA to the Florida Department of Environmental Protection (DEP) on September 16, 2016. The USACE consistency determination was provided to Florida over 90 days prior to the expected agency decision on the ACF WCM update and EIS. Compliance with these and other relevant environmental requirements is documented in section 6 of the EIS.

Water Quantity

The change in lake levels, flow conditions downstream of USACE reservoirs, drought operations, navigation flow targets, and water supply intake structures depend mainly on the BIs, hydrologic conditions, system operations, and water supply options incorporated for the different alternatives.

Lake levels and conservation storage. Under the PAA, conditions are expected to be slightly adverse at Lake Lanier, slightly beneficial at West Point Lake, and adverse at Walter F. George Lake compared to the NAA. Water surface elevations at all three of those reservoirs would be affected by changes in water management measures in the PAA compared to the NAA, including changes to reservoir action zones, drought operations, and, to a lesser extent, seasonal minimum flows at Peachtree Creek and releases for navigation when sufficient water is available in the system. Lake Lanier water surface elevations and conservation storage values are expected to experience a slightly adverse effect as a result of increased water supply withdrawals and consumptive use, but little adverse effect would be noted in West Point Lake and Walter F. George Lake as a result of projected future use of water in Metro Atlanta under the PAA. No appreciable changes would be expected at Lake George W. Andrews, Lake Seminole, or the nonfederal reservoirs in the basin compared to the NAA.

Flow conditions downstream of USACE reservoirs. Slightly beneficial changes in flow conditions in the Chattahoochee River from Buford Dam to Bull Sluice Lake (Morgan Falls Dam) would be expected under the PAA compared to the NAA. Slightly adverse (reduced) flow conditions would be expected to occur between Morgan Falls Dam and the confluence with Peachtree Creek under the PAA. Changes from Buford Dam to Peachtree Creek would be influenced by revised water management measures under the PAA, including seasonal minimum flows at Peachtree Creek, provision of releases to support navigation, and drought operations. In addition, increased releases from Buford Dam needed to support future downstream water supply withdrawals for Metro Atlanta and the points of water supply withdrawals and returns of treated wastewater also would influence the changes. Compared to the NAA, the PAA would result in no appreciable change in flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake and from West Point Dam downstream to Walter F. George Lake. Slightly adverse changes in flow conditions would be expected in the Chattahoochee River between Walter F. George Lock and Dam and Jim Woodruff Lock and Dam. Those changes would principally result from revised water management measures in the PAA, including provision of seasonal releases to support navigation, and drought operations. The PAA would have no appreciable effect on flow conditions downstream of Jim Woodruff Lock and Dam or on freshwater inflows into Apalachicola Bay compared to the NAA.

Drought operations and management. Generally, the PAA would take a more proactive approach to conserving reservoir storage as drier conditions develop in the basin than continued operations under the NAA, while continuing to meet downstream commitments and needs. Thus, drought operations under the PAA would have a slightly beneficial overall effect from a system operations perspective. The revised drought plan could trigger slightly constrained operations more frequently and over slightly longer periods, and the extent of those operations would gradually increase only as worsening drought conditions might dictate over time. The revised drought operations plan in the PAA would enable USACE to operate the USACE reservoir projects more effectively in response to drought conditions similar to those experienced several times over the modeled period of record and better position USACE to address a more severe drought of record in the future.

Navigation flow targets. The PAA would provide a substantially beneficial improvement in the provision of sufficient navigation target flows and in the availability of a reliable 7-ft navigation channel depth in the Apalachicola River for a January–May navigation season as long as sufficient water is available in the system. The management measure to provide navigation flows under the PAA would capitalize on a time of the year when flows are naturally higher and augment those flow conditions only as necessary during that period to ensure that adequate navigation depths would be available. The PAA would essentially double the percent of time that channel depths would be available in a January–May navigation season and the number of navigation seasons over the period of record that 7-ft depths would be fully available compared to the NAA, without appreciably depleting conservation storage in the system. Improvements in the availability of a 9-ft navigation channel depth under the PAA compared to the NAA would be minimal. The releases that would be necessary to sustain 9-ft navigation depths in the Apalachicola River from January through May each year to an extent that would benefit navigation interests would be impossible without substantial adverse effects on reservoir conservation storage and overall system operations.

Water supply intake structures. Under the PAA, lake levels and stream flow conditions in the mainstem rivers of the ACF Basin would be sufficient to allow for full continued operation of water supply intake structures in the basin. Overall, negligible/no changes would be expected compared to the NAA.

Water Quality

Water temperature. The effects of water temperature are based on the water quality standards set by the states where a substantially beneficial change is defined by a decrease in water temperature by 3.2 degrees Celsius (°C), and a substantially adverse change is defined by an increase in water temperature by 3.2 °C. Subsequent changes would be based on changes to water temperature within the criteria indicative of a reduction in fish growth at 1–2 °C. These changes were assumed to be slightly adverse/beneficial changes. Compared to the NAA, changes under the PAA and the other alternatives would be negligible.

Dissolved oxygen. The effects of dissolved oxygen (DO) are based on the water quality standards set by the states where a substantially beneficial change is defined by meeting the water quality standards when they would not be met under the NAA, and a substantially adverse change is defined by not meeting the standard when it would be met under the NAA. Minimum DO concentrations can be within 4–5 milligrams per liter (mg/L). A 10-percent decrease of this range is considered to have adverse effects as defined in existing EPA work. Based on the measurement error of 0.1 mg/L, a decrease of DO by 0.1–0.5 mg/L was used to define slightly adverse effects and a decrease greater than 0.5 mg/L was set to define an adverse change.

At Lake Lanier, slightly adverse effects would be expected under the PAA as compared to the NAA. From Buford Dam to Peachtree Creek (Atlanta), negligible changes would be expected under the PAA. From Atlanta to West Point Lake, slightly adverse changes would be expected under the PAA. Negligible/no changes would be expected at the remaining sections of the ACF Basin under the PAA.

Phosphorous. The states have established total phosphorus (TP) standards to protect water bodies in the ACF Basin from harmful algal problems. The effects of TP are based on the water quality standards set by the states for the lakes, where a substantially beneficial change is defined by meeting the water quality standard when it would be exceeded under the NAA, and a substantially adverse change is defined by exceeding the standard when it would be met under the NAA. A 10-percent increase in TP concentrations (0.01 mg/L) and a 20-percent increase (0.02 mg/L) define slightly adverse and adverse effects; similar decreases would result in beneficial effects.

At Lake Lanier, negligible/no change would be expected under the PAA. From Buford Dam to Peachtree Creek (Atlanta), slightly adverse changes would be expected under the PAA. From Atlanta to West Point Lake, substantially adverse changes would be expected under the PAA. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the total phosphorus loads in the river, which under limited circumstances could result in substantial adverse changes to water quality. At West Point Lake, slightly adverse changes would be expected under the PAA. From West Point Dam to Walter F. George Lake, substantially adverse changes would be expected under the PAA. Negligible/no changes would be expected at the remaining sections of the ACF Basin under the PAA.

Nitrogen. The effects of total nitrogen are based on the water quality standards set by the states where a substantially beneficial change is defined by meeting the water quality standard when it would be exceeded under the NAA, and a substantially adverse change is defined by exceeding the standard when it would be met under the NAA. Subsequent changes would be based on an increase by 0.5 mg/L from the NAA, which was set as the dividing line between slightly adverse and adverse changes; or a decrease of 0.5 mg/L from the NAA for slightly beneficial or beneficial.

At Lake Lanier, slightly adverse changes would be expected under the PAA. From Buford Dam to Peachtree Creek (Atlanta), slightly adverse changes would be expected under the PAA. From Atlanta into West Point Lake, adverse changes would be expected under the PAA. From West Point Lake to Lake Seminole, slightly adverse changes would be expected under the PAA. At Lake Seminole, negligible/no changes would be expected under the PAA. Negligible/no changes would be expected at Apalachicola River of the ACF Basin for the PAA.

Chlorophyll *a*. The effects of chlorophyll *a* are based on the water quality standards set by the states for the reservoirs, where a substantially beneficial change is defined by meeting the water quality standard when the NAA exceeds the standard and a substantially adverse change is defined by exceeding the standard when it would be met under the NAA. The breakpoint for slightly adverse/beneficial and adverse/beneficial effects was based on best professional judgment. Negligible/no changes would be expected in chlorophyll *a* under the PAA.

Geology and Soils

Tailwater degradation downstream of projects and bank erosion within the river portions above the project pools and downstream of Jim Woodruff Lock and Dam are important channel forming processes in the ACF Basin. Similarly, lake sedimentation is dominated by flood events when the erosive forces throughout the watershed are most severe and the most sediment is delivered to the rivers and lakes. Lake shorelines at all of the ACF projects are expected to continue to erode at the present rate and lake

sedimentation to continue at the present rate. In general, the shoreline erosion trends indicate that the highest rates occurred during the first 20 to 25 years after impoundment and have since slowed. Compared to the NAA, the PAA would have a negligible effect on tailwater degradation and bank erosion downstream of reservoirs in the ACF Basin. The PAA would have a slightly beneficial effect on reservoir shoreline erosion at Lake Lanier and West Point Lake, slightly adverse effect at Walter F George Lake, and a negligible effect at Lake George W. Andrews, Lake Seminole, and nonfederal reservoirs on the Chattahoochee and Flint rivers.

Land Use

An adverse effect on land use is any change in use that would be incompatible with existing or adjacent land uses. Adverse effects on land use around reservoirs could be experienced with lower water surface elevation conditions, which can diminish or impair the shoreline for its intended land use because of exposed shoreline and lake bed. As water surface elevations decline, boat launching ramps, beaches, and shoreline fishing areas can become unusable; navigation hazards can surface; channels to marinas can become impassable; and private boat docks can become unusable. The PAA would be expected to have a slightly adverse or adverse effect on land use at Lake Lanier and Walter F. George Lake due to the increased likelihood that lake levels would be slightly lower at certain times compared to current operations reflected in the NAA. Slightly beneficial effects would be expected at West Point Lake due to a slight improvement in water surface elevations compared to the NAA. Negligible change would be expected at Lake George W. Andrews, Lake Seminole, or nonfederal reservoirs.

Biological Resources

In conjunction with the analysis of potential effects of the Master WCM update and WSSA on biological resources, as summarized herein and presented in more detail in the EIS, USACE has sought the input of USFWS in accordance with the FWCA and the ESA throughout the entire process, beginning as early as 2006. Wherever practicable, USFWS and other natural resource agency input has been considered and incorporated into the alternative plans. These coordination and consultation efforts are documented in the EIS.

Vegetation and wildlife resources. Compared to the NAA, negligible change would be expected to vegetation and wildlife resources along the Chattahoochee, Flint, or Apalachicola rivers under the PAA. Flows along the Chattahoochee River are controlled, and the river downstream of Buford Dam is disconnected from the floodplains, so under all alternatives considered the proposed changes in water management in the ACF Basin would have no incremental effect on terrestrial biological resources. The Flint River is essentially uncontrolled, and negligible change would be expected under the PAA. Although there would be slight variations among the PAA and other alternatives considered in drought conditions in the Apalachicola River and Bay, the magnitude and duration of floodplain inundations along the river and bay would be very similar to those under the NAA.

Riverine fish and aquatic resources. In the Chattahoochee River between Buford Dam and Peachtree Creek (Atlanta), the PAA would likely have a slightly adverse effect on fish and aquatic resources compared to the NAA. A slight decrease in DO and increase in nutrients below the dam would be expected under the PAA. Between Peachtree Creek (Atlanta) and West Point Lake, effects on fish and aquatic resources would be expected to be substantially adverse because of a larger increase in nutrients and decrease in DO than under the NAA. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the total phosphorus and nitrogen loads in the river, which under limited circumstances could result in substantial adverse changes to water quality. As in past years of drought, working closely with states and affected

stakeholders USACE releases may be made to assist with public health and safety throughout the ACF Basin. In the Chattahoochee River downstream of West Point Dam, minor increases in nutrients under the PAA would have slightly adverse effects on fish and aquatic resources. In the Chattahoochee River downstream of Walter F. George Lock and Dam, the PAA would have little to no effect on fish and aquatic resources compared to the NAA. In the Apalachicola River, no appreciable effects on fish and aquatic resources would be expected under the PAA compared to the NAA.

Reservoir fish and aquatic resources. The effects of the PAA on fish and aquatic resources in reservoirs in the ACF Basin compared to the NAA would be negligible.

Estuarine fish and aquatic resources. Compared to the NAA, the PAA would be expected to have a negligible effect on the hydrodynamic and salinity characteristics of the Apalachicola Bay estuary. No effects on fish and aquatic resources in estuaries would be expected under the PAA as compared to the NAA. Because the changes in flow and water quality conditions in the Apalachicola River and Bay between the NAA and the PAA would be negligible, no incremental effects on species for which essential fish habitat has been designated under a fishery management plan would be expected to occur as a result of implementing the PAA.

Protected species. Formal ESA section 7 consultation with USFWS has been conducted and completed for the PAA prior to public review of the final EIS for the Master WCM update. Current operations represented by the NAA have been subjected to ESA section 7 consultation and are in compliance with the ESA. In its Biological Assessment in support of the ESA section 7 consultation, USACE determined that the PAA may adversely affect the fat threeridge *(Amblema neislerii)*, purple bankclimber *(Elliptoideus sloatianus)*, and Chipola slabshell *(Elliptio chipolaensis)*, but was not likely to adversely affect their designated critical habitat. Additionally, USACE determined that the proposed action may affect, but is not likely to adversely affect, the Gulf sturgeon *(Acipenser oxyrinchus desotoi)* and its designated critical habitat. The analyses used to inform these determinations were consistent with the previous consultations with the USFWS regarding Jim Woodruff Lock and Dam operations. During consultation, the USFWS concurred with the USACE effects determination for the listed mussel species and associated critical habitats but concluded that the PAA may adversely affect the Gulf sturgeon and its designated critical habitat as well as designated critical habitat for the three listed mussels. Although USACE disagreed with this determination, after extended discussions with the USFWS, USACE acquiesced to formal consultation on the Gulf sturgeon.

On September 14, 2016, the USFWS issued a BO for the PAA for the ACF WCM update addressing these listed species. In the BO the USFWS determined that the PAA: 1) will not jeopardize the continued existence of the Gulf sturgeon, the fat threeridge, purple bankclimber, and Chipola slabshell; and 2) will not destroy or adversely modify designated critical habitat for the fat threeridge, purple bankclimber, and Chipola slabshell. The BO included pertinent Incidental Take Statements affected species, Reasonable and Prudent Measures (RPMs) to minimize incidental take, and Terms and Conditions to implement the RPMs. The BO considered that the WCM is reviewed every 5 years pursuant to USACE South Atlantic Division policy; therefore, it was issued with the understanding that the WCM may be revised or updated within 5 years and that this BO will be reviewed, or consultation reinitiated, at that time.

The PAA would be expected to have a slightly beneficial effect on shoal bass because recruitment performance would be slightly higher compared to the NAA.

Fish and wildlife management facilities. Compared to existing USACE operations under the NAA, the PAA would not be expected to affect the facilities or operations of the Eufaula NWR or the Buford Trout Hatchery or the other three fish hatcheries in the ACF Basin.

Socioeconomics

Municipal and industrial water supply. The PAA assumes 242 mgd would be withdrawn from Lake Lanier and 379 mgd would be released from Buford Dam to support withdrawals out of the Chattahoochee River. A reallocation to support a withdrawal of 222 mgd under the PAA, would satisfy a substantial portion of Georgia's 2050 water supply need. This gross withdrawal of 222 mgd would require a reallocation of about 254,170 ac-ft of storage at a first cost of about $61.0 million (2016 price level). The PAA would represent a substantially beneficial effect relative to M&I water supply in the upper Chattahoochee River Basin compared to the NAA. None of the other M&I water supplies in the basin are likely to be affected by the implementation of the PAA.

Navigation. Under the NAA, a 9-ft channel would be available 2.7 percent of the time over the modeled period of record for the months of January–May. A 7-ft channel would be available 20.5 percent of the time over the period of record from January through May. Under the PAA, a 9-ft channel would be available 2.7 percent of the time over the period of record from January through May (no change from the NAA). A 7-ft channel would be available 42.5 percent of the time over the period of record from January through May. This represents a 22-percent difference over the NAA. This increase could likely have a beneficial effect for commercial navigation on the system.

Hydroelectric power generation. The NAA would provide a total energy and capacity benefit of about $180.19 million (2016 price levels and fiscal year 2017 interest rate of 2.875 percent and a 50-year period of analysis). Under the PAA, a slight reduction in the total energy and capacity benefit of about $953,000 (or about 0.5 percent) would be expected.

Agricultural water supply. Neither the NAA nor the PAA would be expected to have any effect on the agricultural water supply in the basin.

Flood risk management. Under the PAA, flood risk management operations would remain unchanged from those currently employed under the NAA. There would be no effect on the flood risk management function in the ACF Basin or the associated benefits.

Recreation. The PAA would be expected to result in a slightly decreased combined annualized recreational value (by 0.15 percent) for Lake Lanier, West Point Lake, and Walter F. George Lake compared to the NAA (fiscal year 2017 unit day values and interest rate of 2.875 percent, and a 50-year period of analysis). Recreation value for other reservoir projects in the ACF Basin would not be affected by the PAA.

Environmental justice. Seasonal fluctuations in the water surface elevations under the NAA could create minor inconveniences for local residents, including low-income and minority populations, who use USACE reservoirs for fishing and other forms of recreation. Those effects would likely be more pronounced at USACE reservoirs under extreme drought conditions. USACE project managers at the lakes work closely with the public under such circumstances and pursue reasonable temporary measures to maintain at least a minimum level of access to the lakes until extreme conditions improve. The PAA would be expected to have the same effects from an environmental justice standpoint as the NAA.

Protection of children. Public use of large reservoir projects for water-based recreation inherently includes a level of health and safety risk to both adults and children. USACE actively pursues measures at operating projects to minimize such risks by implementing water safety and other education programs, providing clear signage, marking designated uses areas, removing hazards where appropriate, restricting public access to certain areas designed for authorized personnel only, and other activities designed to promote safe use, many of which are directly focused on children who visit the projects. The PAA would be expected to have the same effects on protection of children as the NAA.

Aesthetic Resources

The PAA would not appreciably affect the aesthetic characteristics (scenic areas and viewsheds) of the rivers and reservoirs in the ACF Basin compared to current conditions under the NAA. Minor deviations in lake levels at times under the PAA would have a negligible effect on scenic areas and viewsheds on the reservoirs.

Cultural Resources

Potential effects on cultural resources due to the proposed Master WCM update are difficult to predict but are most likely to occur around areas that might be susceptible to erosion or deposition of sediments over time. Potential effects are expected to be consistent with a 2009 study, in which 93 percent of the cultural sites would be expected to experience erosion and 33 percent would be expected to experience deposition. Additional investigations in 2014, as discussed in more detail in the EIS, reaffirmed the findings of the 2009 study. These percentages represent multivariant trends rather than an indication of adverse effects to cultural resources that would be specifically tied to USACE water management. These trends correlate with the geomorphology of the existing environment as represented in the NAA rather than with modified water management practices that would occur under the PAA or any of the other alternatives.

Other resource areas

The PAA would not result in a change to existing air quality, noise, or traffic and transportation conditions in the ACF Basin or an increased likelihood of exposure to hazardous, toxic, or radioactive waste materials.

Climate Change Analysis

Potential Effects of PAA on Climate Conditions. Minor emissions associated with vehicle and equipment use to conduct routine operation and maintenance activities around the USACE reservoir projects would continue for the PAA at about the same level as the NAA. The amount of hydropower likely to be produced under the PAA would likely be slightly lower compared to the NAA. Assuming that the minor difference would be made up by power generation from fossil fuels, the PAA would result in a negligible increase in greenhouse gas emissions and no measurable effect on climate conditions.

Potential Effects of Climate Change on Future ACF Basin Project Operations. In response to USACE guidance and public scoping input, the USACE Institute for Water Resources conducted an analysis of the potential effects of climate change on ACF reservoir operations for the NAA and the other alternatives, including the PAA. For the climate change analysis, the climate change-affected unimpaired flow (UIF) results for 2021–2050 were carried forward for comparison to results for the NAA and the PAA (Alt7K). Years 2021–2050 most closely match the anticipated project lifespan for the Master WCM update and the WSSA analyses. The high-low range of potential climate change-affected outputs generally follow the same seasonal trends as the NAA values. However, the range of high and low boundaries for the modeled climate change-affected values generally indicate greater extremes. The high and low extremes are no more severe than those that have been historically experienced in the ACF Basin. Generally, the plotted PAA values tend to fall within the range of climate change-affected results, indicating that the PAA water management scenario would likely be flexible and adaptable enough to perform effectively within the range of hydrologic conditions represented.

CUMULATIVE EFFECTS

Constructing dams in riverine ecosystems abruptly, severely, and permanently alters many important physical and biological processes involving the movement of water, energy, sediments, nutrients, and biota. In addition to the 14 major USACE and nonfederal dams impounding the ACF mainstem rivers, there are several hundred reservoirs that are 20 acres or larger and many more smaller farm ponds and local impoundments in the ACF Basin. These existing impoundments serve a variety of purposes, including water supply for livestock and irrigation, fish and wildlife conservation, recreation, M&I water supply, and other localized uses. There are 11 nonfederal public water supply reservoir projects in the Metro Atlanta area in the ACF Basin for which USACE has issued DA permits under section 404 of the CWA since 1988 or for which the DA permit application has been made. The two pending DA permit applications for the proposed Bear Creek Reservoir in south Fulton County, Georgia and for Glades Reservoir in Hall County, Georgia were withdrawn in September 2015 and April 2016, respectively. Studies have identified 16 additional locations in the ACF Basin in Georgia that might be suitable for future water supply reservoir development. No specific plans presently exist for those sites, and it is not appropriate to speculate on what actions water providers might elect to pursue in the future in response to water resource-related litigation or water allocation formulas that could be derived by the states of Alabama, Florida, and Georgia. The amount of conservation storage in Lake Lanier that would be reallocated to water supply under the PAA would negate the need to construct Glades Reservoir, and perhaps other potential reservoirs that have been identified, to provide for future water supply.

One effect of converting flowing water habitat to still water by dam construction along ACF Basin mainstem rivers and tributaries has been the decline or loss of river-dependent species of freshwater fishes, mussels, and snails, including the decline of anadromous fish habitat. New dams in the basin would replicate many of those effects elsewhere in the tributary streams and add to the cumulative alteration of natural flow regimes and habitat fragmentation. As indicated above, the PAA may negate the need for some additional water supply reservoirs in the upper portion of the ACF basin, thus avoiding the potential future conversion of river and stream habitat in the basin to reservoirs.

Human-induced stressors can further compromise resources in the basin. As population growth continues, the impacts on terrestrial ecosystems, aquatic systems (including wetlands), and important archaeological resources are expected to become more vulnerable and potentially degraded. Proposals for nonfederal development activities (recreation, power line crossing, roads, etc.) on and adjacent to USACE project lands are periodically considered and typically involve leases or easements from USACE. Such activities in the ACF Basin are not expected to directly impact water management decisions or project purposes nor would these activities likely be impacted by the PAA. Various private sector power interests have also pursued steps to acquire a Federal Energy Regulatory Commission license for nonfederal hydroelectric power development at George W. Andrews Lock and Dam, beginning in 1983 and continuing to the present. If the current effort does not result in nonfederal hydropower development, it is likely that other nonfederal hydropower interests will file permit applications with FERC in the future.

Apalachicola Bay estuary faces a variety of anthropogenic pressures. Amid that pressure, even with variable system conditions, the estuary has generally remained a productive estuarine ecosystem. The PAA for update of the Master WCM would likely have negligible effect on the aquatic resources and ecological function of the Apalachicola Bay estuary. Review of HEC-ResSim model outputs for flow on the Apalachicola River at Chattahoochee and Blountstown indicate that the PAA would have little effect on the flow regime in the river at those locations compared to the NAA and, consequently, little effect on inflow to the Apalachicola Bay estuary compared to the NAA. Therefore, the PAA, or any of the other alternatives, would be expected to have a negligible incremental effect on the hydrodynamic regime, aquatic resources, and ecological function of the Apalachicola Bay estuary compared to the NAA. Any negligible changes to hydrodynamic conditions in the bay that would occur under the PAA would most

likely be inconsequential compared to the cumulative effects of anticipated sea level rise on physical and ecological conditions in the estuary.

Water quality is influenced by a number of factors, including pollutant loads and in-stream flows (water quantity). A water body's ability to assimilate pollutants is dependent on the amount of water in-stream, especially during low flow periods. Agencies regulating water quality in rivers and reservoirs will continue to monitor them for impairment and improvement and enforce reductions until standards are met. That balance of what is allowable and what is discharged is an ongoing cycle of monitoring, assessment, and implementation. Changes in discharges during low flow conditions by some entities holding discharge permits would be expected to affect water quality during low flow periods. However, over time it is expected that water quality standards will be met because of reductions achieved through the Water Pollution Control Act of 1972, as amended.

MITIGATION

CEQ regulations for the implementation of the National Environmental Policy Act (NEPA) define mitigation at 40 CFR 1508.20 to include avoiding, minimizing, rectifying (by repairing, rehabilitating, or restoring), reducing or eliminating, and/or compensating for adverse impacts that would likely result from a proposed federal action. As potential water management measures were identified and alternatives were developed, potential actions to offset any adverse effects also were identified, analyzed, and considered in the planning process. The iterative process employed by USACE to formulate and evaluate water management alternatives and water supply options was coupled with substantial coordination with USFWS and others. These factors provided a strong framework for (1) considering the incremental effects of the various components of the alternatives, and (2) adjusting proposed operations to minimize adverse effects on the natural environment, as well as social, cultural, and economic impacts. Updating the reservoir operations in the ACF Basin and the Master Manual and project WCMs that guide project operations would not involve construction or any other activity that would result in a permanent and irreversible physical change to natural systems of the ACF Basin to an extent greater than has already occurred under the NAA.

Increased water withdrawals from the Chattahoochee River to meet the needs of Metro Atlanta communities would result in a corresponding increase in treated wastewater returns to the river between Atlanta and West Point Lake. The impact analysis showed that the PAA would result in increased TP loadings that would have a substantially adverse effect on water quality. Substantially adverse effects also would be expected from Atlanta into West Point Lake and downstream of West Point Lake to the headwaters of Walter F. George Lake. The adverse water quality effects in those portions of the Chattahoochee River would principally be associated with increased treated wastewater discharges to the river rather than USACE project operations. The GAEPD could require changes to discharge permits for some facilities. After a thorough analysis of the impacts from the PAA and other alternatives, it was determined that specific compensatory mitigation measures for USACE were not required or necessary.

Other adverse effects identified in the EIS for the PAA and other alternatives on flow conditions, land use, biological resources, socioeconomic considerations, and other resource areas generally range from negligible to slightly adverse. Consequently, specific compensatory mitigation measures would not be necessary for USACE to implement based on the analysis of the PAA (Alt7K) and other alternatives. No specific mitigation commitments are included in the PAA or other alternatives, but all the alternatives incorporate measures known to benefit fish and wildlife such as current fish spawning and passage procedures and ramping rates and specific flow targets in the Apalachicola River at Chattahoochee, Florida. Water management inherently involves adapting to unforeseen conditions. Because adverse effects of the water control plan might occur in the future due to unforeseen conditions, actions would be taken within applicable authority and policies, and in coordination with other interests, to address such

conditions when they occur through the implementation of temporary deviations to the water control plan, such as interim operations plans.

OTHER NEPA CONSIDERATIONS

The irreversible or irretrievable commitments of resources for the update of the ACF Master Manual as proposed in the PAA would be negligible. Further, the PAA would not be expected to substantially alter the present relationship between short-term uses of man's environment and maintenance and enhancement of long-term productivity. The proposed Master Manual update includes operational adjustments that best balance the multiple purposes of the USACE projects in the ACF Basin, including those that would sustain and improve environmental conditions in the basin.

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1 Purpose, Need, and Scope

1.1 Introduction

This environmental impact statement (EIS) evaluates proposals by the U.S. Army Corps of Engineers (USACE) to adopt an updated *Master Water Control Manual, Apalachicola-Chattahoochee-Flint River (ACF) Basin, Alabama, Florida, Georgia* (Master WCM or Master Manual), including a water supply storage assessment (WSSA) addressing reallocation of storage in Lake Sidney Lanier (Lake Lanier). The WSSA addresses a request from the State of Georgia for reallocation of storage in Lake Lanier to satisfy future water supply needs of certain north Georgia communities. The EIS has been prepared to comply with the requirements of the National Environmental Policy Act of 1969 (NEPA), as amended, Title 42 of the *United States Code* (U.S.C.) sections 4321−4347; the Council on Environmental Quality's (CEQ's) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, Title 40 of the *Code of Federal Regulations* (CFR) parts 1500–1508; and Engineer Regulation (ER) 200-2-2, *Environmental Quality—Procedures for Implementing NEPA* (also published as 33 CFR 230).

The Apalachicola-Chattahoochee-Flint River (ACF) Basin comprises 19,573 square miles in Alabama, Florida, and Georgia (Figure 1.1-1). USACE operates five reservoir projects in the ACF Basin:

- Buford Dam and Lake Lanier
- West Point Dam and Lake
- Walter F. George Lock and Dam and Lake
- George W. Andrews Lock and Dam and Lake George W. Andrews
- Jim Woodruff Lock and Dam and Lake Seminole

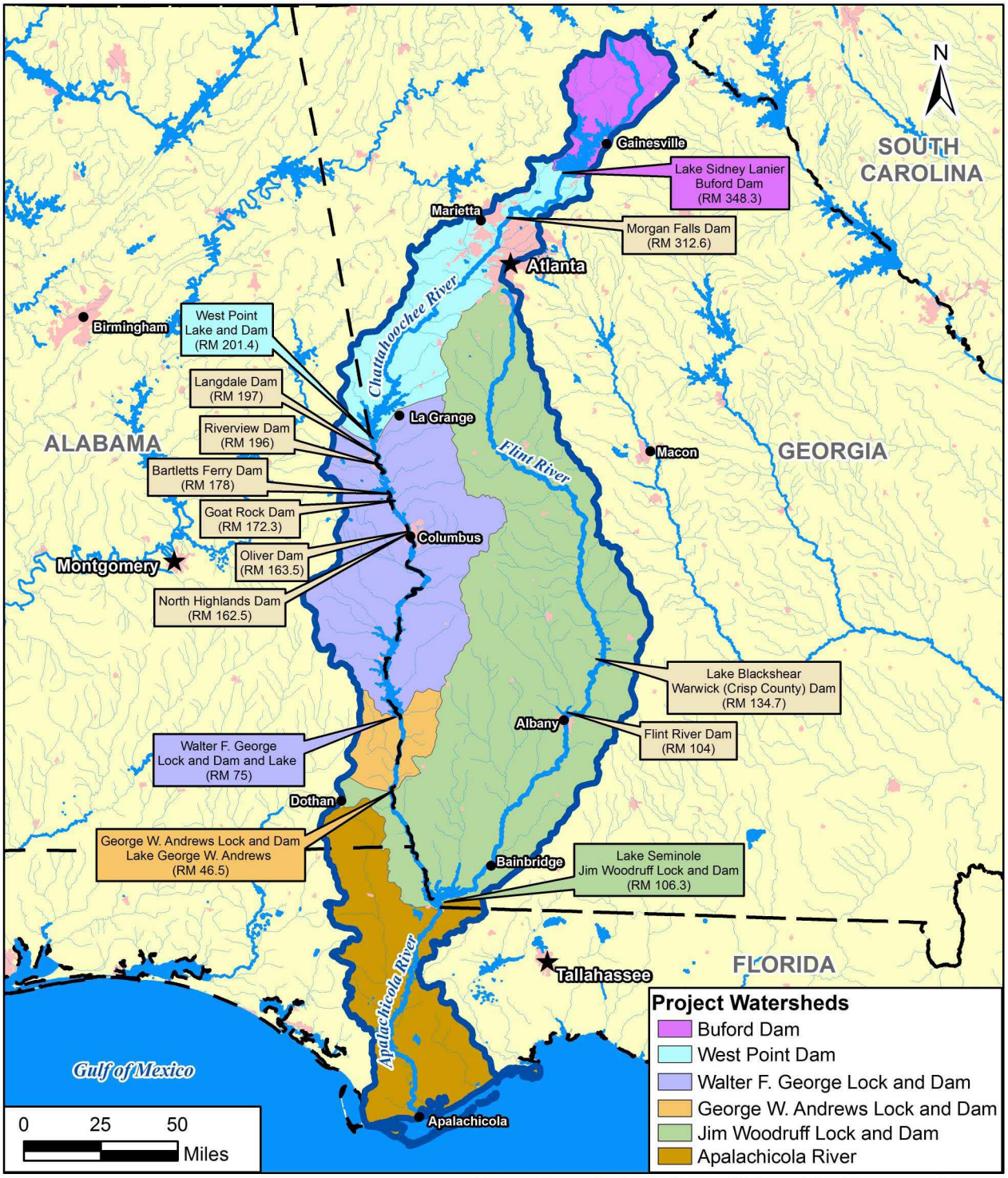
USACE operates and manages those projects as a system to meet their authorized purposes, which include flood risk management,[1] hydropower, navigation, fish and wildlife conservation, recreation, water quality, and water supply.

1.2 Purpose and Need

Section 7 of the Flood Control Act of 1944 provides that:

> It shall be the duty of the Secretary of the Army to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations... (33 U.S.C. 709).

[1] USACE generally uses the term "flood risk management" rather than "flood control" or "flood damage reduction" to characterize the USACE mission to manage and reduce risk of loss of life and property damage associated with flood events (USACE IWR 2009). Therefore, the term "flood risk management" is used, along with "flood control," where appropriate, throughout this EIS to describe that mission area. The updated terminology does not reflect any change in the originally authorized flood control purpose or to operations in support of that authorized purpose.



Apalachicola, Chattahoochee, and Flint Rivers Basin Map

Figure 1.1-1

The original Master Manual for the ACF Basin dates to 1958, shortly after completion of the Jim Woodruff Lock and Dam and about the time Buford Dam was completed. The original 1958 Master Manual does not include water control manuals (WCMs) for Buford Dam, West Point Dam, Walter F. George Lock and Dam, or George W. Andrews Lock and Dam projects, all of which were completed later. The individual reservoir project WCMs were completed as the projects were constructed and placed into operation, and when approved, the project-specific manuals were attached as appendices to the 1958 Master Manual. The individual WCMs were updated at various dates extending as far back as the 1970s and 1980s; additional updates were approved in the 1990s.

A draft update to the main body of the 1958 Master Manual for the ACF Basin was prepared in 1989, along with certain changes to the project WCMs. Those proposed updates, however, were never finalized or formally approved because of litigation that ensued in 1990 and thereafter. Section 3.5 summarizes the history of this litigation. The 1989 Master Manual update incorporated several operational adjustments, primarily focusing on adjustments gathered through experience and lessons learned during severe drought periods in the 1980s and proposed reallocations of storage at Lake Lanier, to accommodate then-current and future water supply withdrawals—a proposed action that was never completed because of the ensuing litigation.

USACE has continued to operate the ACF projects essentially in accordance with the status quo reflected in the 1989 Master Manual update, making minor adjustments as additional experience and circumstances have dictated. In addition, USACE has continued to accommodate water supply withdrawals from Lake Lanier and from the Chattahoochee River downstream, although USACE, due to ensuing litigation, has never taken action to effect a formal reallocation of storage in Lake Lanier, nor to accommodate the future water supply needs that were anticipated in 1989. A more detailed background of the Master Manual and individual project WCMs, as well as a more thorough discussion of the issue of water supply from the Buford project, is provided in section 3. The draft updated Master Manual and individual project manuals are included in appendix A.

The proposed action is to update the water control plans and manuals for the ACF Basin as directed by Secretary of the Army Pete Geren on January 30, 2008. Specifically, the purpose and need for the federal action is to determine how the USACE projects in the ACF Basin should be operated for their authorized purposes, in light of current conditions and applicable law, and to implement those operations through updated water control plans and manuals. Conditions in the basin (e.g., population, socioeconomic, land use, infrastructure, and demand for water resources) have changed substantially since USACE reservoirs were authorized and constructed, and a variety of applicable federal and state environmental laws have been passed and implemented. Operation of USACE reservoir projects in the basin both affect, and are affected by, current conditions in the basin and must comply with current laws and regulations. This action will result in an updated Master Manual, including updated water control plans and manuals for the ACF system and each USACE project within that system, that reflect operations under existing congressional authorizations, taking into account changes in basin hydrology and demands from years of growth and development, new/rehabilitated structural features, legal developments, and environmental issues. For more detail, see section 3.3.

The updated Master Manual will also include a comprehensive basinwide drought operations plan in accordance with the pertinent USACE regulations. Both the Master WCM and the drought operations plan are needed to accomplish specific congressionally authorized and general statutory authorized project purposes in the basin.

Updates to the WCMs are also needed to:

- Capture project and system operations that have been refined over the years because of changes in basin hydrology and withdrawals/consumption that resulted from years of growth and development.
- Reflect drought operations requirements to account for new data and operational changes.
- Update data reflecting basin conditions.
- Account for new or rehabilitated project structural features.
- Address environmental objectives for water quality, federally listed threatened and endangered species, and fish management.
- Capture and use real-time data provided by additional gages and monitoring devices installed since the last Master Manual updates.
- Use the latest computer models and techniques to evaluate and establish guidelines for project operations.
- Improve and streamline methods for data exchange between USACE and other agencies.

On May 16, 2000, the Governor of the State of Georgia submitted a formal request to the Assistant Secretary of the Army for Civil Works to adjust the operation of Lake Lanier and to enter into agreements with the state or water supply providers to accommodate increases in water supply withdrawals from Lake Lanier and downstream at Atlanta over the next 30 years, culminating in total gross withdrawals of 705 million gallons per day (mgd)—297 mgd from Lake Lanier and 408 mgd downstream—by the year 2030. The Assistant Secretary of the Army for Civil Works in 2002 denied Georgia's request, concluding that a reallocation of conservation storage in Lake Lanier sufficient to accommodate the requested withdrawals would exceed the Secretary's authority. The 2011 decision of the 11th Circuit Court of Appeals, discussed in more detail in section 3.5.2.8.2, set aside the Army's 2002 decision to deny Georgia's request and ordered USACE to reconsider whether it has the legal authority to operate the Buford project to accommodate Georgia's request. USACE provided a legal opinion on remand, concluding that it has sufficient authority under applicable law to accommodate that request, but noting that any decision to take action on Georgia's request would require a separate analysis.

On January 11, 2013, the Governor of the State of Georgia provided the Assistant Secretary of the Army for Civil Works with updated demographic and water demand data to confirm the continued need for 705 mgd to meet Georgia's water needs from Lake Lanier and the Chattahoochee River to approximately the year 2040 rather than 2030 as specified in the 2000 request. The 2013 request was considered in the draft EIS published in October 2015. On December 4, 2015, the Georgia Environmental Protection Division (GAEPD), on behalf of the State of Georgia, provided additional updated demographic and water demand data (referred to as Georgia's 2015 request) that reduced the state's needs from a total of 705 mgd to a total of 597–621 mgd—242 mgd from Lake Lanier (instead of 297 mgd) and 355–379 mgd downstream (instead of 408 mgd)—through the year 2050 rather than 2040 as specified in the 2013 request (GAEPD 2015a).

Because of the Circuit Court ruling of June 2011 and the USACE legal opinion, updating the water control plans and manuals will include making a decision on Georgia's water supply request. Accordingly, this EIS considers, along with operations for all authorized purposes, an expanded range of water supply options associated with the Buford Dam/Lake Lanier project, including current levels of water supply withdrawals and additional amounts that Georgia in 2015 requested from Lake Lanier and downstream at Atlanta. The litigation discussed in the previous paragraph has now been vacated and Georgia's request for water supply from Lake Lanier is considered in this EIS.

Any proposed changes to the ACF Basin water control operations that would not accomplish all authorized purposes of the system or that would require substantial structural modifications or congressional authorization would not be consistent with the purpose and need of updating the Master WCM. Accordingly, this EIS does not address any structural changes to USACE ACF Basin improvements or proposed changes to water management practices that are expected to exceed existing authority. Further, to the extent that existing operations must be adjusted to come into compliance with applicable law, such changes will be included as part of any proposed action (other than the No Action Alternative [NAA]).

1.3 Scope of the EIS

The purpose of scoping, in accordance with the requirements of NEPA, is to solicit input from other agencies and the public to help determine the range of issues to be addressed and to identify the significant issues to be analyzed in-depth with respect to the proposed action. The process also helps to deemphasize insignificant issues, thereby allowing USACE to identify the range of actions, alternatives, and impacts to be considered in the EIS for the update of the Master Manual. The scoping process for this EIS was initiated in February 2008 with the issuance of a notice of intent (NOI) to prepare an EIS and publication in the *Federal Register* of a notice in September 2008 announcing public scoping meetings. Public scoping meetings were held at five strategic locations within the ACF Basin between October 20 and 29, 2008. The formal scoping period ended November 21, 2008. The results of this scoping were published by USACE in a final scoping report in January 2009.

The scope of the federal action was subsequently refined because of a July 17, 2009, federal district court order in the case *In re Tri-State Water Rights Litigation*. The court's ruling introduced new information and circumstances that affected some of the determinations reflected in the January 2009 final scoping report. Accordingly, on November 19, 2009, USACE reopened public scoping to address the court's ruling. The reopened scoping period provided the public an opportunity to submit comments on the significant new information and circumstances introduced by the July 17, 2009, court order. The results of the reopened scoping were documented in the March 2010 updated scoping report.

In 2012, the scope of the federal action was further refined because of a ruling by the U.S. Court of Appeals for the 11th Circuit in June 2011, which vacated the 2009 district court order in the case *In re Tri-State Water Rights Litigation* and directed USACE to determine its legal authority to operate Buford Dam and Lake Lanier to accommodate water supply withdrawals. In compliance with the 11th Circuit's order, USACE's chief counsel issued a legal opinion on June 25, 2012, concluding that USACE has the legal authority to accommodate both current and increased levels of water supply withdrawals from Lake Lanier and downstream at Atlanta, in light of several different statutory authorities, and based on preliminary analysis of impacts to other authorized purposes (Stockdale 2012). In light of this legal opinion and the 11th Circuit's ruling, USACE again reopened scoping on October 12, 2012, to provide the public an opportunity to submit comments on the new circumstances resulting from the ruling.

The scope of the federal action examined in this EIS is to update the water control plans and manuals to reflect operations as they have evolved because of changing conditions in the basin and to fully comply with agency regulations, federal laws, and applicable law. The scope of this EIS also includes a WSSA that considers both current and increased levels of water supply withdrawals from Lake Lanier and downstream at Atlanta. The WSSA fully complies with agency regulations and federal laws pertaining to water supply from a federal reservoir and is included as appendix B to this EIS. As further described in the EIS, the scope is limited to the geographic areas in the ACF Basin directly or indirectly affected by the proposed action.

This EIS identifies, documents, and evaluates the environmental effects of operating USACE projects in the ACF Basin under alternative management regimes that could reasonably be expected to accomplish the purpose and need of the proposed federal action. The purpose of the EIS is to inform decision makers and the public of the likely environmental consequences of the proposed action and alternatives. The range of actions, alternatives, and effects considered in this EIS are driven by the requirements set forth by Congress and USACE policies for project operation. As explained in section 1.2, this EIS considers operational changes within existing congressional authorities, as determined by recent court rulings, and delegated, discretionary authorities, and does not consider operational changes that would be expected to require additional congressional authority. Accordingly, this EIS considers, along with operations for all authorized purposes, an expanded range of water supply options associated with the Buford Dam/Lake Lanier project, including current levels of water supply withdrawals and additional amounts that Georgia has requested from Lake Lanier and downstream at Atlanta.

Environmental impact analysis must be proportionate to the nature and scope of the action, the complexity and level of anticipated effects on important resources, and the capacity of USACE decisions to influence those effects in a productive, meaningful way from the standpoint of environmental quality. The environmental analysis for this EIS is consistent with the diverse array of operations associated with water management. The project site for the proposed action encompasses USACE projects in the ACF Basin. The regions of influence for the environmental resources and socioeconomic conditions are resource-dependent. The use and management of water resources and the influence of water use and management on environmental and socioeconomic conditions has attracted much interest in the region since before construction of USACE reservoirs. Since the late 1980s, when the increased demands on water resources in the ACF Basin prompted litigation as described in section 3.5, the ACF Basin has experienced additional water demands and undergone several periods of record drought.

1.4 Public Involvement

Under the regulations issued by the CEQ, the evaluation of potential environmental effects of federal actions is open to the public (40 CFR 1500–1508). Public participation in the NEPA process promotes both open communications between the public and USACE and better decision making. All persons and organizations that have a potential interest in the proposed action, including minority, low-income, disadvantaged, and Native American groups, are urged to participate in the NEPA environmental analysis process.

Opportunities for public participation with respect to the proposed action are guided by CEQ regulations and USACE regulations. Those regulations provide for six major opportunities for public participation in conjunction with preparing this EIS: (1) issuance of an NOI to prepare an EIS, (2) scoping, (3) independent external peer review, (4) public review of the draft EIS, (5) public meeting(s) on the draft EIS, and (6) review of the final EIS. Each of those steps in the process provides for public involvement and is briefly discussed below. Throughout the process, the public can obtain information on the status and progress of the proposed action and the EIS through USACE, Mobile District Public Affairs Office by calling 251-690-2505. In addition, interested persons can visit USACE, Mobile District's Web site for the Master WCM update at www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate.aspx.

1.4.1 Notice of Intent

The NOI informing the public that an EIS is being prepared is the first formal step in the NEPA public involvement process. The agency proposing the action publishes the NOI in the *Federal Register* before the start of the scoping process. The NOI includes a description of the proposed action and gives the name

and address of an agency contact person. On February 22, 2008, USACE published an NOI declaring its intent to prepare an EIS for the proposed action (appendix C).

Supplemental NOIs were published to announce additional information for the public scoping process.

- A supplement to the February 22, 2008, NOI was published on September 19, 2008, announcing the dates and locations of five public scoping meetings.
- On November 19, 2009, another NOI was published to announce the reopening of public scoping, in response to a July 2009 federal court ruling in the case *In re Tri-State Water Rights Litigation*.
- Another NOI was published in the *Federal Register* on October 12, 2012, reopening the public scoping process to revise the scope of the EIS in light of a June 28, 2011, Decision of the United States Court of Appeals for the 11th Circuit and a June 2012 legal opinion of USACE's chief counsel regarding authority to accommodate municipal and industrial water supply from the Buford Dam and Lake Lanier project.

1.4.2 Scoping Process

In fall 2008, USACE, Mobile District conducted public scoping for preparation of this EIS. The purpose of the scoping, in accordance with the requirements of NEPA, was to solicit input from other agencies and the public. The hope was that the input would help identify all the relevant issues and alternatives that should be addressed in the EIS as well as supporting documentation for a decision on implementing an update to the Master Manual and the reservoir-specific WCMs to be included as appendices to the Master Manual. All materials related to the scoping are available from USACE, Mobile District's Web site for the Master Manual update at www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate/ACFDocumentLibrary.aspx, and so are not included as an appendix to this document.

USACE had the following scoping objectives:

- Identify public and agency concerns;
- Clearly define the environmental issues and alternatives to be examined in the EIS, including the elimination of insignificant issues;
- Identify related issues that originate from separate legislation, regulations, or Executive Orders (EOs) (e.g., federally listed threatened and endangered species or environmental justice concerns);
- Identify state and local agency requirements that must be addressed; and
- Identify available sources of data, studies, or tools that could provide information valuable in preparing the EIS.

In 2008 USACE's scoping process consisted of the following elements:

- Publishing an NOI to prepare an EIS in the *Federal Register*
- Publishing an announcement of the dates and locations of five public scoping meetings in the *Federal Register*
- Updating the existing mailing list by means of an initial postcard requesting accurate contact information
- Distributing a newsletter and a public notice announcing public scoping meetings and locations to federal, state, and local agencies and officials; stakeholders; and other interested parties

- Preparing and launching a Web site that described the NEPA process and all the public involvement activities planned during EIS preparation and served as a tool for collecting public comments and updating the project mailing list
- Distributing a press release to media outlets
- Sending agency scoping and tribal consultation letters by e-mail
- Sending agency scoping and tribal consultation letters by the U.S. Postal Service
- Holding a federal agency meeting and Web conference to inform the agencies and solicit comments
- Hosting a stakeholder's workshop to share the new and improved version of reservoir simulation software called Hydrologic Engineering Center-Reservoir System Simulation (HEC-ResSim) with all stakeholders groups involved with water management issues in the basin
- Holding five public scoping meetings to inform the public about the proposed action and to solicit oral and written comments on the issues that should be addressed in the EIS
- Reviewing and evaluating the oral and written comments received during the open comment period
- Publishing the scoping report on a Web site (http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate/ACFDocumentLibrary.aspx)
- Distributing a newsletter announcing publication of the scoping report to federal, state, and local agencies and officials; stakeholders; tribes; and other interested parties

As noted above, on September 19, 2008, a supplement to the NOI was published in the *Federal Register* to invite the public to participate in the NEPA scoping process and provided details on the dates and locations of the five open-house-style public scoping meetings scheduled at various locations throughout the ACF Basin, as well as on the various methods to be used to collect comments from the public for consideration by USACE in preparing the draft EIS.

Public scoping meetings for the ACF Basin were held in October 2008 at five locations throughout the basin (Dothan, Alabama; Apalachicola, Florida; and Atlanta, Gainesville, and LaGrange, Georgia). An open-house format was used at each meeting, and information stations with displays and handouts were set up. Subject matter experts from USACE and environmental contractors staffed each station at which information on various aspects of the proposed action was disseminated. A total of 1,018 stakeholders participated in the five public scoping meetings. USACE published a final scoping report in January 2009, which is available at http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate/ACFDocumentLibrary.aspx.

1.4.2.1 Rescoping in 2009

On July 17, 2009, the United States District Court for the Middle District of Florida issued an order in the case *In re Tri-State Water Rights Litigation,* which addressed USACE's authority to provide water supply benefits through its operation of the Lake Lanier project. The court's ruling introduced new information and circumstances that affected some of the determinations reflected in the *Final Scoping Report* issued by USACE in January 2009. On November 19, 2009, USACE reopened public scoping in response to the court's ruling. The reopened scoping period provided the public an opportunity to submit comments on the new information and circumstances introduced by the court order. As a result of the order, USACE proposed to revise the scope of the EIS and Master Manual updates in the following respects:

- In updating the ACF Basin water control plans and manuals, USACE would consider only operations that are within its existing authority. USACE previously announced its intent to update the plans and manuals to reflect current operations. Because the court had held that USACE lacked authority to continue to support present levels of water supply withdrawals at Lake Lanier or to reallocate storage to accommodate those or additional withdrawals, and because the court had ordered that most withdrawals from Lake Lanier must cease in within three years of the date of the court's order or July 17, 2012, USACE proposed to update the plans and manuals for operating the Lake Lanier project in a manner that reflected the court's order. Thus, USACE would not continue to accommodate the present level of withdrawals beyond July 2012, nor would USACE consider a reallocation of storage for water supply at Lake Lanier as part of the process for updating the ACF Basin water control plans and manuals.
- Pursuant to the court's order, within three years of the date of the court's order or July 17, 2012, the updated WCMs would reflect that water supply withdrawals from Lake Lanier would be limited to the amounts authorized by relocation agreements with the cities of Gainesville and Buford, Georgia. Those agreements, which were executed at the time of the reservoir's construction, authorize withdrawals of 8 mgd for Gainesville and 2 mgd for Buford—a combined 10 mgd.[2]
- Pursuant to the court's order, within three years of the court's order or July 17, 2012, the updated WCMs would reflect that "the required off-peak flow [at Buford Dam] would be 600 cfs [cubic feet per second]." Thus, when USACE was not generating hydroelectric power to meet the peak demand, it would not release more than 600 cfs from Buford Dam to support downstream water supply withdrawals.
- The relocation agreements, as described above, represent legal instruments that provided compensation to property owners (the cities of Buford and Gainesville) for the taking of property associated with construction of Buford Dam (Lake Lanier). Both cities had existing intake structures and water treatment plants on riparian lands prior to commencement of project construction. Under relocation agreements, the cities were allowed to relocate their existing water supply intakes and continue to withdraw water.

USACE's reopened scoping process in 2009 consisted of the following additional elements:

- Publishing an announcement in the *Federal Register* on November 19, 2009, that public scoping was to be reopened
- Distributing a public notice announcing the reopening of public scoping by email and through the U.S. Postal Service for those who did not have an email address or who requested hard-copy notices
- Preparing and launching a Web site that described the NEPA process and all the public involvement activities planned during EIS preparation and served as a tool for collecting public comments and updating the project mailing list
- Distributing a press release to media outlets
- Reviewing and evaluating the written comments received during the open comment period

[2] Unlike withdrawals under the Water Supply Act of 1958, relocation contract are provided as compensation for inundation of existing water intakes at the time of project construction. All withdrawal amounts are shown in gross withdrawals, the only contract that utilizes a net withdrawal figure is the relocation contract for the City of Gainesville due to the specific terms of the contract. Presently, Gainesville withdraws 18 mgd and returns 10 mgd resulting in a net withdrawal of 8 mgd. The total gross withdrawal under relocation contracts for Gainesville and Buford is 20 mgd.

- Publishing the scoping report on a Web site at http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate/ACFDocumentLibrary.aspx
- Distributing a newsletter announcing publication of the scoping report to federal, state, and local agencies and officials; stakeholders; tribes; and other interested parties

1.4.2.2 Rescoping in 2012

In compliance with the 11th Circuit's order discussed in section 3.5.2.8.2, USACE's chief counsel issued a legal opinion on June 25, 2012, concluding that USACE has the legal authority to accommodate both current and increased levels of water supply withdrawals from Lake Lanier and downstream at Atlanta (see section 3.5.2.8.3). In light of this legal opinion and the 11th Circuit's ruling, USACE reopened scoping on October 12, 2012, to provide the public an opportunity to submit comments on the new circumstances resulting from the ruling.

As a result of the June 2011 ruling, USACE revised the scope of the EIS and Master Manual updates in the following respects:

- In updating the ACF Basin water control plans and manuals, USACE will consider operations that are within its existing authority under the River and Harbor Act of 1946 by taking into account the 2011 11th Circuit Court of Appeals opinion and USACE 2012 legal opinion.
- In updating the WCMs, USACE will consider the authority under Public Law 84-841, enacted July 30, 1956 (the 1956 Act) (see discussion in section 2.1.1.2.1) to contract for 11,200 acre-feet (ac-ft) of storage with Gwinnett County.
- USACE will reconsider Georgia's 2000 water supply request (updated in 2015).

USACE's reopened scoping process in 2012 included the following additional elements:

- Publishing an announcement in the *Federal Register* on October 12, 2012, that public scoping was to be reopened
- Distributing a newsletter on October 12, 2012, announcing the reopening of public scoping by email and through the U.S. Postal Service for those who did not have an email address or who requested hard-copy notices
- Updating the project Web site to reflect the 2011 decision and to serve as a tool for collecting public comments and expanding the project mailing list
- Distributing a press release on October 12, 2012, to media outlets
- Reviewing and evaluating the written comments received during the open comment period
- Distributing a newsletter during the public scoping process notifying the public of an extension of the comment period end date by email and through the U.S. Postal Service for those who did not have an email address or who requested hard-copy notices
- Publishing the updated scoping report on a Web site at http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate/ACFDocumentLibrary.aspx
- Distributing a newsletter on April 4, 2013, announcing publication of the scoping report to federal, state, and local agencies and officials; stakeholders; tribes; and other interested parties

1.4.2.3 Additional Public Involvement Activities

USACE, Mobile District and the Hydrologic Engineering Center hosted a workshop from September 30 to October 2, 2008, at Jim Woodruff Lock and Dam to share information and data pertaining to a new and improved version of HEC's reservoir simulation software called HEC-ResSim. Workshop attendees included all stakeholders groups involved with water management issues in the basin. Twenty-eight modelers attended the workshop. Twenty-three of the modelers represented three federal agencies, three state agencies, and one university; the five remaining modelers were private consultants representing the stakeholders.

The session proved very successful in terms of its objectives:

- To introduce the participants to the HEC-ResSim software.
- To initiate technology transfer by providing the participants with a copy of the software and the Alabama, Coosa, and Tallapoosa/Apalachicola, Chattahoochee, and Flint models, walk the participants through the model, and answer questions.
- To foster relationships by continuing longstanding technical working relationships with the stakeholders.

On May 3-5, 2011, the Mobile District hosted a follow-up HEC-ResSim technical workshop. Representatives from all three states (Alabama, Florida, and Georgia), federal agencies, and technical experts from other stakeholders, academia, and consulting firms attended the workshop. The purpose of the workshop was to update the participants on further development and refinement of the HEC-ResSim model for specific application to the ACF and to present model results for runs of the baseline (existing) project operations. The workshop served as an excellent vehicle for continued technology transfer and relationship building among the technical experts.

USACE, Mobile District offers several opportunities for public involvement at the request of stakeholders. The opportunity to be a *Water Manager for a Day* includes an introduction to river forecasting, participating in a weekly meeting with all the Mobile District basin managers, and one-on-one time with each basin manager. USACE district and division leaders have participated in numerous river excursions to meet and listen to stakeholders. A number of briefings and presentations on the Master WCM update process have also been given to groups at their request.

1.4.3 Public Scoping Comments

The public scoping effort for updates to the Master WCM in 2008, 2009, and 2012 resulted in a total of 3,600 comments from over 960 individuals, organizations, and agencies. The agencies consisted of federal, state, and local governments. The federal agencies that submitted comments were the U.S. Environmental Protection Agency (EPA) Region 4; the Southeastern Power Administration; the National Park Service (NPS) (Chattahoochee River National Recreation Area), the National Marine Fisheries Service (Southeast Regional Office), and the U.S. Fish and Wildlife Service (USFWS). Leaders from the Alabama, Florida, and Georgia congressional delegations submitted comments, as did the Governor of Georgia, the Georgia State House of Representatives, and a Georgia State Senator. The three states—Alabama, Florida, and Georgia—submitted comments through their associated state agencies. Other local governmental agencies, including the Metropolitan North Georgia Water Planning District (MNGWPD); Atlanta Regional Commission (ARC); Franklin County, Florida; Forsyth, Hall, Troup, and Gwinnett counties in Georgia; and the cities of Cumming, Columbus Consolidated Government, Douglasville, and LaGrange in Georgia submitted comments as well.

Two petitions were received during the scoping process in 2008. One was from West Point Lake Advisory Council Needs Your Show of Support, signed by 2,809 individuals. The second petition included comments on the *Potential for the Turkey Run Landfill to Pollute Groundwater and Surface Waters in Violation of Georgia Environmental Protection Division Solid Waste Management Rules and Landfill Permit*, signed by 58 individuals. During the reopened scoping process in 2012, the LaGrange-Troup County Chamber of Commerce distributed a petition *U.S. Army Corps of Engineers: Change operation rule curve for West Point Lake*, signed by 2,985 individuals. The petition described the local economic effect of West Point Lake and the local economy's dependence on lake levels and requested that USACE change the guide curve at West Point Lake in the late summer/early fall. This petition was received through email, U.S. mail, and original signature pages.

All the comments from scoping were reviewed, analyzed, and organized into the 12 categories shown in Table 1.4-1. The table also shows the number of comments by category.

Table 1.4-1.
Comments Categorized by Segment

Category	2008	2009	2012	Total Number of Comments
Water Management Recommendations	868	53	307	1,228
Socioeconomics and Recreation	404	14	288	706
Biological Resources	284	35	265	584
NEPA	79	80	82	241
Drought Operations	191	5	12	208
Water Quality	155	12	22	189
Water Supply	117	19	13	149
Data, Studies, and Analytical Tools	56	4	37	97
Flood Risk Management	9	2	71	82
Other Resources	52	6	7	65
Navigation	28	4	9	41
Hydropower	26	0	5	31
Total	*2,269*	*234*	*1,118*	*3,621*

As shown in Table 1.4-1, the greatest number of comments (1,228) was related to water management recommendations, which included the seven authorized project purposes and USACE ability to balance needs throughout the ACF Basin. Other comments in that category addressed alternatives to consider (or potential mitigation measures), demand projections as they relate to downstream and future needs, and overall water conservation in the basin.

Issues and concerns regarding socioeconomics and the tie between water levels, recreation, and regional economics received the second most comments (706). Most of the comments received in this category pertained to the adverse socioeconomic impacts that have occurred in the northern portions of the ACF Basin due to extremely low water levels in Lake Lanier and low or inconsistent water levels in West Point Lake. Similar comments were made by stakeholders in the middle and lower reaches of the basin that attributed adverse economic conditions to low water flows. Comments were also made regarding the following concerns:

- Adverse impacts on low-income and minority populations of low lake levels;
- The potential for collapse of the seafood and fishing industry in the Apalachicola Bay region;

- Safety hazards due to low water levels;
- Property values, aesthetics, and quality of life; and
- Direct and indirect impacts of basin water management practices on socioeconomics.

The primary message stakeholders conveyed was that USACE should fully assess in the EIS the socioeconomic impacts of water management practices at the individual projects and in the overall system.

The three categories that received the next most comments were biological resources (584), drought operations (208), and NEPA (241).

- Biological resources comments pertained to fisheries; threatened and endangered species; flow concerns for Apalachicola Bay; and other biological issues such as habitat, research, and monitoring.
- The drought operation comments generally referenced drought conditions in the Lake Lanier watershed over the past decade. Some comments suggested that during periods of extreme drought conditions, USACE needs to redirect and optimize its operational practices to balance project purposes by establishing management triggers, conservative reservoir operations, emergency drought measures, and water supply conservation measures and/or by prioritizing reservoir purposes.
- NEPA-related comments discussed public involvement, the schedule, the baseline, the proposed action and alternatives, mitigation measures, compliance with other regulations, and cooperating agencies.

During scoping, several entities expressed interest in becoming a cooperating agency. USACE has been attempting to update the ACF WCMs for 27 years and during that time has participated in coordination activities including: the interstate compact process with Alabama, Florida, and Georgia (until the states allowed the compact to expire); subsequent negotiations among the states supervised by the Secretary of the Interior; multiple rounds of NEPA scoping; and numerous other coordination efforts with pertinent federal and state agencies. As the Master WCM update is inherently a USACE function, the nature of this being an operational change to an existing authorized project, and in view of ongoing litigation at the beginning of the process, USACE determined not to involve other entities as formal cooperating agencies in the NEPA process. Nevertheless, USACE has maintained efforts to coordinate with agencies and stakeholders as is appropriate under NEPA.

Water quality (189 comments) and water supply (149 comments) were the next two categories. Water quality concerns were related to the following issues:

- Wastewater dilution
- Recreational uses
- Impacts of low lake levels and low flows
- Reevaluation of low flow requirements
- Salinity in Apalachicola Bay
- Monitoring
- Effects of population growth
- Industrial discharges
- Maintaining existing minimum flows

- The effect of the Revised Interim Operations Plan (RIOP)
- Total maximum daily loads

The water supply comments pertained to the following issues:

- Importance compared to downstream uses
- Public water supply
- Real-time monitoring at the City of Atlanta's intake
- Concern over future availability
- Consideration of the MNGWPD's plans
- Lack of congressional authority
- Cumulative effects
- Population growth
- Monitoring of the use of storage

The remaining comment categories, with a total of 316 comments, were data, studies, and analytical tools; flood risk management; other resources; navigation; and hydropower.

Scoping issues as expressed by the states of Alabama, Florida, and Georgia. The following summary identifies the key issues, concerns, and recommendations provided by the states during the three rounds of scoping as described above:

Alabama.

- Thorough and accurate critical yield analyses are essential to determine the amount of water available to address competing demands for water and water storage in the driest of conditions and to develop WCMs that satisfy the authorized project purposes. The critical yield should be determined in an open and public process.
- USACE should establish the baseline for any proposed changes to the WCMs, and it should be based on specifically authorized project purposes (navigation, hydropower, and flood control). USACE must use an appropriate baseline based on the existing ACF manual promulgated in 1958.
- USACE and the states should agree upon the computer model that will be used to evaluate the impact of any changes to the baseline operations.
- USACE should assess whether any changes in the baseline conditions are necessary to comply with existing laws and regulations. USACE should not evaluate operations that have been found to exceed its legal authority.
- The updated WCMs should establish some degree of certainty in drought conditions.
- USACE must account for the impacts of its operations on navigation in the Chattahoochee River.
- USACE should not base any operational decisions in the ACF on projections of economic impacts related to reductions in water supply or recreation opportunities.
- Some proposed reservoir projects in Georgia might affect inflows into the federal reservoirs in the basin, including inflows from the Flint River. A detailed assessment of the environmental and operational impacts of such proposed projects on future operations of federal and non-federal projects in the basin is needed.

- USACE must include a complete assessment of the impacts of operations pursuant to the revised Master WCM on the Middle Chattahoochee region in the EIS. Any operating regime must be created to ensure that certain minimum flows are maintained at all times in the Middle Chattahoochee region (specifically at Columbus, Georgia and Columbia, Alabama).
- Atlanta-area interests should not drive the process. The USACE must also recognize that water supply accommodation for the Atlanta area is not an *all-or-nothing* proposition where all the area's water supply needs to be met out of the federal reservoirs or none at all.
- USACE must consider the municipal and industrial water-supply needs of entities in the Alabama portion of the basin. Alabama's needs related to agricultural water supply must also be taken into account in the EIS. Agricultural water use in the basin is expected to steadily increase, with the most rapid increase expected in the Alabama portion of the basin.
- USACE must consider the action zones used at the federal projects. The actions zones have approximately 80 percent of the conservation storage pool at Lake Lanier in zone 4.
- USACE must account for the effects of fluctuating and declining pool levels on recreation at the reservoirs below Lake Lanier in the ACF Basin, including the potential inability of the Alabama marine patrol in West Point Lake to reach several areas of the lake if levels drop significantly because of low inflows.
- USACE should account for the potential impact of project operations on Eufaula National Wildlife Refuge.
- Alabama is concerned that the treated wastewater return rates assumption associated with proposed Georgia withdrawals are unrealistic and the ability of USACE to enforce the assumed level of returns.
- Alabama has several specific concerns with the USACE 2012 legal opinion, which defines basic assumptions for the WCM update process (described in section 3.5.2.8.3).

Florida.

- Florida contends that the current USACE WCM update process is inconsistent with federal laws and inadequate for both NEPA and the Water Resources Development Act. USACE actions that affect the Apalachicola River and Bay must be consistent to the maximum extent practicable with the Florida Coastal Management Plan.
- USACE should analyze the effects of the WCM update on Apalachicola Bay salinity and nutrient composition, and the corresponding economic impact on Apalachicola Bay and surrounding region; Apalachicola River floodplain habitats; the Apalachicola River's channel morphology due to altered flows and changes in operation; and relevant cumulative impacts.
- USACE must rigorously explore and objectively evaluate all reasonable alternatives and, for alternatives that were eliminated from detailed study, briefly discuss the reasons for their having been eliminated. The alternatives analysis should include: operating plans or action zones that differ from current operations; all available means to maximize likelihood that endangered and threatened species in the Apalachicola River will recover to the point of de-listing; cumulative impacts from other water supply options that the State of Georgia will develop.
- USACE must use the appropriate environmental baseline for the NEPA analysis, which is the 1958 Master Manual prepared for the ACF.
- USACE should consider include an alternative based on true basin inflow; an alternative that uses the entire conservation pool in Lake Lanier; a strong conservation alternative; and a recovery-based alternative.

- USACE must explore potential mitigation measures, including measures within and outside its jurisdiction. The key mitigation measures must include conservation and water transfers. USACE should consider additional system-wide mitigation with regard to water quantity and flows in the ACF Basin.
- An important element of the WCM revision, and its NEPA review, is an accurate critical yield for the ACF River Basin and each of the USACE reservoirs.
- Development and use of a new model, such as *HEC-ResSim*, should occur only with input and approval from all three states. USACE should afford the states adequate opportunity to review, become acquainted with, comment on, and endorse the assumptions underlying a new model.
- USACE must evaluate the following impacts: impacts to Apalachicola River and Bay ecosystem; incremental changes that have occurred since the 1970s; impacts in conjunction with proposed new sources for water supply or diversion; impacts of growth induced by providing new sources of water supply in the ACF Basin.
- Aggressive conservation efforts are essential to maintaining the integrity of the river and reservoir system. Because the river system is over-allocated, any serious analysis of ACF reservoir operations must address this challenge and evaluate available mechanisms to protect inflows to federal reservoirs. USACE must be less conservative in maintaining upstream reservoir levels at the expense of downstream river flows. USACE can no longer assume that all needs can be met without proactively insisting on more aggressive upstream conservation.
- Continued insistence on elevating storage levels, irrespective of increasing demands, and without regard to empirical evidence that such operations devastated Apalachicola Bay and its oyster population is unacceptable. The USACE must take a proactive role to promote conservation in the basin instead of leaving the matter entirely up to Georgia.
- The Apalachicola River needs more flow, not less, to help recover from the devastating mortality in the bay that occurred this summer (2012) and previous massive die-offs of endangered mussels, decline in fisheries, and drying of the floodplain forest that has occurred in recent years.
- Florida has developed an alternative operating regime based on five core principles: (1) release triggers based on "revised basin inflow" instead of USACE's "net basin inflow"; (2) a full suite of minimum flows based on historic exceedance values that vary with seasons, lake storage zones, and general inflow conditions (dry or normal/wet); (3) sharing of "revised basin inflow" in the form of additional releases of 50 percent of available "revised basin inflow" over the minimum release; (4) elimination of *Drought Operations* (5,000 cfs minimum) and *Exceptional Drought Operations* (4,500 cfs minimum); (5) full use of conservation storage.
- USACE, while meeting its various obligations, must draw more heavily on storage to minimize departures from the natural hydrograph.

Georgia.

- GAEPD recommends strongly that USACE not make the Interim Operations Plan, including the Revised Interim Operations Plan, the proposed action. The RIOP is not the only alternative for meeting endangered species needs. The RIOP is interim until the Master Manual is updated and is not the appropriate choice for the No Action Alternative.
- Issuing water withdrawal permits is a state and local action, and therefore it should not be addressed within the scope of connected, cumulative, and similar actions.
- USACE is required only to examine reasonable and feasible alternatives. The No Action Alternative should be interpreted to mean no change from current management operations.

- USACE should not limit alternatives to only its own authorities. Georgia believes the Corps has the authority to operate Lake Lanier to meet the projected future municipal and industrial needs.
- USACE must take into account Georgia's future water supply needs. Georgia has submitted updated information in support of the Georgia water supply request.
- The HEC-ResSim model is inconsistent with the established HEC-5 Existing Conditions model.
- USACE must consider the impact on the human environment of water supply alternatives to Lake Lanier. Failing to consider water supply in the current EIS process would result in a waste of Corps resources and taxpayer dollars.

The specific scoping issues, concerns, and recommendations from the three states, as summarized above, are representative of scoping comments made by a broad range of stakeholders in the basin. Additionally, the scoping comments expressed by the three states are consistent with their respective positions over the litigation history summarized in section 3.5 as well as their subsequent comments on the draft EIS. The extent to which the scoping comments made by the states and all other commenters were considered in the Master WCM update process is summarized in appendix D and in the alternative formulation and analysis discussions in section 4 and 5.

Throughout this NEPA process, the public has been able to obtain information on the status of the Master Manual update and the EIS by checking the Mobile District Web site at www.sam.usace.army.mil. The scoping reports covering all three rounds of public scoping are posted at http://www.sam.usace.army.mil/Missions/PlanningEnvironmental/ACFMasterWaterControlManualUpdate.aspx and can be downloaded with or without the appendices.

1.4.4 Analysis of Public Scoping Comments

As described in more detail in section 4, stakeholder comments assisted in identifying water resources/water management problems as well as measures (or alternatives) the public wished to have considered in updating the Master WCM.[3] Considering the purpose and need for this EIS, USACE developed eight screening criteria to guide information gathering, to help identify solutions, and to formulate alternatives. The screening criteria, which are summarized below, helped define the scope of the proposed updates to the Master Manual and to identify relevant public/agency issues and concerns to be addressed in the EIS. They also guided the consideration of input received from the public and from federal and state agencies, as well as suggestions from within USACE.

Any proposed measure (or alternative) considered in the update process for the Master Manual should:

1. Meet the purpose and need of the proposed federal action
2. Address one or more of the congressionally authorized project purposes
3. Maintain at least the current level of flood risk management
4. Be consistent with the contemporary water resources needs of the basin to the extent practicable
5. Support the operation of the projects in the ACF Basin as a system
6. Not increase the risk to public safety in the facility or downstream of the project
7. Not exceed the physical limitations of or pose risks to the structural integrity of the projects
8. Not violate USACE responsibilities under the Endangered Species Act (ESA)

[3] A *measure* is defined as a feature or activity that can be implemented at a specific geographic site to address one or more of the objectives for the Master WCM.

In addition to their application in considering public and agency input, these criteria were also used to conduct initial screening of potential water management measures for more detailed evaluation and possible inclusion in one or more of the Master WCM update alternatives. The initial screening process is described in more detail in section 4.

The following paragraphs provide additional discussion of the screening criteria:

1. A measure (or alternative) should meet the purpose and need of the proposed federal action.

   As explained in section 1.2, the purpose of the proposed action is to update the Master WCM for the ACF Basin to specify how USACE projects should be operated for their congressionally authorized purposes, taking into account changes in basin hydrology and demands from years of growth and development, new/rehabilitated structural features, legal developments, and environmental issues. This includes considering, along with operations for all authorized purposes, an expanded range of water supply options associated with the Buford Dam/Lake Lanier project, including current levels of water supply withdrawals and additional amounts that Georgia has requested from Lake Lanier and downstream at Atlanta. Any other proposed changes that would require feasibility-level studies and additional congressional authorization (e.g., changes that would seriously affect other project purposes or require substantial structural modifications) are not consistent with the purpose and need of updating the Master WCM or of this EIS.

2. A measure (or alternative) should address one or more of the congressionally authorized project purposes.

   In accordance with USACE governing regulations, water control plans are prepared giving appropriate consideration to all applicable congressional acts relating to the operation of federal facilities. For the ACF Basin, the congressional acts include the authorizing legislation, referenced project documents, and relevant general authorities (e.g., the Fish and Wildlife Coordination Act, Federal Water Project Recreation Act-Uniform Policies, Water Pollution Control Act of 1972 as amended, the ESA, the Flood Control Act of 1944, and the Water Supply Act of 1958).

3. A measure (or alternative) should maintain at least the current level of flood risk management.

   USACE operates projects in the ACF Basin to provide flood risk management, as Congress intended when authorizing the system and projects. Continued growth and development in the ACF Basin floodplain have implications to flood risk management that must be considered. Any proposed action should not significantly alter the level of flood risk management intended by the Congress in its authorizing language or increase the current levels, frequency, and duration of flood damage.

4. A measure (or alternative) should be consistent with the contemporary water resources needs of the basin to the extent practicable.

   Engineer Manual (EM) 1110-2-3600(2)(1)(b) and (3)(1)(b) states than an overarching goal of water control plans is to account for changing local conditions and needs in the basin (USACE 1987). Even after the projects are constructed, further refinements or enhancements of the water control procedures are often necessary to account for changed conditions resulting from new requirements, additional data, or changes in the basin. Such changes, however, must be consistent with the project's authorized purposes.

5. A measure (or alternative) should support the operation of the projects in the ACF Basin as a system.

   Authorizing documents call for operation of the projects proposed for the ACF Basin as a system. The operation of a multiple-project system such as the ACF Basin requires integrated WCMs and plans whereby projects are regulated jointly to achieve the overall river basin management objectives (USACE 1987).

6. A measure (or alternative) should not increase the risk to public safety in the facility or downstream of the project.

   Pursuant to ER 1110-2-240(6) (g) and EM 1110-2-3600, one of the prime requirements in project or system regulation is the safety of the users of the facility and the general public at the projects and downstream of the projects (USACE 2016a, 1987). USACE operates the projects and systems in full compliance with USACE safety regulations. Measures (or alternatives) that would pose safety risks to the facility personnel or the general public were not considered.

7. A measure (or alternative) that exceeds the physical limitations of, or poses risks to, the structural integrity of the projects should not be considered.

   The federal action is an updated Master WCM to reflect existing infrastructure and authorized project purposes. Therefore, measures (or alternatives) that would physically modify one or more projects or that would pose risks to the structural integrity of the existing projects were not considered.

8. Any measure (or alternative) that violates USACE responsibilities under the ESA will not be considered.

   USACE has previously met those obligations through formal consultation that resulted in a 2006 Interim Operations Plan (IOP) and, subsequently, RIOPs in 2008 and 2012.[4] As part of its WCM and plans update, USACE entered into formal consultation with USFWS under section 7 of the ESA regarding federally listed threatened and endangered species in the ACF Basin. Consultation was concluded in September 2016, and the Biological Opinion is included in appendix J. The results of that consultation have been incorporated into operations under the updated Master WCM.

USACE has not developed formal responses to the comments received during scoping but reviewed the comments and suggestions received as categorized in the scoping report and developed summaries of the major themes. The major comments and suggestions received during the scoping process are each listed in appendix D together with a statement of whether the comment or suggestion was eliminated by the screening criteria or was considered in updating the Master WCM, including reference to where in the EIS the comment or suggestion was addressed in more detail. The comments and suggestions are identified by a 2-letter abbreviation of the category of the comment or suggestion followed by a number, as shown in Table 1.4-2.

[4] Consultation with USFWS under section 7 of the ESA was initiated by USACE in 2006 resulting in a Biological Opinion for an IOP (USACE, Mobile District 2008a). See section 2.1.1.2.4.4.

Table 1.4-2.
Summary of Comment/Suggestion Identifiers Used in Appendix D

Category	Appendix D Identifier
Water Management	WM1-WM73
Socioeconomics and Recreation	SR1-SR15
NEPA Process	NEPA1-NEPA18
Biological Resources	BR1-BR23
Drought Operations	DO1-DO9
Water Quality	WQ1-WQ22
Water Supply	WS1-WS25
Data, Studies, and Analytical Tools	DS1-DS19
Other Resources	OR1-OR5
Navigation	NV1-NV4
Hydropower	HP1-HP9
Flood Risk Management	FRM1-FRM6

1.4.5 Public Review of the Draft EIS

The draft EIS was filed with EPA by letter dated September 23, 2015. The EPA notice of availability (NOA) of the draft EIS for public review and comment was published in the *Federal Register* on October 2, 2015, initiating a 60-day comment period ending on December 1, 2015. Subsequently, USACE received multiple requests for extension of the comment period. In response to the requests, USACE extended the comment period by an additional 45 days, ending on January 15, 2016, providing a total public comment period of 105 days. Copies of the draft EIS were provided to agencies, tribes, and members of the public who had specifically requested a copy. In addition, copies of the draft EIS were provided to local libraries in locations throughout the ACF Basin. A complete EIS distribution list is provided in section 10. A newsletter was distributed to other interested parties advising them that the draft EIS could be downloaded from the USACE, Mobile District's Web site or obtained on CD by submitting a request in writing. Agencies, organizations, and individuals were invited to review and comment on the document with respect to its completeness and on the proposed action, the alternatives, and the adequacy of the analysis. During the comment period, USACE also held a series of five public meetings, using an open house format, in cities across the ACF Basin to present information, answer questions, and receive comments on the draft EIS. The public meeting locations and dates were as follows: Gainesville, Georgia, on October 26, 2015; West Point, Georgia, on October 27, 2015; Eufaula, Alabama, on October 28, 2015; Bainbridge, Georgia, on October 29, 2015; and Eastpoint, Florida, on November 9, 2015. USACE advertised the time and locations of the meetings through a newsletter distributed to all parties on the project mailing list; press releases sent to local newspapers and radio and television news outlets; and the ACF Basin project Web site.

1.4.6 Final EIS

As provided for in CEQ regulations, USACE considered all comments on the draft EIS provided by the public and agencies. The final EIS includes responses to comments received during the draft EIS public review period and incorporates appropriate revisions and updates derived from those public comments. Also, the State of Georgia provided additional information in December 2015 (during the draft EIS comment period) reflecting population projections revised downward for Metro Atlanta and, accordingly,

future water demand projections also revised downward. Public comments and USACE responses are presented in appendix C.

The draft EIS considered and analyzed Georgia's 2013 water supply request. Georgia provided revised population and water demand projections to USACE in December 2015 during the public comment period for the draft EIS. Thus, it was necessary for USACE to consider a revised array of water supply options for its subsequent efforts to complete the ACF Master WCM update EIS and WSSA. In Georgia's 2015 revised request, overall water demand projections for Metro Atlanta were reduced, projected return rates were revised, and the proposed Glades Reservoir was eliminated from the state's water supply proposal. These changes addressed many of the agency and public comments on the draft EIS. Section 5.1 provides more detail on these water supply related changes that followed the release of the draft EIS for public comment. Agency and public comments on the draft EIS did not lead to appreciable changes in the proposed updates to system-wide water management practices for the ACF Basin (known as Water Management Alternative 7) as presented in the draft EIS (see section 4.2.7 for details). When Water Management Alternative 7 was combined with the revised array of water supply options to establish an updated set of alternatives, which were subsequently modeled and analyzed, the new Proposed Action Alternative (PAA) (Alternative 7K) was similar in its scope and its overall effects to the PAA presented in the draft EIS (named Alternative 7H). Consequently, USACE made a determination to prepare a final EIS for review rather that publish a revised draft EIS.

Revisions and updates to key sections of the draft EIS and the appendices included in the final EIS are summarized below:

- Sections 1 through 3 include minor technical and administrative corrections and updates based on agency and public comments, independent external peer review comments, and relevant additional information obtained since the draft EIS was published.
- Section 4 was updated to more fully describe and clarify (1) the two-phased plan formulation process (water management alternatives/water supply options) to determine the alternatives evaluated in detail in section 6 (see the introduction to section 4); (2) how modeling was used in both phases of the plan formulation process to assess and narrow the array of alternatives considered in detail in section 6 and to provide a technical foundation for environmental impact assessment of the alternatives considered in detail in section 6 (see section 4.1); (3) the screening process for water management measures (see sections 4.1.1 through 4.1.5); and (4) consideration of an alternative offered by the ACF Stakeholders (ACFS) organization in comments on the draft EIS (see section 4.1.4). In addition, section 4 incorporates technical and administrative corrections and updates based on agency and public comments, independent external peer review comments, and relevant additional information obtained since the draft EIS was published.
- Section 5 was updated to incorporate additional information provided by the State of Georgia in 2015 regarding (1) future water supply needs for communities withdrawing or expected to withdraw from Lake Lanier; (2) future water supply needs for communities withdrawing from the Chattahoochee River downstream of Buford Dam; and (3) expected return rates associated with lake and river withdrawals. The water supply needs considered in the final EIS were generally revised downward and extend over a longer planning horizon (from 2040 to 2050) than included in the previous 2013 request from Georgia, which was used in the formulation of alternatives presented in the draft EIS. Further, the final EIS eliminated Glades Reservoir as a reasonably foreseeable source of future water supply when the GAEPD rescinded the *need certification* for the reservoir in early 2016. This additional information resulted in several new alternatives (including a new PAA), all of which are within the range of the alternatives evaluated in the draft EIS. In addition, section 5 incorporates technical and administrative corrections and updates based on agency and public comments, independent external peer review comments, and relevant additional information obtained since the draft EIS was published.

- Section 6 was updated to address additional alternatives (including the new PAA) that were developed in accordance with the additional water supply information from Georgia as presented in the updated section 5 of the EIS. The updated analysis that includes the new alternatives was based on additional HEC-ResSim and HEC-5Q water quality modeling that incorporated the revised water supply information. All pertinent subsections within section 6 have been updated accordingly. Section 6 also incorporates technical and administrative corrections and updates based on agency and public comments, independent external peer review comments, and other relevant additional information obtained since the draft EIS was published.
- Sections 7 through 12 include minor administrative corrections and updates.
- Appendix A (Master WCM and Individual Project WCMs) was updated to include pertinent technical corrections and administrative updates based on agency and public comments, independent external peer review comments, and relevant additional information obtained since the draft EIS was published.
- Appendix B (Water Supply Storage Assessment Report) was updated to include the analysis of the new alternatives that incorporate additional population projections and water supply demand projections provided by Georgia in December 2015.
- Appendix C (Pertinent Correspondence) was updated to incorporate agency and public comments on the draft EIS (with USACE responses) as well as relevant new correspondence.
- Appendix E (HEC-ResSim Modeling Report) was updated to reflect analysis of the additional alternatives based on changes presented in section 5 of the EIS and to incorporate technical and administrative corrections and updates based on comments from agencies, the public, and independent external peer review.
- Appendix J (USFWS Coordination) was updated to incorporate documentation of ESA section 7 consultation that occurred following agency and public review of the draft EIS as well as the final Fish and Wildlife Coordination Act Report for the Master Manual update.
- Appendix K (HEC-5Q Water Quality Modeling Report) was updated to reflect analysis of the additional alternatives based on changes presented in section 5 of the EIS and to incorporate technical and administrative corrections and updates based on comments from agencies, the public, and independent external peer review.
- Appendix L (Coastal Zone Management Statement of Consistency) was updated to include approved administrative changes to the Florida Coastal Management Program and to address Florida's comments on the Statement of Consistency in the draft EIS.
- Appendix M (Recreation Benefit Analysis) was updated to reflect analysis of the additional alternatives based on changes presented in section 5 of the EIS.
- Appendix N (USACE Institute for Water Resources ACF Climate Change Support Analysis) was updated to reflect the additional information available following coordination of the draft EIS and in response to comments on the draft EIS from agencies, the public, and independent external peer review.
- Appendix O (Unimpaired Flow Dataset) was added to describe the development of the unimpaired flow dataset.

USACE has made copies of the final EIS available to agencies (federal, state, and local), tribes, private interest groups and organizations, and interested individuals who received the draft EIS, and has provided copies to local libraries. The final EIS will be available for review for 30 days following publication of an NOA in the *Federal Register* in accordance with established procedures reflected in the CEQ and USACE NEPA regulations. USACE also has advertised the availability of the final EIS through a newsletter distributed to all parties on the project mailing list; press releases sent to local newspapers and radio and television news outlets; and the project Web site.

1.4.7 Record of Decision

No sooner than 30 days after filing the final EIS with the EPA and publication of the NOA for the final EIS in the *Federal Register* by EPA, USACE will prepare a record of decision (ROD) for the update of the Master Manual and the individual project WCMs that will summarize alternatives that were considered and relevant factors that were balanced in making the decision, and identify means that have been adopted to mitigate for adverse effects. USACE will notify the public of the approved ROD in a newsletter distribution to the project mailing list; in press releases to local newspapers, radio, and television news; and on the project Web site.

1.4.8 Impact Analysis Performed

An interdisciplinary team of environmental scientists, biologists, planners, economists, engineers, archaeologists, and historians has analyzed the proposed action and alternatives in light of existing conditions and has identified relevant beneficial and adverse effects associated with the action.

- Existing conditions are described in section 2, Affected Environment.
- Understanding existing conditions provided a framework for water management as described in section 3, Framework for Decision Making, to define the proposed action.
- Development and descriptions of the alternatives addressing water management and water supply storage, including the NAA and PAA, are discussed in sections 4 and 5.
- The expected effects of the proposed action are described in section 6, Environmental Consequences, for each environmental resource area. Section 6 also addresses the potential effects associated with climate change, cumulative effects, and potential mitigation measures.

The environmental resources addressed in this EIS include water resources, geology and soils, climate, land use, biological resources and ecosystems, socioeconomic resources, aesthetic resources, air quality, noise, traffic and transportation, cultural resources, and hazardous and toxic materials.

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2 Affected Environment

This section of the EIS describes the physical and social conditions of the geographic area in which the impacts of the proposed action and alternatives are expected to occur, referred to as the *region of influence* (ROI). The affected environment serves as a baseline from which potential environmental and socioeconomic effects likely to result from proposed changes in the way USACE manages individual projects within the ACF Basin will be identified and evaluated. More importantly, the baseline will assist in demonstrating how those proposed changes will affect the functioning of the ACF Basin as a whole.

For the proposed Master WCM update and the WSSA, the ROI is generally defined as the ACF Basin in Alabama, Florida, and Georgia, downstream to and including Apalachicola Bay, as depicted in Figure 1.1-1. The affected environment depicts conditions, as they exist, in accordance with the most recent available data for each resource area. The level of detail provided is commensurate with the intensity, context, and duration of the potential impacts to a given resource. The ROI may vary by resource area depending on a variety of factors including natural boundaries, geopolitical boundaries, and the likely extent of impacts to the resource. When historical context is particularly relevant to understanding the current conditions for a given resource area, pertinent, historical data and information has also been included.

Understanding water resources in the ACF Basin (including water management, use, and quality) is the foundation for understanding the affected environment. This section begins with a description of water resources and continues by addressing the resource areas of geology and soils, climate, land use, biological resources, socioeconomics, aesthetic resources, air quality and general conformity, noise, traffic and transportation, cultural resources, and hazardous and toxic waste. Municipal and industrial (M&I) water demands, navigation, hydroelectric power generation, agricultural water supply, flood risk management, recreation, population, income, employment, environmental justice, and the protection of children are captured within socioeconomics.

Note that all elevation data in this EIS addressing USACE project structures, reservoir water surface elevations, and other pertinent elevation information are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

2.1 Water Resources

This section examines the complex interrelationships between surface water, groundwater, and the numerous competing demands on water resources in the ACF Basin. Water resource conditions in the ACF Basin can generally be described in the context of four variables:

- Quantity (or volume) of available water;
- Quality (physical, chemical, and biological integrity);
- Timing (when water is available in the system for natural and human use); and
- Distribution (the extent to which available water in the system is controlled, managed, or consumed for various purposes).

Section 2.1.1 addresses water quantity conditions for the ACF Basin, including timing and distribution (water management) aspects. Section 2.1.2 principally focuses on characterizing water quality conditions in the basin.

Much of the information in this section was developed during the Comprehensive Study in the 1990s involving the states of Alabama, Florida, and Georgia, and USACE, which were the principal partners in the study. Substantial additional water quantity and quality data have been collected and analyzed since the Comprehensive Study was completed by those parties as well as the U.S. Geological Survey (USGS), EPA, the three states, and other interests.

2.1.1 Water Quantity Affected Environment

This section discusses the water quantity aspects of the ACF Basin under existing conditions. It examines issues such as flow rates, flow durations, reservoir water levels, and groundwater quantities in the ACF Basin. It also discusses the many factors that can affect water quantity, including weather conditions, M&I consumption, agricultural use for irrigation, thermal power plants, and reservoirs for hydroelectric power generation and flood risk management.

In conjunction with meeting authorized project purposes, an important function of the many reservoirs in the ACF Basin is to store water when there is an abundance of rain and to release water when there is less rain in an effort to ensure that all water needs can be met throughout the year. Water management in this context is a complex process that requires consideration of many competing demands for water in the basin, consideration of past and anticipated future hydrologic conditions, collaboration with agencies and stakeholders, and determination of the most appropriate operating conditions for all the reservoirs in the basin to meet both human and natural system needs.

Water is managed in the reservoir projects in the ACF Basin for a variety of purposes, including flood risk management, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water supply, and water quality. Water demands can be consumptive or nonconsumptive. *Consumptive* demands involve withdrawal of water from the basin for some purpose and not returning it or any portion thereof, directly back to the basin. Municipal, industrial, and thermal power water supply consumes a portion of the withdrawn water and returns a portion of the water back to the basin as treated wastewater. For purposes of this analysis, agricultural water supply withdrawals are assumed to provide no return flows to the surface water streams. In contrast, hydroelectric power generation demand is a *nonconsumptive* use of water. It uses the flow in the river to drive hydroelectric power turbines to generate electricity, but no water is withdrawn or lost from the system.

In considering basin water management, it is critical to account for the various withdrawals (losses) from and returns (gains) to the system. Water is lost to the system through evapotranspiration (the total of evaporation and plant transpiration), M&I water withdrawals, thermal cooling water withdrawals, agricultural water withdrawals, groundwater transfers, and interbasin transfers. Water is returned, or added, to the basin through precipitation, treated M&I wastewater discharges, thermal power plant discharges, groundwater baseflow contribution, and interbasin transfers. Figure 2.1-1 schematically illustrates the gains of water to and losses of water from the basin. Water uses within the ACF Basin, and their associated gains and losses, are discussed in more detail later in the sections to follow.

2.1.1.1 Hydrologic Characteristics of the ACF Basin

Hydrologic characteristics of the basin are defined by various parameters, including precipitation, runoff, land use, geology, and man-made structures to manage water resources.

2.1.1.1.1 Precipitation

The mean annual rainfall in the Flint River Basin (Georgia) and Chattahoochee River Basin (Alabama and Georgia) generally ranges from about 50 to 55 inches per year (in/yr). In the Apalachicola River Basin (Florida), the mean annual rainfall generally is above 55 in/yr and may be as high as 66 in/yr in

certain locations. Table 2.1-1 depicts the mean annual rainfall, along with the record high and low annual rainfall totals from four precipitation stations in the ACF Basin, all with periods of record of more than 100 years. The highest recorded rainfall occurred in 1964 for most of the ACF Basin.

The average monthly total rainfalls at these four stations are also presented in Figure 2.1-2 to provide an indication of the seasonal variations in rainfall over the basin. At the upper end of the basin, rainfall is distributed throughout the year but tends to be more prevalent in the winter months (December–March) and lowest in the fall (September–November). In the lower end of the basin, rainfall is distributed throughout the year but tends to be higher in the summer months (June–August) (SERCC 2010).

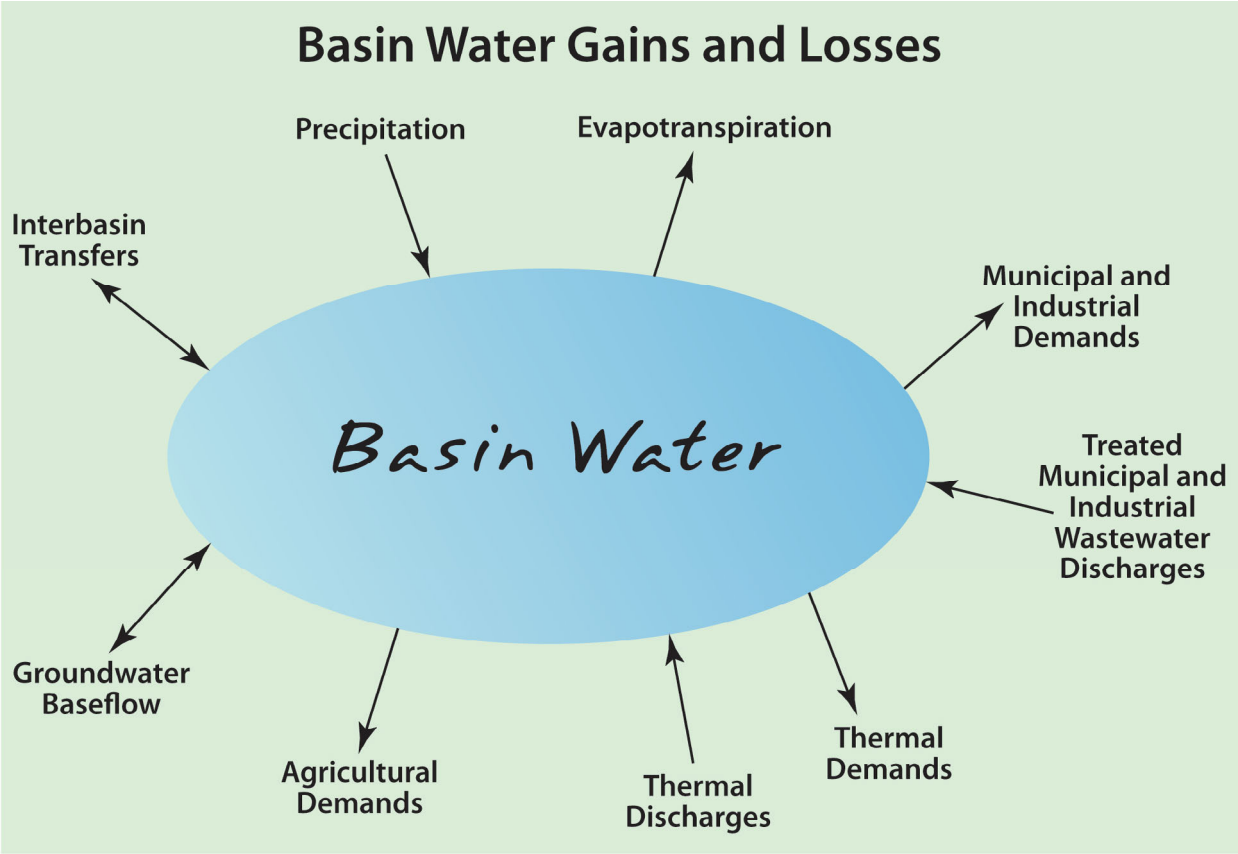


Figure 2.1-1. ACF Basin Water Gains and Losses.

Table 2.1-1.
Precipitation Record for the ACF Basin

Station Number	Location	Period of Record	Average (inches)	High (inches)	Year	Low (inches)	Year
093621	Gainesville, GA	1891–2012	53.27	74.64	1964	20.96	1904
099291	West Point, GA	1891–2012	51.24	74.34	1964	29.99	1954
090140	Albany, GA	1891–2012	50.04	71.46	1964	32.06	1954
089566	Wewahitchka, FL	1901–2012	65.81	104.13	1965	40.89	2000

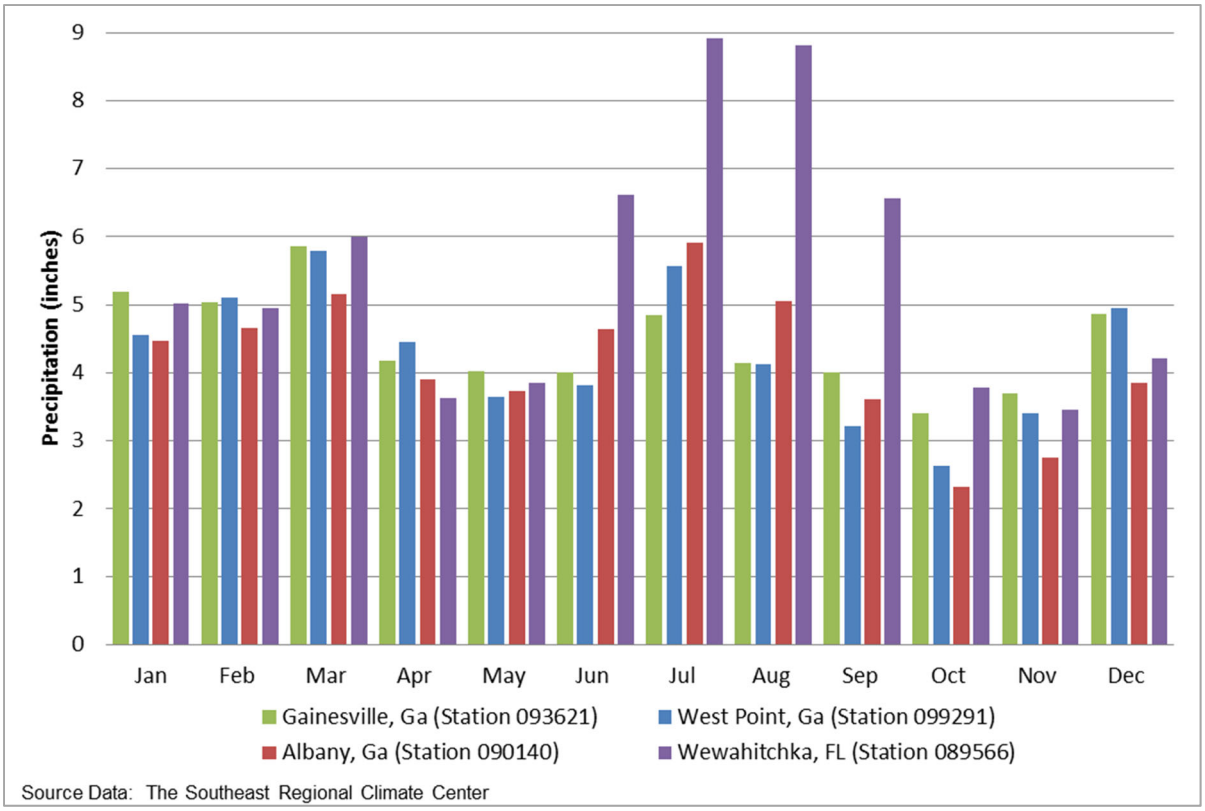


Figure 2.1-2. Average Total Monthly Precipitation Record (10/1/1891–4/30/2012) for the ACF Basin.

Yearly rainfall amounts can be highly variable from year to year, as shown in Figure 2.1-3 and Figure 2.1-4, with yearly totals ranging over 40 inches in a 3-year span. The wet and drought periods produced by these variations in rainfall are cyclical in nature, and the differences in rainfall can be attributed to changes in climate and weather patterns. Periods of heavy rainfall can be caused by El Niño events, which bring heavy winter rain to the Southeast, and active hurricane seasons, which can bring heavy rainfall in the late summer and fall. Droughts are loosely associated with La Niña events, but they are more likely caused by atmosphere-ocean climate variability and by internal atmosphere variability (Seager et al. 2009).

Additional detailed information on precipitation characteristics in the ACF Basin is available in the Master WCM and individual ACF project water control manuals (WCMs) in appendix A.

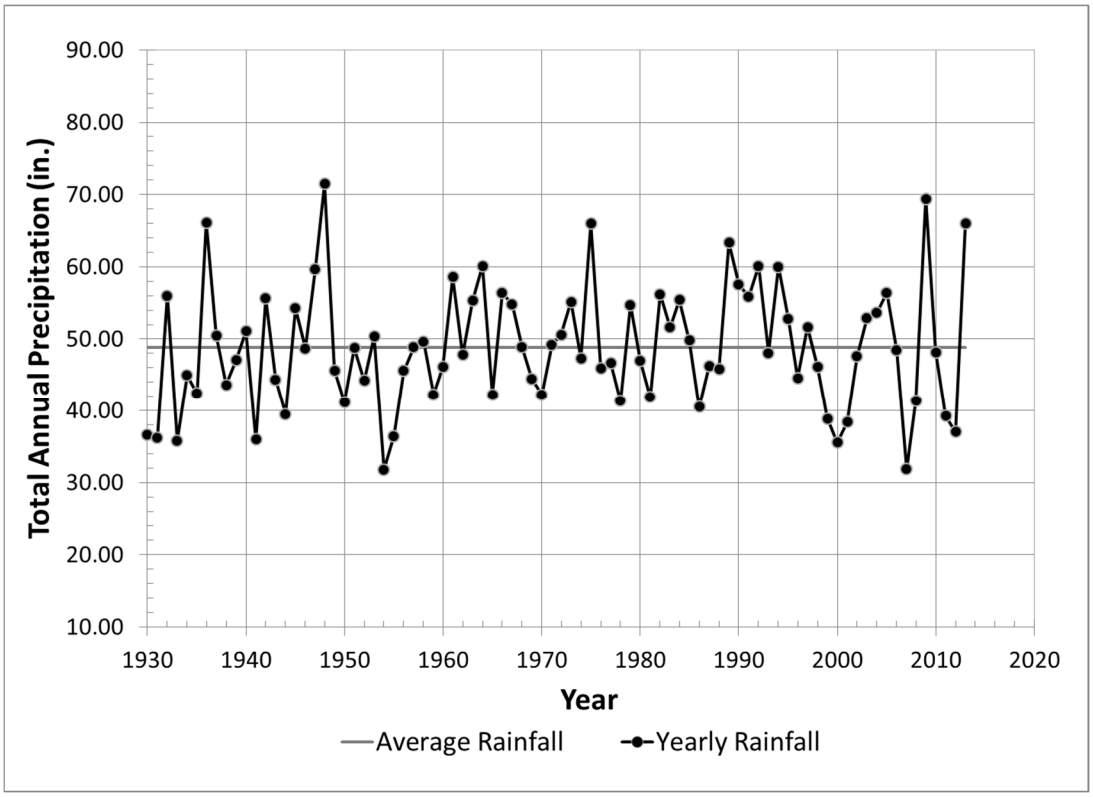


Figure 2.1-3. Yearly Rainfall for Atlanta, GA.

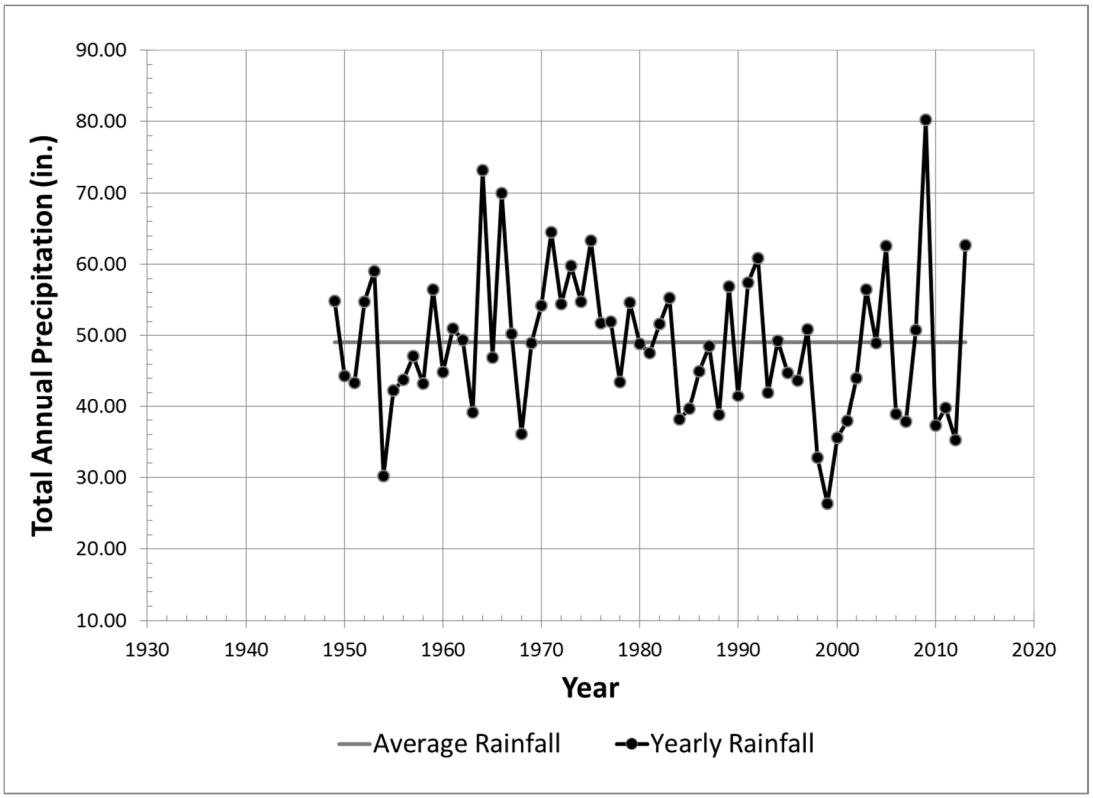


Figure 2.1-4. Yearly Rainfall for Columbus, GA.

2.1.1.1.1.1 Extreme Rainfall Events and Floods

Major flood-producing storms over the ACF Basin are usually of the frontal type, occurring in the winter and spring and lasting from 2 to 4 days. Their effect on the basin depends on their magnitude and orientation. The axes of the frontal-type storms generally cut across the long, narrow basin. Occasionally, a tropical storm or hurricane in summer or early fall will cause major flooding over the entire basin. Summer storms are typically thunderstorms with high intensities over relatively small areas that can produce serious local flooding. Under normal runoff conditions, from 5 to 6 inches of intense rainfall over a large area is required to produce widespread flooding. On many of the minor tributaries, 3 to 4 inches is sufficient to produce local floods. Some of the more significant rainfall and flooding events in the ACF Basin since 1900 are described in detail in the Master WCM and individual project WCMs in appendix A. The following paragraphs provide a brief summary of those events.

July 1916 Event—The storm of July 5–10, 1916, resulted from a hurricane that formed in the Caribbean Sea and moved northwest across the Gulf of Mexico, entering the United States east of the mouth of the Mississippi River on the evening of July 5. The disturbance continued inland across western Mississippi, turned eastward on July 7, and subsequently moved northeastward across Alabama. The heavy precipitation covered a large portion of the region, including nearly all of Alabama, the northwestern part of Florida, and large areas of Mississippi and Georgia. The storm produced general flood conditions throughout the southeastern states and, because it occurred during the middle of the growing season, caused enormous agricultural damage. The heaviest recorded rainfall in the ACF Basin was 23 inches at Blakeley, Georgia. A total of 22.7 inches fell at Alaga, Alabama, where 12.7 inches were recorded in 1 day. Flood stages were exceeded throughout the basin.

December 1919 Event—Flood-producing rainfall was experienced December 8–9, 1919, diminishing on December 10. The area of heaviest precipitation extended across southeastern Mississippi, central Alabama, and northern Georgia. The center of greatest rainfall was at Norcross, Georgia, with a total of 12.9 inches. The storm caused extreme flooding in the Chattahoochee River north of Columbus and on the upper Flint River. Flooding was moderate in the lower part of the basin.

March 1929 Event—The storm of March 11–16, 1929, resulted from a widely extending low-pressure area that developed over eastern Colorado and moved rapidly eastward causing heavy rains, particularly in Alabama and parts of Mississippi, Georgia, and Tennessee. This storm was one of the greatest storms ever recorded in this country and is outstanding with regard to intensities of precipitation over large areas. The main center was at Elba, in southeast Alabama, with a total of 29.6 inches recorded in 3 days, of which 20 inches were estimated to have fallen in 24 hours. In the ACF Basin, the most intense rainfall was recorded at Blakely, Georgia, which had a storm total of 12.9 inches and Goat Rock, which had 12.8 inches. Essentially, the entire ACF Basin received at least 4 inches of rain. Floods were moderate in the upper basin and more severe in downstream areas.

February 1961 Event—February 1961 started out cold and dry, a continuation of the weather experienced over the area during most of the preceding months of December and January. Some scattered light rains occurred during the first week of February, but not nearly enough to overcome the moisture deficit. Drought conditions were further intensified from February 9 to 18. Beginning on February 18, the dry period was abruptly followed by the rainiest 8-day period experienced in Georgia since weather records began. The rains were heaviest in the west central part of the state where both LaGrange and West Point recorded more than 17 inches in 8 days, with as much as 7 inches falling during a 24-hour period. Most locations northwest of Columbus reported more than 8 inches of rain during this period, with several areas exceeding 12 inches, enough to make February 1961 the wettest February since 1929. The heavy rainfall caused flash flooding along many northern Georgia streams with major flooding developing on the Chattahoochee River in the West Point to Columbus, Georgia, area.

July 1994 Event—On the afternoon of June 30, 1994, Tropical Storm Alberto formed in the southeastern Gulf of Mexico between the Yucatan Peninsula and the western tip of Cuba. During the first 18 hours, the storm slowly drifted to the west, and then it began a more northwestward course. It continued that course until Saturday, July 2, when the storm began turning northerly. Alberto was near-hurricane strength when it made landfall near Fort Walton Beach, Florida, on Sunday, July 3. The main threats over portions of Alabama, Florida, and Georgia were heavy rainfall and the potential for tornadoes. Due to climatic conditions, Tropical Storm Alberto became nearly stationary for several days as it moved over Georgia. Many stations reported rainfall totals exceeding 10 inches. Atlanta received 12–15 inches of rainfall, and other locations in central and southern Georgia reported 20–26 inches. Cuthbert, Georgia, in Randolph County reported 23.87 inches. The greatest flooding occurred in the Flint and Apalachicola basins. The storm caused the worst flooding on record in the lower Flint Basin, resulting in exceptional damage in Albany and other communities in the area.

May 2003 Event—During the 3-day period of May 5–7, 2003, heavy rain fell across north and central Georgia, especially in western and extreme northern counties. Some locations such as Troup and southern Meriwether counties between Atlanta and Columbus received nearly 1 ft of rain. Soils were already saturated from previous rainfall, resulting in rapid rises on many of the small streams in the western half of north and central Georgia. Moderate flooding was noted on numerous rivers and creeks in Georgia, including the Flint River near Culloden, the Conasauga River near Tilton, Sweetwater Creek near Austell, and the Chattahoochee River at West Point. At the City of West Point, the Chattahoochee River crested at 23.2 ft, more than 4 ft above flood stage, shortly after midnight on May 8, the highest level since February 1961, when the river rose to 24.9 ft (prior to construction of West Point Dam). USACE calculated the peak flow at 170,000 cfs. Without West Point Dam, USACE estimated that the Chattahoochee River at the City of West Point would have risen to around 34 ft.

September 2009 Event—The flood of September 2009 resembled a tropical event but was, in fact, caused by steady rain for 8 days. Rain began falling on Metro Atlanta on September 15, with the National Weather Service (NWS) reporting only 0.04 inch that day at the Hartsfield-Jackson Atlanta International Airport. Additional rain fell throughout the week, with only a trace amount recorded for September 18. However, a large rain event occurred in north Georgia, particularly Metro Atlanta, September 19. The NWS monitoring station at the Atlanta airport recorded 3.70 inches of rainfall from daybreak to 8:00 p.m. (more than doubling the previous record for rainfall on that date), while outlying monitoring stations recorded 5 inches of rainfall in a 13-hour period. Inside the city limits of Atlanta, several neighborhoods were flooded. The I-75/I-85 Downtown Connector, one of Georgia's busiest expressways, was submerged by floodwaters. The Governor of Georgia declared a state of emergency and requested a disaster declaration from the U.S. government for 17 counties in Georgia. The counties were Bartow, Carroll, Cherokee, Cobb, Coweta, DeKalb, Douglas, Fulton, Gwinnett, Heard, Newton, Paulding, and Rockdale around Metro Atlanta; Catoosa, Chattooga, and Walker in far northwest Georgia; and Stephens in northeast Georgia. According to the USGS, the magnitude of flooding in rivers and streams in Cobb and Douglas counties, just west of the City of Atlanta, was so great that the likelihood of recurrence was on the order of 0.2 percent (1 in 500) in any given year (commonly referred to as a *500-year storm*).

2.1.1.1.1.2 Historic Droughts

Most drought experts agree that when drought occurs, it progresses in stages. The first stage of drought is *meteorological drought*—when precipitation falls below normal levels—is usually the first indicator because it can develop quickly. This type of drought is normally expressed as a *rainfall deficit*, in a measure of deviation from normal—such as inches below normal, or a percentile. The second stage of drought is *agricultural drought,* which occurs when the amount of moisture in the soil no longer meets the needs of a particular crop. When agricultural drought occurs at a critical time of year, it can result in water-deficient topsoil, which may hinder germination, and reduce crop yield—especially if moisture is

not replenished during the growing season. This type of drought is usually measured in soil moisture levels and can be devastating to agricultural communities (GAEPD 2000).

Hydrological drought is the third stage of drought and occurs when surface and subsurface (ground) water supplies fall below normal levels due to prolonged meteorological drought. Indicators of hydrological drought include decreased streamflow rates (measured in cfs), lake levels, and groundwater levels. Hydrological drought can be detrimental to the environment, upsetting the hydrologic cycle and impacting fish, wildlife, and plant species. If hydrological drought persists for prolonged periods, demand for water may exceed supply, leading to the fourth stage—*socioeconomic drought*. A socioeconomic drought can take many months or even years to develop, often with devastating social and economic consequences for the people who are dependent on water resources for health, drinking water, and jobs (GAEPD 2000). The historic droughts affecting the ACF Basin discussed in this section have progressed to hydrological and, in most cases, to socioeconomic drought stages.

During the past 8 decades, the ACF Basin has experienced numerous droughts, several of which are considered severe. The impacts of each drought have varied across the basin. For instance, the 1930–1935 drought exceeded the 10-year recurrence interval for the northeast portion of the ACF Basin, but exceeded the 25-year recurrence interval in the southwestern portion of Georgia. The recurrence interval is the average time between droughts of a given severity. For example, a 25-year drought recurrence interval means that the drought conditions experienced would be expected to occur, on average, once every 25 years (or a 4-percent chance in any given year). In 1938–1940, the upper Chattahoochee River basin experienced a drought with a recurrence interval of 50 years, and in 1950–1957 the basin experienced a 25-year-recurrence-interval drought (USGS 2000).

Subsequent to the construction of Jim Woodruff Lock and Dam and Buford Dam by USACE in the 1950s, the ACF Basin experienced several serious droughts. Those events are summarized below.

1980–1982 Drought—The 1980–1982 drought resulted in the lowest streamflows since 1954 in most areas, and the lowest streamflows since 1925 in some areas. Recurrence intervals of 10 to 25 years were common in most of Georgia. Pool levels at four major reservoirs receded to the lowest levels since first filling. Groundwater levels in many observation wells were lower than previously observed. Nearly continuous declines were recorded in some wells for as long as 20 consecutive months, and water levels remained below previous record lows for as long as 9 consecutive months (USGS 2000).

1985–1989 Drought—The 1985–1989 drought in northern Georgia resulted in streamflows that were near the lowest of the 1900s. By 1988, the drought had reached recurrence intervals of 50–100 years in extreme northern Georgia, 10–25 years in central Georgia, and less than 10 years in southern Georgia. Water supply shortages occurred in Georgia in 1986. Shortages first occurred in a few Atlanta metropolitan systems, primarily because of large demand and small reservoir storage. As the drought continued, other systems in the southern part of the metropolitan area also had water supply problems as did several municipalities in northern and central Georgia. During 1986, USACE significantly decreased the release of water from Lake Lanier, but reservoir levels continued to recede to about 2 ft above the record minimum lake level, which occurred during the 1980–1982 drought. Groundwater levels in northern Georgia were significantly less than normal during the 1985–1989 drought, and shortages in groundwater supplies from domestic wells occurred in the northern one-third of the state (USGS 2000). During this drought period (in 1986), USACE and the states of Georgia, Florida, and Alabama established a drought management committee, which for the ACF Basin meant opening communication among the stakeholders to prepare for future supply stresses.

1998–2003 Drought—During the 1998–2003 period, streamflow gauging stations throughout Georgia established new record daily low flows, with recurrence intervals ranging from about 20 years to greater than 50-year recurrence interval low flows. From 1998 and 2000, streamflow averaged between 50 and 80 percent of normal. The rainfall deficit in 1999 was close to 11 inches. From January to August 2000, more than 40 wells statewide, mostly in the southwest parts of Georgia, recorded low water levels (Chaisson 2012). The drought reached a peak in the summer of 2000, and severe conditions prompted the Georgia Department of Natural Resources (GADNR) to implement statewide restrictions on outdoor water use.

2006–2008 Drought—The 2006–2008 drought was the most devastating recorded in Alabama and western Georgia. Precipitation declines began in December 2005. The shortfalls continued through winter 2006–2007 and spring 2007, exhibiting the driest winter and spring in the period of record. The drought reached peak intensity in 2007, resulting in a D-4 Exceptional Drought Intensity (the worst measured) throughout the summer of 2007. Rainfall at Gainesville, Georgia (Lake Lanier) was only about 20 inches for the entire year (USACE, Mobile District 2010c). The drought continued through the winter of 2008. The summer of 2007 was especially hot, and wildfires plagued southern Georgia. Tropical systems did not affect north Georgia during the hurricane season, but the drought of southern Georgia ended with Tropical Storm Barry in 2007.

During the drought, Governor Sonny Perdue issued a declaration of disaster and asked for federal aid for the 85 counties affected by the "historic" drought. Outdoor water use was banned in Metro Atlanta, except under very limited circumstances. Lake Lanier's historic low, recorded on December 26, 2007, was 1050.79 ft, which was 20.21 ft below full summer pool level. In May 2008, Lake Lanier was still 13 ft below its full level.

2011–2012 Drought—From about May 2011 through 2012, areas in central and southwest Georgia experienced drought conditions ranging from severe to extreme. This drought did not appreciably affect the upper Chattahoochee River Basin, but the Flint River portion of the ACF Basin was directly and significantly affected. The Flint River experienced record low flow conditions during much of the drought period, and agricultural activities in the Flint River Basin were significantly affected (Knox 2012). Groundwater levels in the lower Flint River Basin were, in many cases, at or near record lows (Stooksbury 2011). The depletion of flows in the Flint River placed more pressure on USACE reservoirs in the Chattahoochee River Basin to provide releases necessary to meet minimum flow requirements downstream of Jim Woodruff Lock and Dam.

2.1.1.1.2 Runoff Characteristics

Within the ACF Basin, rainfall occurs throughout the year but is less abundant in August through November. The amount of rainfall that actually contributes to streamflow varies much more than the rainfall. Several factors such as plant growth and seasonal rainfall patterns contribute to the volume of runoff. In severe droughts in the upper Chattahoochee River Basin, the runoff from significant (3+ inches) rain events can be as low as 5 percent of the rainfall. Figure 2.1-5, Figure 2.1-6, and Figure 2.1-7 present the average monthly rainfall and runoff for three segments of the basin: (1) above Atlanta, Georgia; (2) Atlanta to Columbus, Georgia; and (3) Columbus to Blountstown, Florida. These figures also show runoff as a percent of rainfall (by month) for the three segments. The mountainous areas in the headwaters of the basin exhibit flashier runoff characteristics and somewhat higher percentages of runoff, ranging from about 28–60 percent of rainfall depending on the time of year. In contrast, runoff as a percent of rainfall between Blountstown, Florida, and Columbus, Georgia, ranges from about 16 to 53 percent depending on the time of year. In all portions of the ACF Basin, runoff as a percentage of rainfall is lowest in July–September.

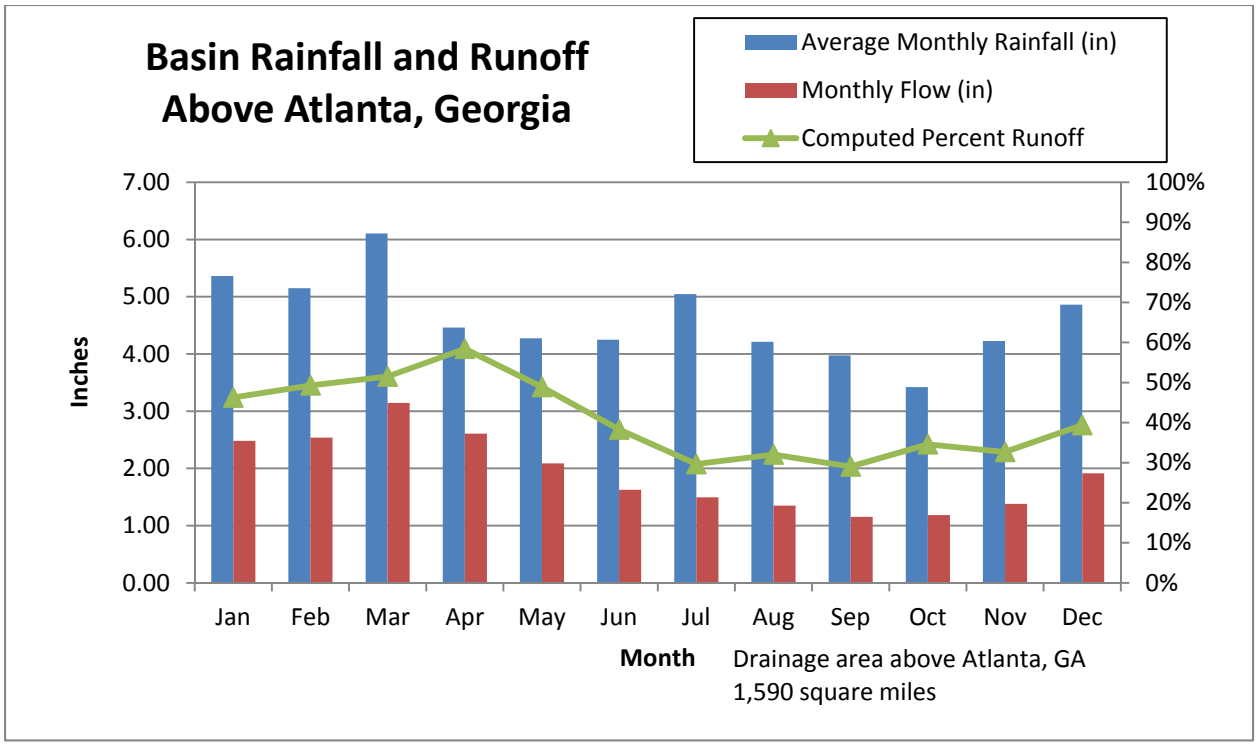


Figure 2.1-5. Basin Rainfall and Runoff above Atlanta, GA.

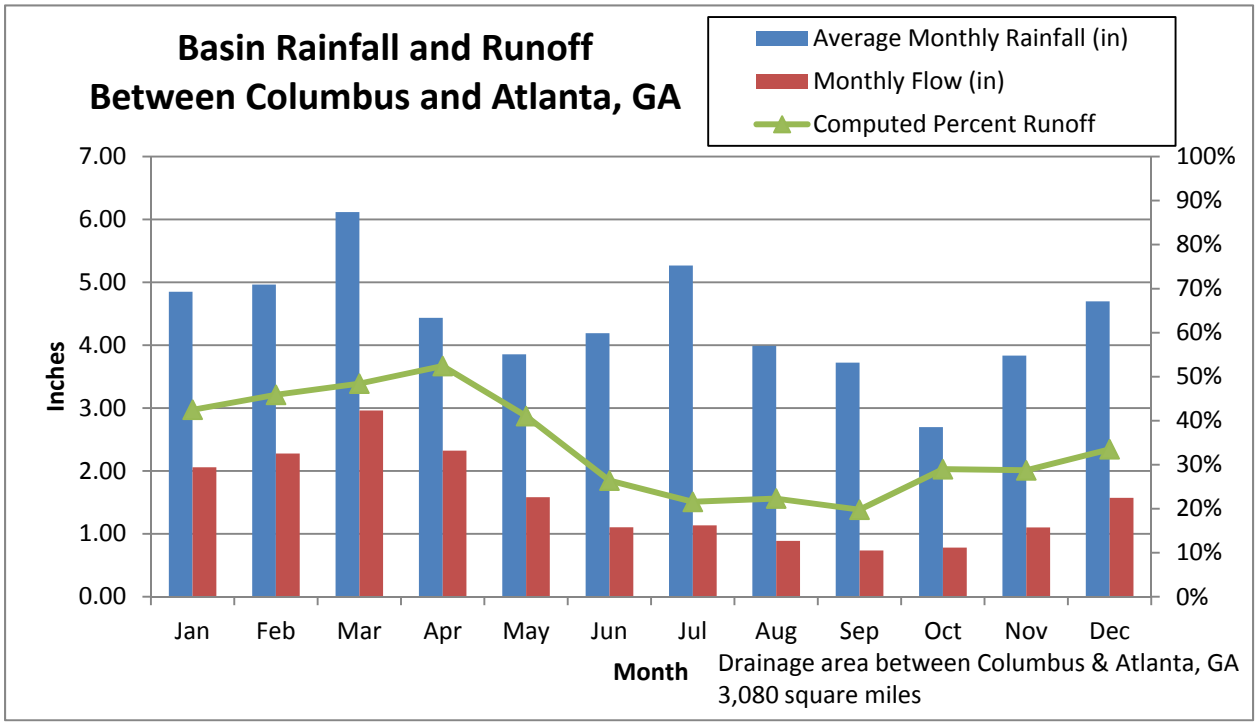


Figure 2.1-6. Basin Rainfall and Runoff between Columbus and Atlanta, GA.

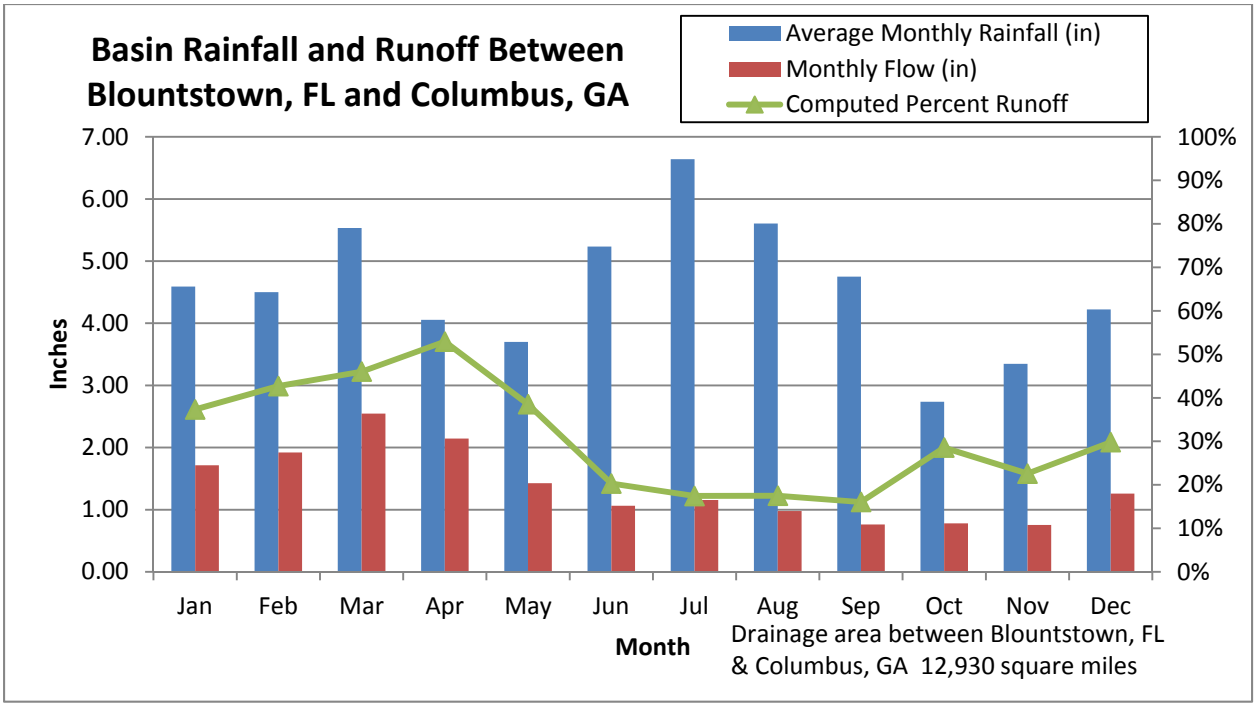


Figure 2.1-7. Basin Rainfall and Runoff between Blountstown, FL, and Columbus, GA.

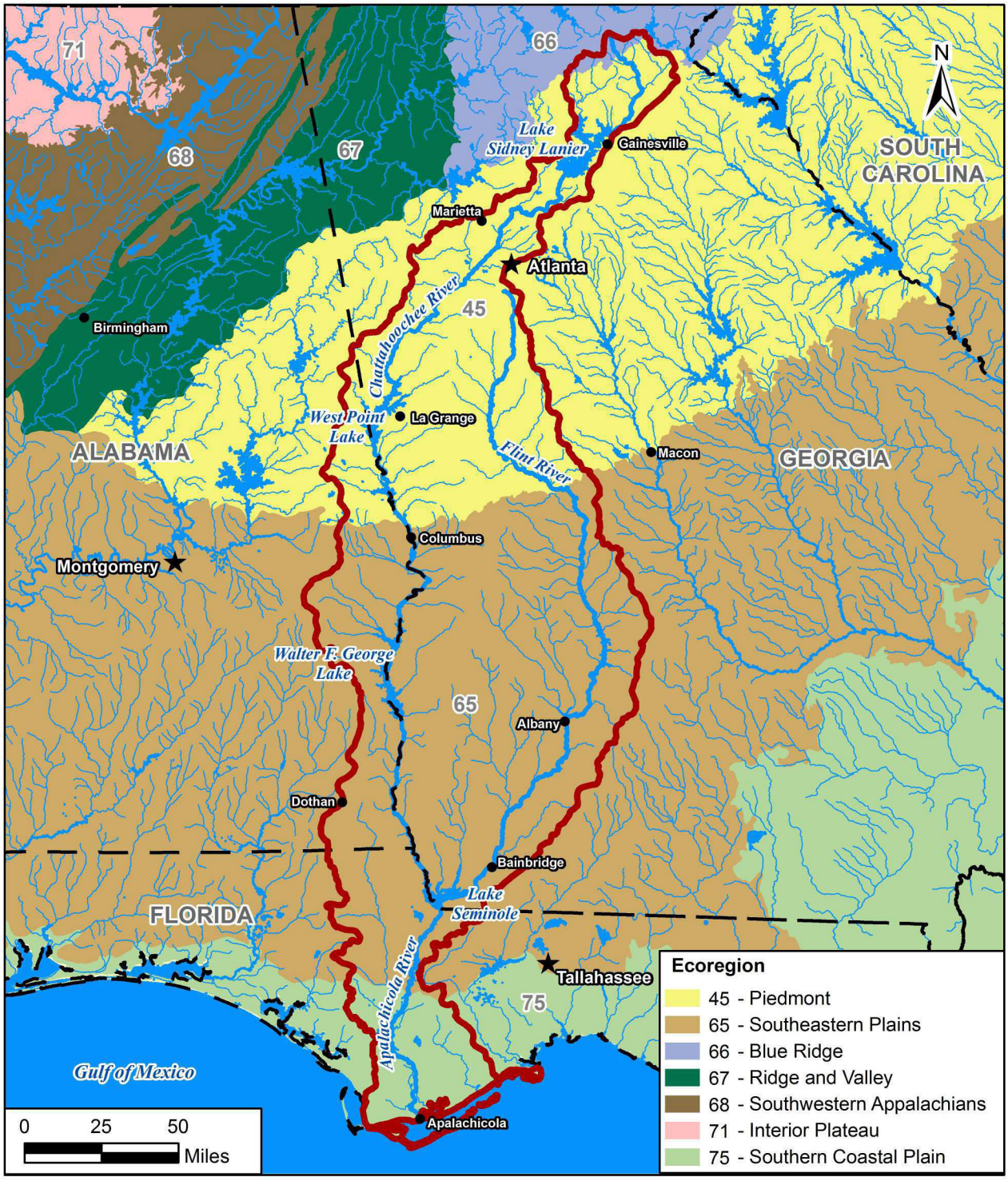
2.1.1.1.3 The Relationship between Geology and Water Quantity

As described in more detail in section 2.2.1, the ACF Basin is divided into four level III ecoregions (Figure 2.1-8). The northernmost portion of the upper Chattahoochee River Basin lies in the Blue Ridge ecoregion, comprising only about 1 percent of the ACF Basin. This ecoregion is characterized by mountain ridges ranging up to about 3,500 ft in altitude. The balance of the upper Chattahoochee River Basin and the upper Flint River Basin are in the Piedmont ecoregion. Most streams in the Chattahoochee River have trellised and rectangular drainage patterns due to the Brevard fault. The Flint River and streams in its basin have dendritic drainage patterns, resembling a branching tree. The streams in the Piedmont are fast flowing and are characterized by rapids and riffles, making them ideal for hydroelectric power generation.

The Southeastern Plains begin at the *Fall Line*, which is the contact point between the crystalline bedrock of the Piedmont and unconsolidated sediments of the Plains (GAEPD 1997). The area is highly dissected by streams, especially in the northern Georgia Sand Hills. The Dougherty Plain district in the south is underlain by limestone, and its karst topography is very flat and has numerous sinkhole-created marshes and wetlands (GAEPD 1997).

Streams in the Southeastern Plains are relatively low-gradient and sandy bottomed, and rivers are wide and sinuous with large floodplains (GAEPD 1997). Streams can be deeply entrenched into aquifers, and many receive significant contributions from groundwater. A description of aquifers is presented in section 2.1.1.1.7. The area has little runoff because annual precipitation and evapotranspiration rates are similar. During times of heavy rainfall events, the wide floodplains are able to store large quantities of water.

The Southern Coastal Plain is a flat, lowland area that contains barrier islands, coastal lagoons, marshes, and swampy lowlands. Soils in the area are generally hydric and have a high capacity to hold and store water. The Southern Coastal Plain is dominated by large alluvial rivers, such as the Apalachicola River, which has a broad floodplain that ranges from 1 to 5 miles (mi) and is dominated by substantial flooding.



Level III Ecoregions

Figure 2.1-8

2.1.1.1.4 The Relationship between Land Use and Water Quantity

Land use can significantly alter watershed hydrographs through increases in impervious surfaces and in anthropogenic water consumption. A more detailed description of land use is presented in section 2.4.

Nearly 50 percent of the ACF Basin is forested; this is down from 55 percent in the 1990s (USGS NLCD 1992). A large portion of the precipitation on forested lands is intercepted and prevented from quickly reaching surface water streams through infiltration and evapotranspiration processes. Following pine plantation harvesting, water yields can increase as much as 35 percent due to decreases in interception and evapotranspiration. Forested ecosystems have high stream baseflows and low, lengthy storm peaks compared to other common land uses because of high infiltration and permeability rates. Forest cover (e.g., leaves and mulch) reduces raindrop velocities, allowing for higher infiltration, and soils have organic concentrations with higher porosities, allowing for higher permeability. During high storm flows, wetland forests, often streamside, can store large quantities of water and reduce downstream flooding impacts.

The intensity of drought and wet periods is exacerbated by changes in land use and population demand on resources. From 1970 to 1990, water use for public supply in the ACF Basin, which includes Metro Atlanta, more than tripled to almost 460 mgd. Severe droughts and increased development in the area have resulted in shortages and restrictions on limited surface water supplies. Demand continued to increase between 1990 and 2010. Concurrently, various conservation measures have been instituted and periodically strengthened to curb the increased demand and per capita water use (MNGWPD 2009). Demand and conservation measures are discussed in more detail in section 2.1.1.2.10.

Total agricultural land in the ACF Basin has decreased over the past couple of decades due to urbanization and farm abandonment, but more than 20 percent of the land cover is still used for agricultural purposes. Agriculture in the ACF Basin uses both surface water and groundwater for crop irrigation and livestock watering. Most crop irrigation occurs in the Lower Flint River Basin and Lower Chattahoochee River Basin. In the Flint River Basin groundwater supplies nearly all of the water needed for crop irrigation, whereas in the Chattahoochee River Basin groundwater supplies only 44 percent of the water needed for crop irrigation. Livestock agricultural uses are throughout the basin, and farmers use both groundwater and surface water to water livestock. Water used for crop irrigation is considered to be 100 percent consumptive because it is incorporated into crops or lost through evapotranspiration. Details of water withdrawals in the basin are provided in section 2.1.1.2.5.

Compared to forested land use, agricultural land uses produce larger storm flows during rain events because of the reduced soil cover. The runoff rates from agricultural areas are similar to the rates from low- and medium-density residential areas.

Urban areas significantly affect water quantity because of the high percentage of impervious cover and increases in water consumption. Rainfall on impervious surfaces is immediately transported to streams, causing high peak flows. Urban areas also have large areas of land with significantly reduced infiltration and permeability rates, such as grassy and barren land. These areas also shed water extremely quickly during storm events. Because less infiltration occurs in residential and industrial areas, very little groundwater recharge occurs and stream baseflows are reduced.

Figure 2.1-9 illustrates the impact of impervious cover on storm peaks and baseflow. The USGS's Peachtree Creek gage (USGS02336300) watershed is in a high- and medium-density urban area, while the USGS's Sweetwater Creek gage (USGS023368400) watershed is in a forested and low- to medium-density urban area. Both streams are major tributaries to the Chattahoochee River and flow through portions of the Metro Atlanta. Although the two gages have a similar contributing area, baseflow in Sweetwater Creek is higher because of the high infiltration and permeability rates of the forested areas.

The peak flow in Peachtree Creek is much higher because of the high percentage of impervious surfaces, which quickly transport water during storm events.

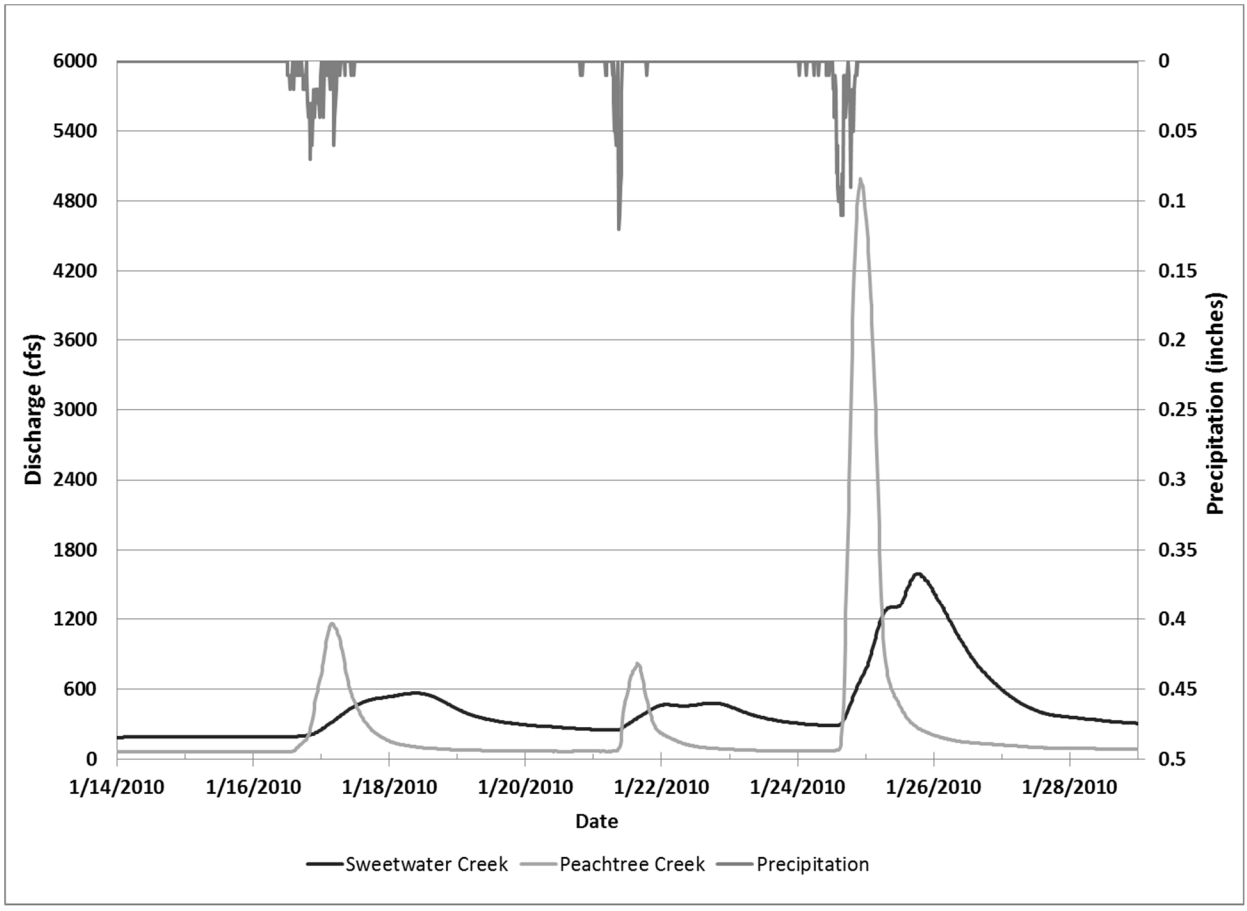


Figure 2.1-9. Discharges during Storm Events for Peachtree Creek (USGS02336300) and Sweetwater Creek (USGS023368400).

Most water removed from the basin for M&I water demands is returned to the basin as treated waste, but demands can alter natural channel flow. In the Chattahoochee River Basin, approximately 82 percent of the water withdrawn is returned (GAEPD 1997), although sources cited elsewhere in this EIS indicate that the returned percentage could be more in the range of 60 to 80 percent. Water is lost from the system through evapotranspiration, interbasin transfers, and thermal water demands. Municipal water suppliers use both surface water and groundwater, depending on supply levels. Water is often returned downstream of the supply source, and groundwater is often returned to the system as surface water. Water use for hydroelectric power generation is nonconsumptive, but hydroelectric dams can alter natural flow regimes because large releases occur during peak power demand periods. Water used for thermoelectric power generation (i.e., fossil fuels and nuclear) is moderately consumptive to nonconsumptive (GAEPD 1997). Historically, the Chattahoochee and Apalachicola rivers were used for barge traffic, and water has been released from dams to help maintain navigable channel depths downstream; navigation is also nonconsumptive. More recent operations for navigation are described in section 2.1.1.2.4.3.

2.1.1.1.5 Surface Water: Rivers

The three principal rivers in the basin are the Chattahoochee, Flint, and Apalachicola rivers (Figure 1.1-1). The Chattahoochee and Flint rivers join to form the Apalachicola River in northwest Florida. The Chattahoochee River has a drainage area of 8,708 square miles (sq mi). The drainage area of the Flint River measures 8,456 sq mi. The remaining 2,409 sq mi of the ACF Basin drain directly into the Apalachicola River. The rivers are shown in profile view on Figure 2.1-10, which reflects the gradient of the rivers and the relative locations of dams and other key geographical features. Major tributaries to the mainstem rivers in the ACF Basin are listed with their respective drainage areas and number of mi above the mouth of its confluent stream, in Table 2.1-2.

Rivers in the ACF Basin include both natural (unregulated) rivers and regulated rivers. The natural rivers exhibit a more consistent pattern, responding to precipitation and drought periods as expected with short periods of high flows and prolonged periods of low flows, respectively. Regulated streams exhibit a variable pattern, with daily variations due to hydroelectric power generation operations (most prominent below peaking projects), navigation releases, lower flood peaks, and higher sustained minimum flows through dry periods as the upstream reservoirs augment low flows. Typical flow patterns (i.e., mean daily discharge) for a regulated stream over a year are illustrated in Figure 2.1-11 (Chattahoochee River), and typical patterns for a more natural (or minimally regulated) stream are illustrated in Figure 2.1-14 (Flint River). Although the two rivers have only slightly different drainage areas, the figures demonstrate the distinctive characteristics of a natural stream vs. a regulated stream.

2.1.1.1.5.1 Chattahoochee River

The Chattahoochee River originates in the Blue Ridge Mountains of north Georgia, near the westernmost tip of South Carolina, and extends to the southwest corner of the state. The Chattahoochee River covers a distance of 434 mi from the Blue Ridge Mountains to Lake Seminole. It flows out of the mountains, past Metro Atlanta, and reaches the Georgia-Alabama border, at which point it forms the border between the two states. From there, the Chattahoochee River flows south to its confluence with the Flint River at Lake Seminole and into the Apalachicola River.

Over most of its length, the Chattahoochee River is controlled by dams, with navigation locks and hydroelectric plants, that provide for navigational use of the river, release water for the production of hydroelectric power generation, temporarily store water for flood risk management, and serve other purposes. The slope of the Chattahoochee River for 50 mi above Buford Dam is approximately 4 feet per mile (ft/mi). The Chattahoochee River is free-flowing only in the headwaters upstream of Lake Lanier. Between Buford Dam and West Point Dam, the slope is fairly uniform and averages about 2.7 ft/mi. Downstream of Buford Dam, the river is affected by dam and reservoir operations. Many of the dams and hydroelectric plants operate in a peaking mode, which can result in daily water level fluctuations in the river of 4 ft or more (USGS 1996). Storage for flood risk management at several of the larger reservoirs reduces the peak flow in the river by storing much of the flood flow.

In contrast to the mainstem of the river, the numerous tributaries of the Chattahoochee River are free-flowing. These streams typically have higher sustained flows during winter months and show sharper responses to storm events throughout the year (USGS 1996).

Table 2.1-2.
Tributaries of the ACF Basin

Stream	Drainage Area (sq mi)	Miles above Mouth of Confluent Stream
Chattahoochee River Basin		
Soque River	166	402
Chestatee River	318	363
Peachtree Creek	122	301
Sweetwater Creek	287	289
Dog River	70	274
Cedar Creek	51	261
New River	172	228
Yellowjacket Creek	192	214
Flat Shoal Creek	200	190
Mulberry Creek	209	174
Upatoi Creek	560	151
Uchee Creek	340	143
Hannahatchee Creek	142	122
Cowikee Creek	480	105
Barbour Creek	101	93
Pataula Creek	40	85
Cemochechobee Creek	105	75
Colomokee Creek	103	67
Abbie Creek	204	59
Omusee Creek	144	48
Sowhatchee Creek	72	35
Bryans Creek	52	29
Chattahoochee River	8,708	108
Flint River Basin		
Line Creek	220	296
Whiteoak Creek	179	291
Redoak Creek	172	282
Liza Creek	185	256
Potato Creek	240	250
Swift Creek	114	244
Auchumpkee Creek	97	235
Patsiliga Creek	152	214
Whitewater Creek	236	186
Buck Creek	189	181
Turkey Creek	174	154
Muckafoonee Creek	1,000	104
Dry Creek	66	91
Racoon Creek	157	81
Cooleewahee Creek	157	70
Ichawaynochaway Creek	1,080	53
Spring Creek	710	3
Flint River	8,456	108
Apalachicola River Basin		
Chipola River	1,270	28
Apalachicola River	2,409	0
New River	569	0
Apalachicola Bay	266	0

The capacity of the Chattahoochee River within its banks varies substantially throughout the river's length. The capacity is about 10,000 cfs between Lake Lanier and Norcross, about 18,000 cfs from Atlanta to Whitesburg, and about 47,500 cfs near West Point and Columbus (USACE, Mobile District 1997). Historically, flows at the USGS gage on the Chattahoochee River at Columbus have been as low as 480 cfs (in October 1931) and as high as 120,000 cfs (in February 1961). The river's slope becomes quite steep through the Fall Line hydroelectric power generation projects, from West Point Dam to Columbus, Georgia, averaging about 10 ft/mi. Downstream of Columbus to Jim Woodruff Lock and Dam, the slope of the river is relatively flat at 1.2 to 0.6 ft/mi. The river's gradient is illustrated in the profile map in Figure 2.1-10. This profile presents river miles (RMs) from the mouth of the Apalachicola River; other references may indicate RMs from the mouth of the Chattahoochee River or Flint River.

The highest monthly average flows occur in the late winter/early spring months of February to April, which is typically the rainy season. Through late spring and summer, lower precipitation and high evapotranspiration combine to reduce river flows. The lowest average monthly flows typically occur at the end of the summer in September. The mean daily discharges during the year at several gages in the Chattahoochee River Basin are illustrated in Figure 2.1-11 through Figure 2.1-13.The reservoirs depicted on Figure 2.1-10 are discussed in detail in section 2.1.1.1.7.

2.1.1.1.5.2 Flint River

The Flint River originates just south of Atlanta and flows about 350 mi in a southerly direction, curving to the west to join the Chattahoochee River at Lake Seminole in the southwest corner of Georgia. The Flint River drainage basin has an average width of about 40 mi. The Flint River is generally fed by groundwater from its headwaters to its mouth. North of the Fall Line, the Flint River receives groundwater by diffuse leakage into the river bottom; south of the Fall Line, groundwater flow from springs becomes more prevalent (Torak 1996).

In the upper reach of the Flint River, above the Fall Line, the slope of the river averages about 2 ft/mi. For about 55 mi across the Fall Line, in the general vicinity of Thomaston, Georgia, the slope averages about 6.7 ft/mi. The lower portion of the Flint River has an average slope of about 1.0 ft/mi (see Figure 2.1-10).

Three tributaries of the lower Flint River have drainage areas of considerable size: Spring Creek (710 sq mi), Ichawaynochaway Creek (1,080 sq mi), and Muckafoonee Creek (1,000 sq mi). There are only two limited-storage-capacity reservoirs on the Flint River (i.e., Lake Blackshear and Lake Worth), and they do not substantially modify the flow in the river. The remainder of the river is free-flowing until it empties into Lake Seminole near the confluence with the Chattahoochee River.

The capacity of the Flint River within its banks ranges from about 30,000 cfs near Montezuma to about 35,000 cfs near Bainbridge, in the headwaters of Lake Seminole. Historically, flows at the Albany gage, which is about midway between Lake Seminole and the Flint River's headwaters, have been as low as 327 cfs (in August 1930) and as high as 119,000 cfs (in July 1994 as a result of Tropical Storm Alberto) (USGS 2008).

Streamflows on the Flint River exhibit a more natural pattern than those on the Chattahoochee River because of the lack of regulation on the Flint. There also is a substantial groundwater-to-surface water transfer in the lower portions of the Flint River, which helps to sustain higher winter flows in the river. Figure 2.1-14 through Figure 2.1-16 depict mean daily discharges throughout the year at several gages on the Flint River.

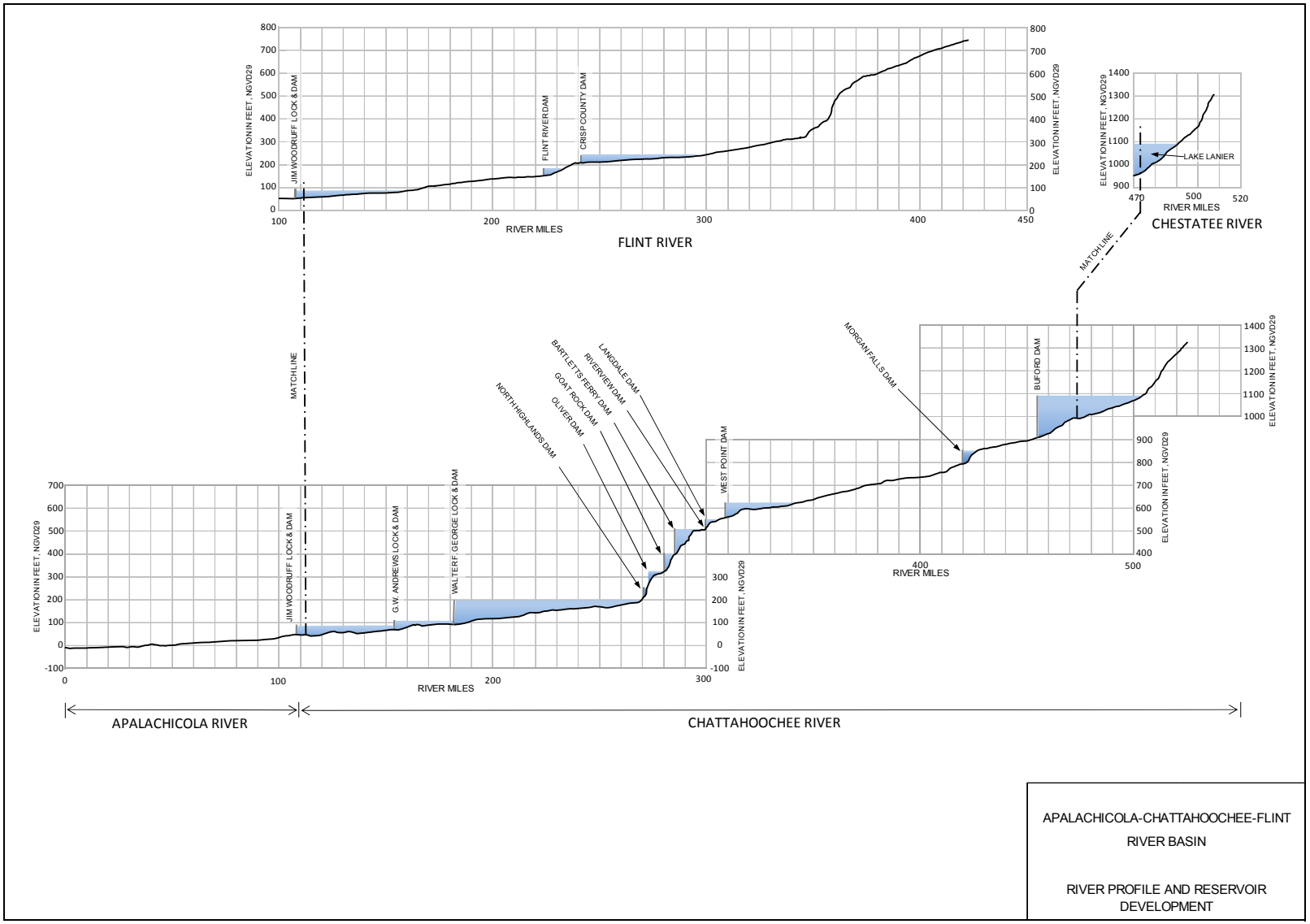


Figure 2.1-10. Apalachicola-Chattahoochee-Flint River Basin Profile Map.

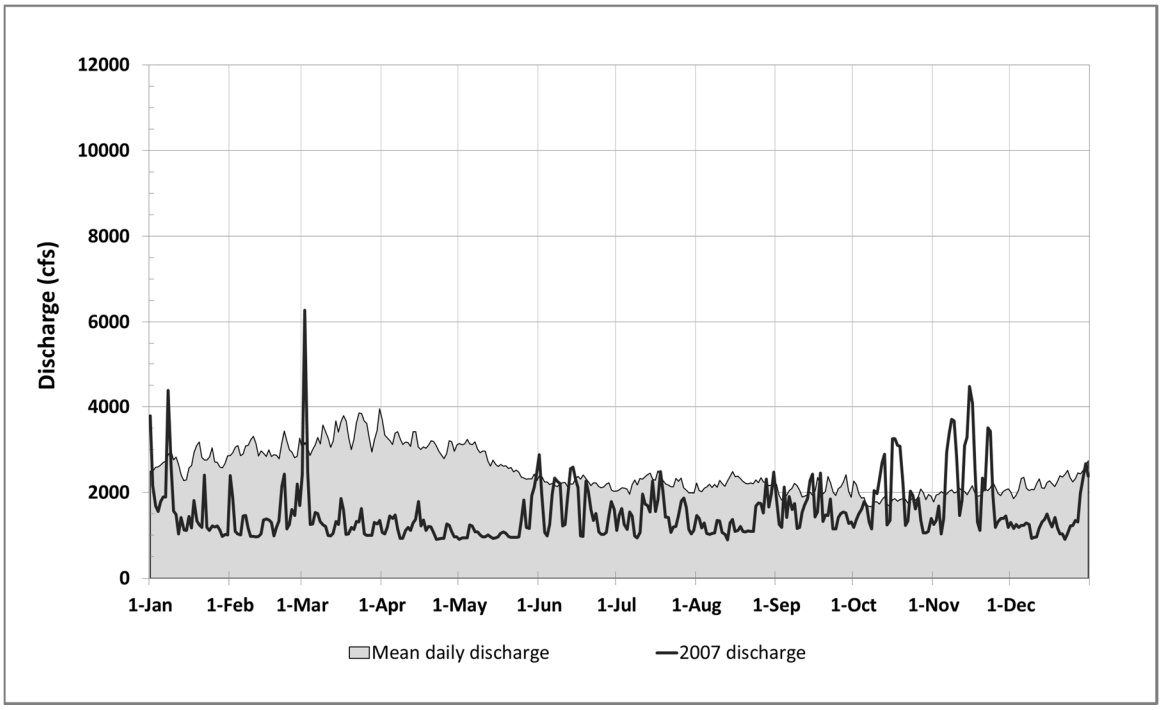


Figure 2.1-11. Chattahoochee River Discharge at USGS Gage 02336000 at Atlanta, GA (1928–2013).

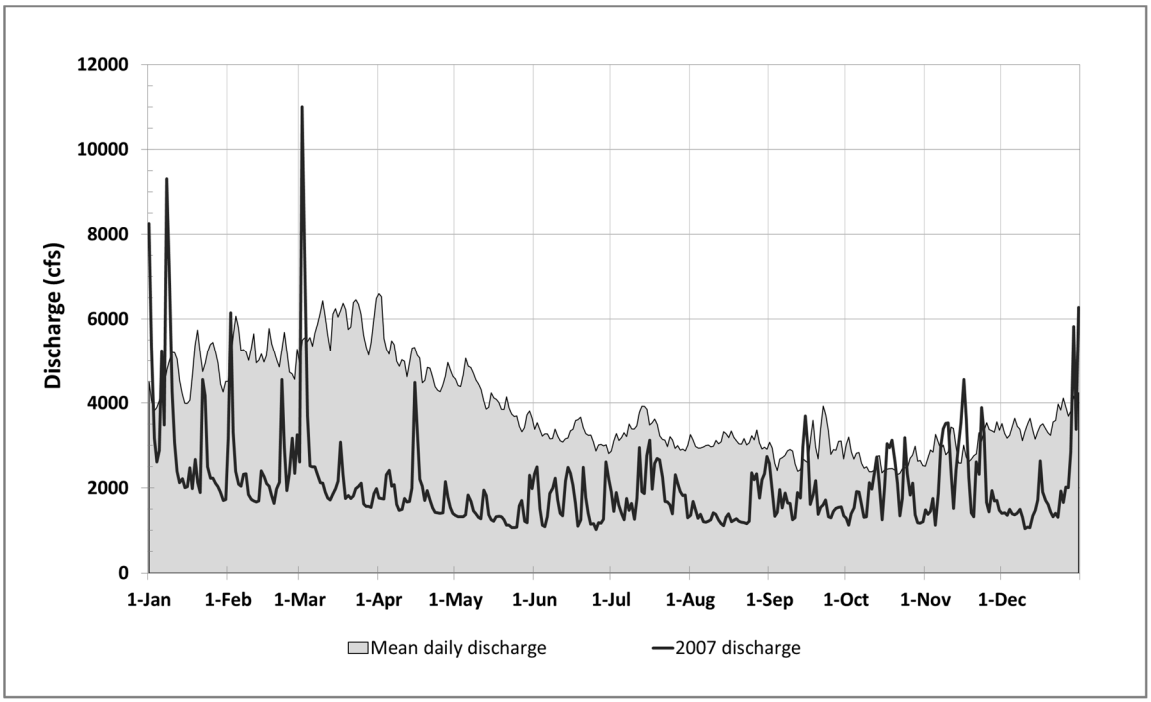


Figure 2.1-12. Chattahoochee River Discharge at USGS Gage 02338000 at Whitesburg, GA (1938–2013).

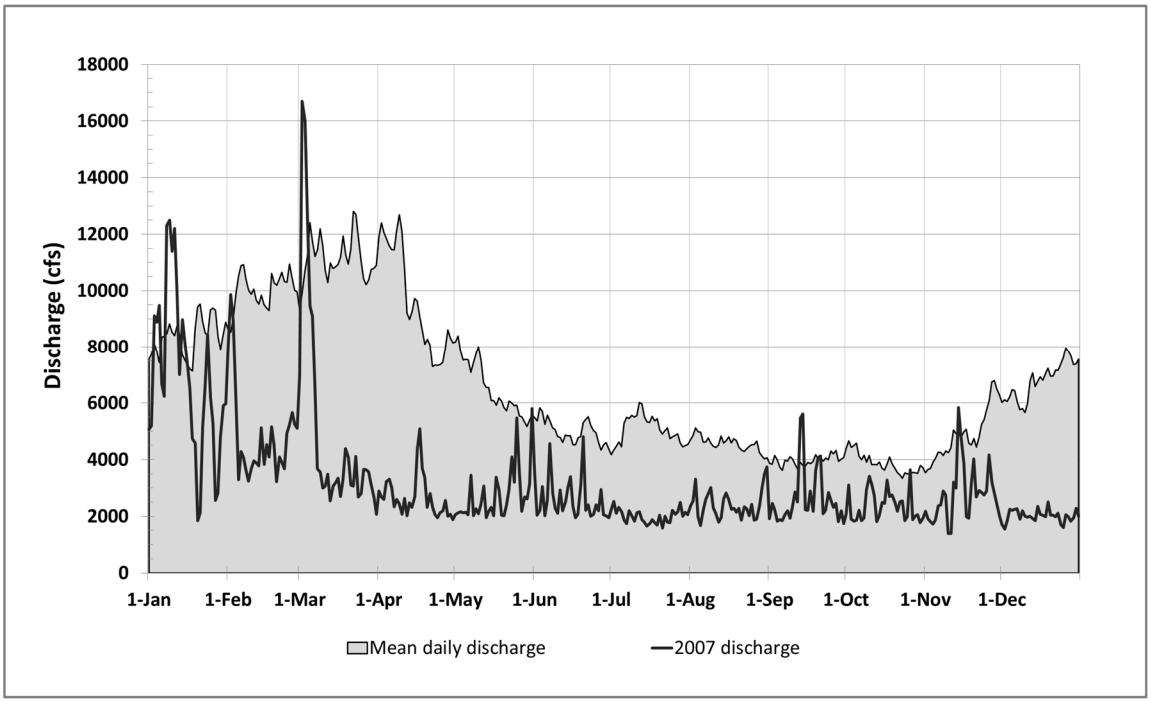


Figure 2.1-13. Chattahoochee River Discharge at USGS Gage 02341505 at Columbus, GA (1929–2013).

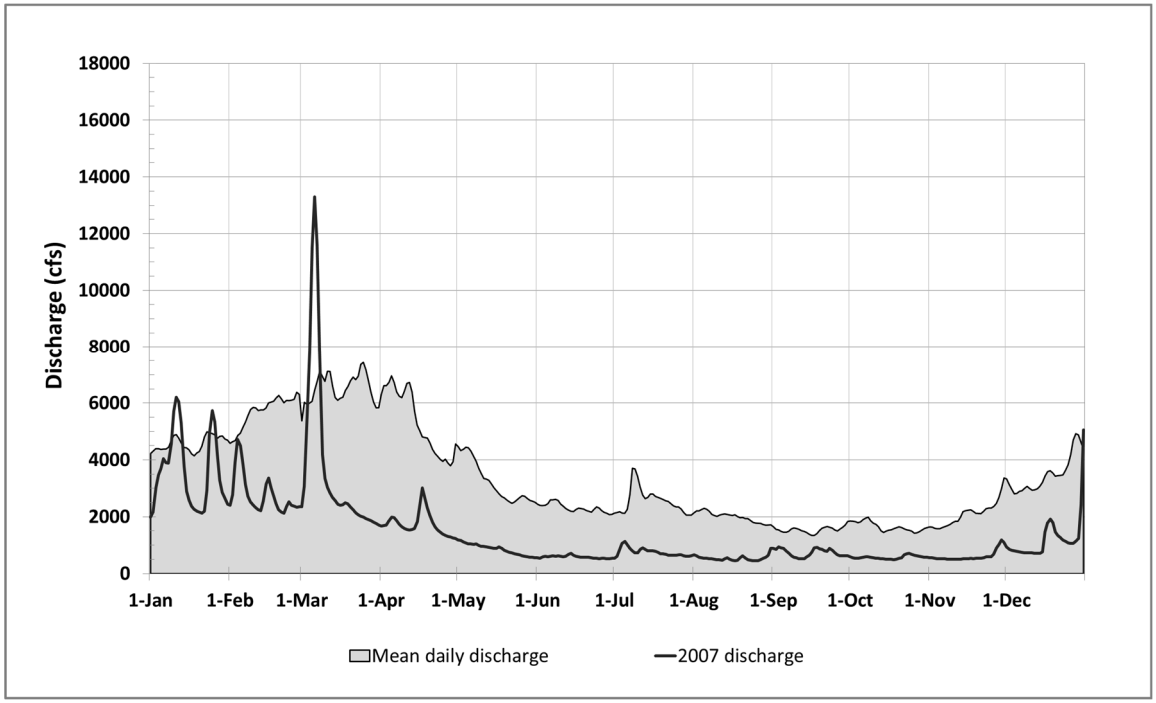


Figure 2.1-14. Flint River Discharge at USGS Gage 02349605 at Montezuma, GA (1904–2013).

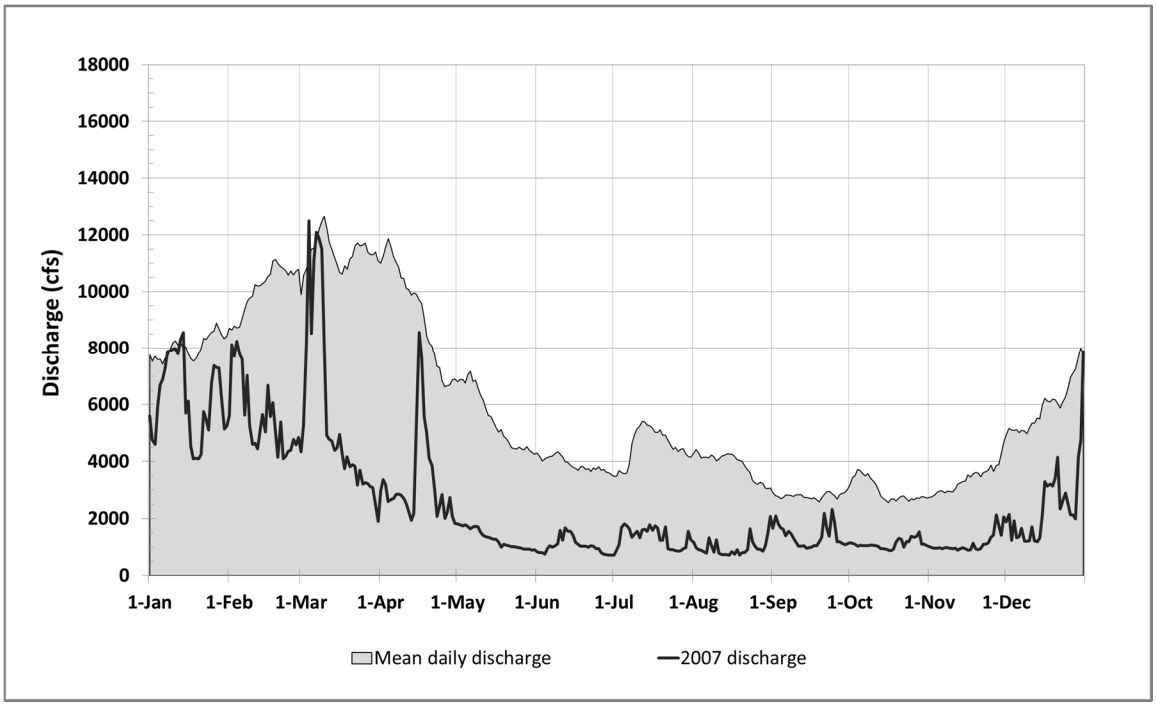


Figure 2.1-15. Flint River Discharge at USGS Gage 02352500 at Albany, GA (1901–2013).

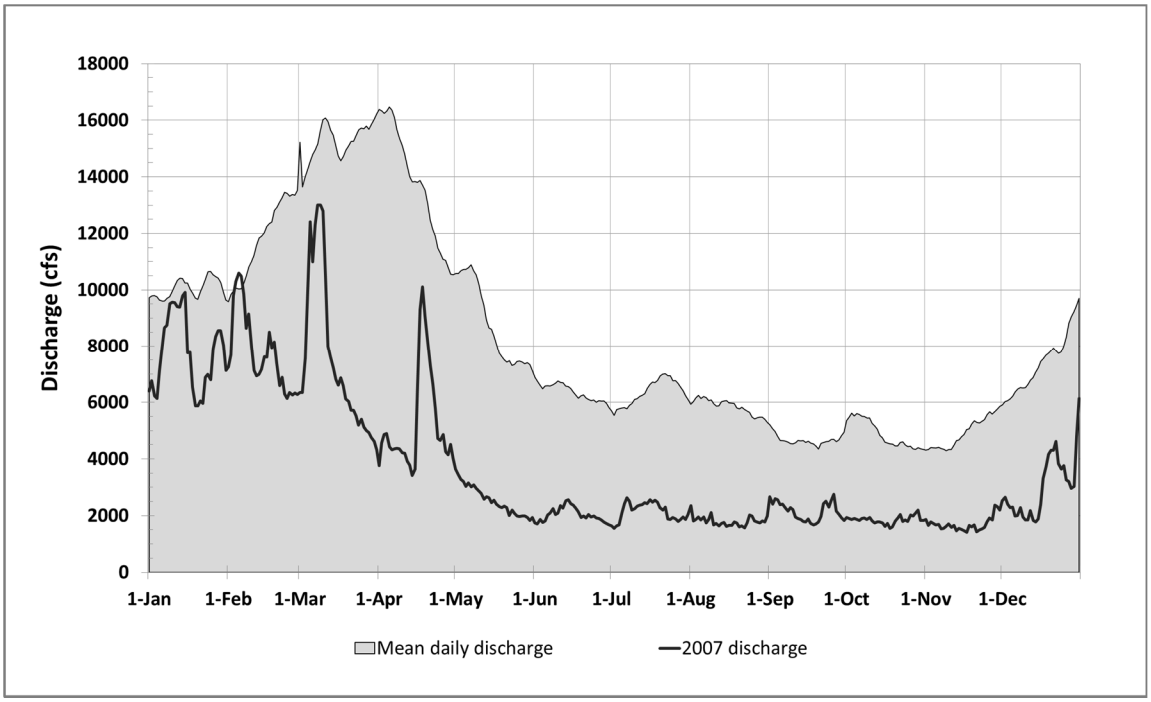


Figure 2.1-16. Flint River Discharge at USGS Gage 02356000 at Bainbridge, GA (1907–2013).

2.1.1.1.5.3 Apalachicola River

The Flint and Chattahoochee rivers converge at Lake Seminole, which is formed by the Jim Woodruff Lock and Dam. The Apalachicola River flows unimpeded for approximately 106 mi from the dam near the Florida-Georgia state line to the Gulf of Mexico at Apalachicola Bay, a major fishery resource for oysters, shrimp, and finfish. The river drains about 2,409 sq mi, and its shallow estuary covers about 208 sq mi. Tides in the Gulf of Mexico influence the Apalachicola River over approximately the lower 25 mi of the river. The tides have a mean range of 2 ft. The width of the river ranges from several hundred ft when confined to its banks to nearly 4.5 mi during flood flows. The discharge of the Apalachicola River accounts for 35 percent of the freshwater flow on the western coast of Florida (USGS 1996). The slope of the Apalachicola River is fairly flat at 0.5–0.7 ft/mi over its entire length (see Figure 2.1-10).

The Chipola River is the only sizable tributary to the Apalachicola River besides the Flint and Chattahoochee rivers. The Chipola River Basin drains 1,270 sq mi, which accounts for about one-half of the Apalachicola River's drainage area in Florida. The Chipola River is a spring-fed river with baseflow derived principally from aquifers (Frick et al. 1996).

The capacity of the Apalachicola River within its banks is approximately 100,000 cfs at Chattahoochee, Florida. Historically, flows at the Chattahoochee gage ranged from a low of 3,900 cfs (during the 1986–1987 drought period) to a peak of 291,000 cfs in 1929 before many of the upstream reservoirs were built (USGS 2009). More recently, flows have been as high as 203,000 cfs in July 1994 after Tropical Storm Alberto brought heavy rains to Georgia.

Mean daily discharge at two gages (Chattahoochee and Blountstown, Florida) are illustrated in Figure 2.1-17 and Figure 2.1-18. Similar to the pattern exhibited by the Chattahoochee and Flint rivers, flows on the Apalachicola River are highest in spring and lowest in late summer. The large seasonal fluctuation in flow in the Apalachicola River is important to the ecological function of the river and its estuary (USGS 1996).

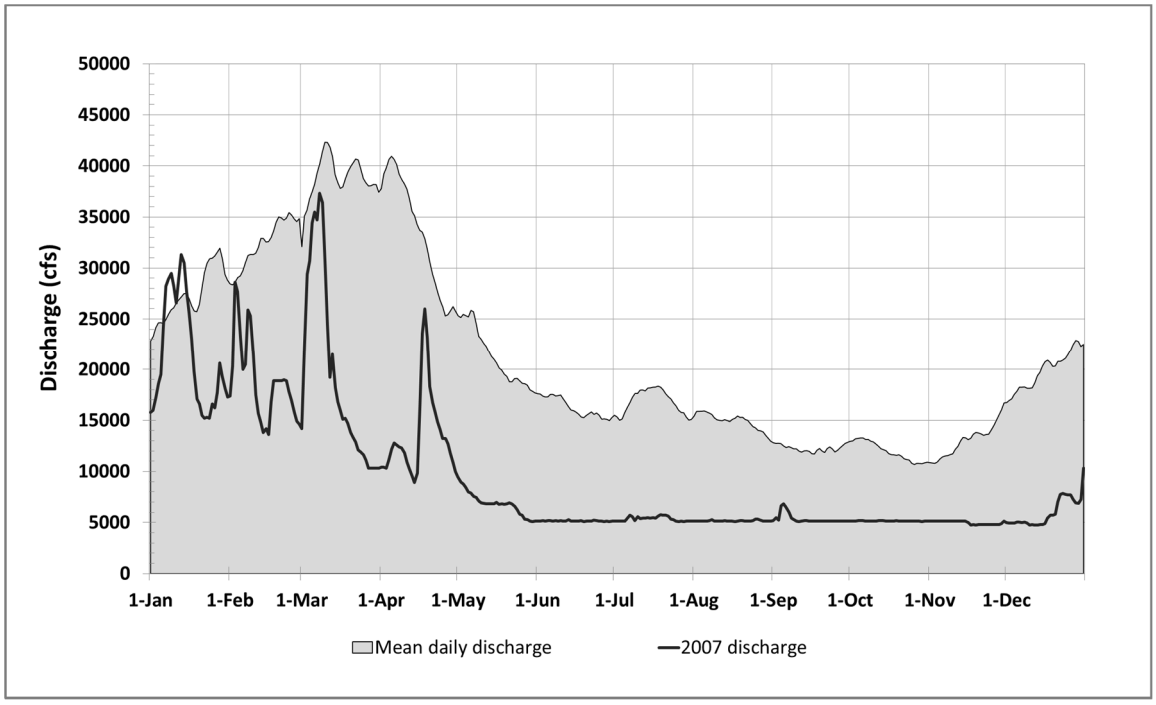


Figure 2.1-17. Apalachicola River Discharge at USGS Gage 02358000 at Chattahoochee, FL (1922–2013).

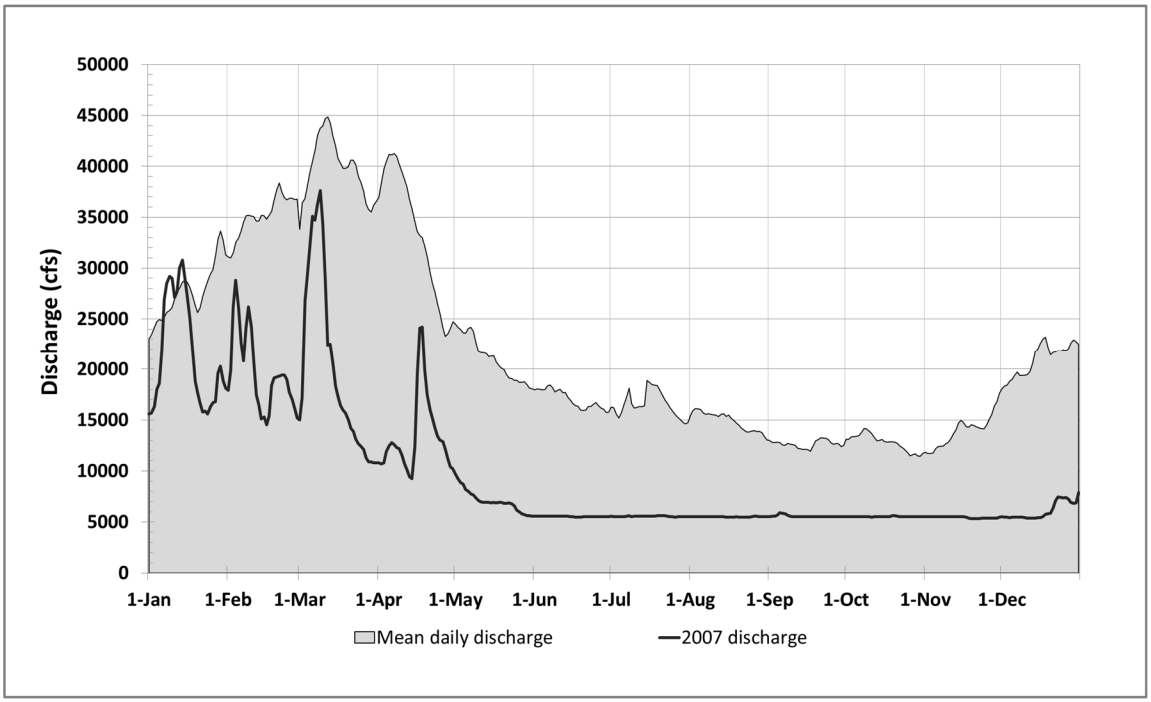


Figure 2.1-18. Apalachicola River Discharge at USGS Gage 02358700 at Blountstown, FL (1957–2011).

2.1.1.1.6 Surface Water: Reservoirs

The history of dam construction on the Chattahoochee River dates back to the early 1800s. Projects on the river at and above Columbus, Georgia, were built to take advantage of the natural stream gradients for power production. Federal interest in the ACF Basin also dates back to the 1800s. Navigation improvements were authorized under the River and Harbor Act (RHA) of 1874. Later, flood control and hydroelectric power generation interests were addressed. The RHAs of 1945 and 1946 provided for the construction of a series of locks, dams, and reservoirs within the ACF Basin by USACE as part of a general plan to provide systemwide benefits for multiple purposes including navigation, flood control (flood risk management), hydropower generation, water supply, water quality, recreation, and fish and wildlife conservation. Modifications of this plan resulted in the completion of five USACE dams—four on the Chattahoochee River and one at the confluence of the Chattahoochee and Flint rivers. Operations of the ACF system and of the individual projects within it are governed by the original authorizing legislation, as amended, and by other general authorities and applicable law.

There are 14 reservoirs on the mainstems of the ACF Rivers: five are federally owned (USACE) projects and nine are privately owned projects. Of the 14 reservoirs, 11 are on the Chattahoochee River, two are on the Flint River, and one is on the Apalachicola River. Figure 1.1-1 shows the location of mainstem dams and power-generating plants in the basin. The reservoirs are also depicted on the profiles of the mainstem rivers in the ACF Basin (Figure 2.1-10). The 14 projects and their key characteristics are listed in Table 2.1-3. A description of each USACE and nonfederal dam (presented in order from upstream to downstream) follows the table.

Table 2.1-3.
Reservoirs on Mainstem ACF Basin Rivers

Basin/River/Project Name	Owner/State/ Year Initially Completed	Drainage Area (sq mi)	Reservoir Size (ac)	Total Storage (ac-ft)[a]	Conservation Storage Summer Elev (ac-ft)	Power Capacity (kW)	Normal (summer) lake elev (ft)	Authorized Purposes for USACE-owned Projects[b]
Chattahoochee River		*8,708*						
Buford Dam/Lake Lanier	USACE/GA/1957	1,034	38,425	2,551,064	1,074,645	127,000	1,071	FRM, HP, NAV, FW, REC, WQ, WS[c]
Morgan Falls Dam/Bull Sluice Lake	GPC/GA/1903	1,360	580	2,450	0	16,800	866	
West Point Dam and Lake	USACE/GA/1975	3,440	25,864	774,798	306,131	87,000	635	FRM, HP, NAV, FW, REC, WQ, WS
Langdale Dam and Lake	GPC/GA/1860	3,640	152	NA[d]	0	1,040	547.7	
Riverview Dam and Lake	GPC/GA/1902	3,661	75	NA[d]	0	480	530.5	
Bartletts Ferry Dam/Lake Harding	GPC/GA/1926	4,240	5,850	181,000	0	173,000	521	
Goat Rock Dam and Lake	GPC/GA/1912	4,510	1,050	11,000	0	38,600	404	
Oliver Dam/Lake Oliver	GPC/GA/1959	4,630	2,150	32,000	0	60,000	337	
North Highlands Dam and Lake	GPC/GA/1900	4,630	131	1,500	0	29,600	269	
Walter F. George Lock and Dam and Lake	USACE/GA/1963	7,460	41,800	884,572	232,800	168,000	190	HP, NAV, FW, REC, WQ
George W. Andrews Lock and Dam/ Lake George W. Andrews	USACE/GA/1963	8,210	1,540	18,180	0	None	102`	NAV, FW, REC, WQ
Flint River		*8,456*						
Warwick Dam/Lake Blackshear	Crisp Co./ GA/1930	3,770	8,700	144,000	0	15,200	237	
Flint River Dam/Lake Worth	GPC/GA/1920	5,290	1,400	NA[d]	0	5,400	182.3	
Apalachicola River		*2,409*	*(Total ACF Basin – 19,573 sq mi)*					
Jim Woodruff Lock and Dam/Lake Seminole	USACE/FL/1954	17,164	37,500	367,318	0	43,350	77	HP, NAV, FW, REC, WQ

Notes: ac = acres; ac-ft = acre-feet; ft = feet; GPC = Georgia Power Company; kW = kilowatts; sq mi = square miles.

[a.] Measured at top of storage for flood risk management.

[b.] As used in this table, the term *authorized purposes* includes purposes expressly identified in the project authorizing documents; incidental benefits recognized in projection authorizations; and objectives that result from other authorities, such as general authorities contained in congressional legislation, for which USACE operates each listed project as of 2009. FRM = flood risk management; FW = fish and wildlife conservation; HP = hydroelectric power generation; NAV = navigation; REC = recreation; WQ = water quality; WS = M&I water supply.

[c.] USACE operates Buford Dam/Lake Lanier project in a manner that accommodates water supply withdrawals from Lake Lanier and from the Chattahoochee River downstream of Buford Dam.

[d.] NA = not available.

Most of the USACE and nonfederal dams in the ACF Basin have hydroelectric power generating capability. Hydroelectric power generation dams convert the force of falling water into electrical power. Although not the primary source of energy in the United States, hydroelectric power generation is still an important source of electricity because it can be started quickly to meet immediate needs and is both a renewable and clean source of energy. Much of the hydroelectric power generation in the ACF Basin is *peaking* power; that is, the generators are turned on when there is the most, or *peak,* demand for power. Air-conditioning and heating are the power uses that often cause the peak demand for power, so the hydroelectric power generation releases usually coincide with daily temperature extremes.

USACE operates five dams in the ACF Basin (in upstream to downstream order): Buford, West Point, Walter F. George (George), and George W. Andrews (Andrews) on the mainstem of the Chattahoochee River, and Jim Woodruff (Woodruff), immediately below the confluence of the Chattahoochee and Flint rivers at the upstream extent of the Apalachicola River. Buford Dam, West Point Dam, and Walter F. George Lock and Dam are reservoirs (Lake Lanier, West Point Lake, and Walter F. George Lake, respectively) with a combined conservation storage capacity (relative to the top of each reservoir's full summer pool) of about 1.6 million acre-feet (ac-ft). Jim Woodruff Lock and Dam (Lake Seminole) is operated as a run-of-river project and only very limited pondage is available to support project purposes (USACE, Mobile District 1998a). George W. Andrews Lock and Dam is also a run-of-river project with no conservation storage.

Each USACE multipurpose storage reservoir is typically subdivided into separate storage levels, as shown in Figure 2.1-19. Level 1, the lowest level, represents the top of the *inactive pool*. When the pool level declines below Level 1 into the inactive storage zone, reservoir releases would be severely curtailed. For the ACF Basin projects, pool levels have not declined into the inactive zone of the storage projects since they were constructed. If a future drought of record would result in a decline of pool levels below Level 1, releases from the inactive zone of the storage reservoirs would be administered as described in section 5.4.2. Level 2 is usually associated with the top of the *conservation pool*, or the guide curve elevation. A *guide curve* is the seasonally variable desired pool elevation in a reservoir to fully meet project purposes. *Conservation storage* is the level of the water stored in a reservoir that can be jointly used or released for all useful purposes, including hydroelectric power, recreation, fish and wildlife conservation, M&I water supply, and water quality. The conservation pool, Level 2, can be subdivided into multiple *action zones*, which are discussed in more detail below. Each action zone triggers a different operating schedule. Level 3 is the top of the flood risk management pool. Typically, the area between the top of the conservation pool and flood risk management is active *flood storage*. Water is stored in this area when it cannot be safely passed through the downstream channel system. Usually, the top of the flood storage level is not the maximum level at which water can be stored. Typically, a reservoir with flood storage has *surcharge storage*, Level 4, to accommodate water above the emergency spillway. In surcharge storage, the outflow is determined by the spillway capacity and cannot be controlled by the operators.

Action zones have been defined for each of the major storage projects on the ACF Basin: Buford, West Point, and Walter F. George. *Action zones* are partitions of a reservoir's conservation storage, as defined in the reservoir water control plan, to guide reservoir managers in meeting project purposes during a wide variety of hydrologic conditions. Each action zone has a set of specific operational rules or guidelines that govern water management operations for the reservoir when the pool elevation is within that zone. For each of the three USACE storage projects, guide curves and action zones within the conservation pools are presented in the following sections. These sections also discuss these three projects in more detail. The action zones for these USACE projects were first outlined in the 1989 draft Master Manual (USACE, Mobile District 1989). A more detailed discussion of action zone considerations relative to the USACE ACF Basin projects is presented in section 4.1.2.2.

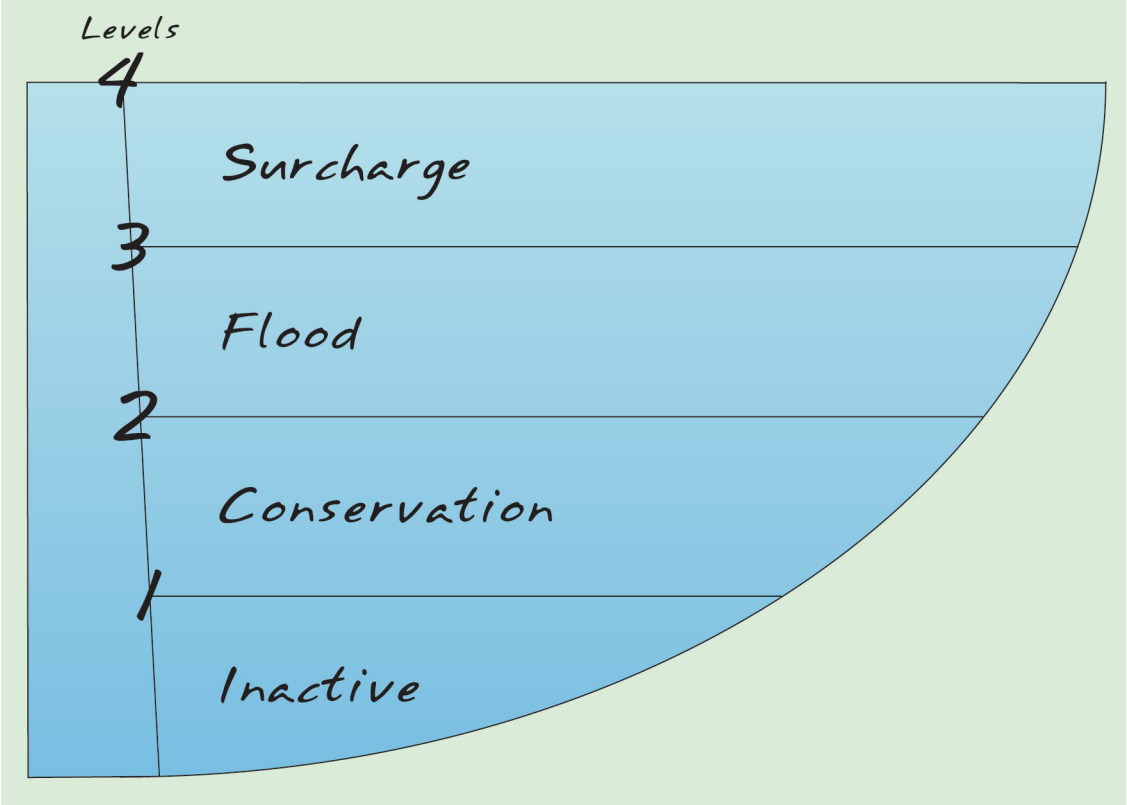


Figure 2.1-19. Schematic of Reservoir Storage.

2.1.1.1.6.1 Lake Lanier and Buford Dam

Lake Lanier is formed by Buford Dam, which is about 48 mi northeast of Atlanta on the Chattahoochee River at RM 348.3. Buford Dam is a USACE multipurpose project, originally authorized by the RHA of 1946, to be operated in conjunction with the other federal works of improvement in the ACF Basin for the authorized system purposes. Buford Dam is operated to provide benefits for authorized purposes including flood risk management, hydropower, navigation, water supply, recreation, water quality, and fish and wildlife conservation. Project purposes for Buford Dam and other USACE projects in the ACF Basin are discussed in more detail in section 2.1.1.2. Construction of the Buford Dam project was completed in 1957, and the reservoir reached full pool by 1959. The Chestatee and Chattahoochee rivers combine in the upper reservoir pool and comprise about 84 percent of the 1,034 sq mi of drainage area into the pool. The size of the reservoir is 38,425 acres (ac) at elevation 1,071 ft. The Buford Dam drainage area is located on the southern slope of the Blue Ridge Mountains and is characterized by the steep slopes of mountain streams. A general map depicting Lake Lanier and Buford Dam is provided as Figure 2.1-20. The authorized project provides for a rolled-earth dam 1,630 ft long with crest at elevation of 1,106 ft at National Geodetic Vertical Datum of 1929 (NGVD), or about 192 ft above streambed elevation; three earthen saddle dikes with a total length of 6,600 ft; a chute spillway with crest at elevation 1,085 ft; a powerhouse in a deep cut, with steel penstocks in tunnels and concrete intake structure at the upstream end of the tunnels; and a flood-control sluice tunnel paralleling the power tunnels.

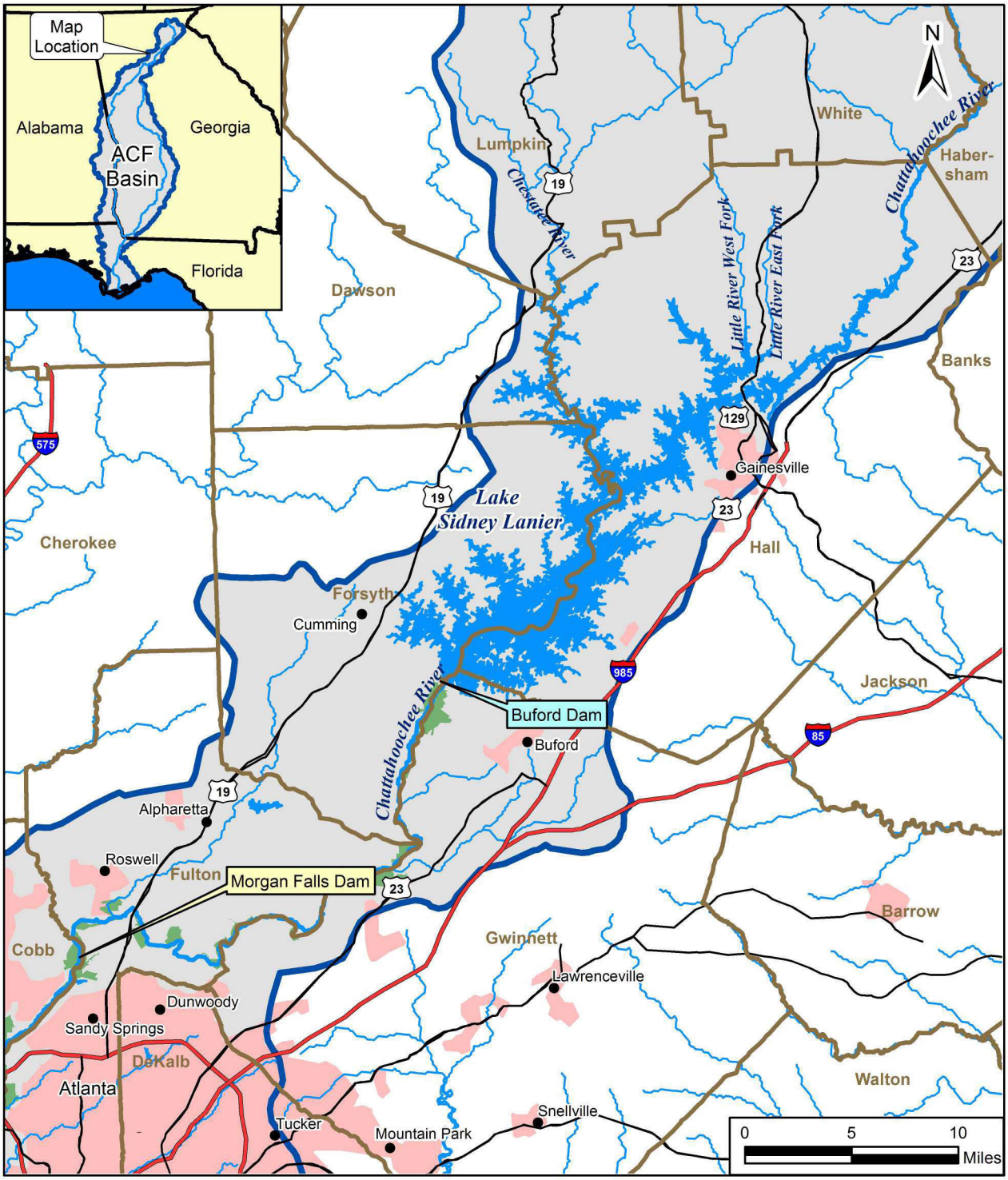

Map Location
Alabama
Georgia
ACF Basin
Florida
N
Lumpkin
White
Haber-sham
Chattahoochee River
Chestatee River
Little River West Fork
Little River East Fork
Dawson
Banks
Gainesville
Lake Sidney Lanier
Cherokee
Forsyth
Cumming
Hall
Jackson
Buford Dam
Buford
Chattahoochee River
Alpharetta
Roswell
Fulton
Morgan Falls Dam
Barrow
Gwinnett
Cobb
Lawrenceville
Dunwoody
Sandy Springs
DeKalb
Atlanta
Walton
Tucker
Mountain Park
Snellville
0 5 10 Miles
LEGEND
ACF Basin Boundary
County Boundary
City
Urban Area
Interstate
U.S. Route
Surface Water
National Park
Service Land
USACE Dam
Nonfederal Dam
Buford Dam/Lake Lanier

Figure 2.1-20

Lake Lanier has a storage capacity (at the top of the conservation pool—elevation 1,071 ft) of 1,948,913 ac-ft. Of that, 1,074,645 ac-ft is conservation storage and 874,268 ac-ft is inactive storage (Figure 2.1-21). The minimum conservation pool elevation is 1,035 ft, and the maximum conservation pool elevations are 1,071 ft in the summer and 1,070 ft in the winter. In addition, 602,151 ac-ft is reserved for flood storage between elevation 1,071 and 1,085 ft. The power installations consist of one 7-megawatt (-MW) generating unit and two units of 60 MW each, for a total of 127 MW. The penstock capacity is 12,000 cfs. The project is typically operated for peaking power on a 5-day-a-week schedule, with occasional peaking on Saturday and Sunday. The number of hours of generation per day depends on the available storage, conditions in the basin, and electrical demand. The 7-MW unit runs continuously (at 600 cfs) to help meet downstream minimum flow requirements.

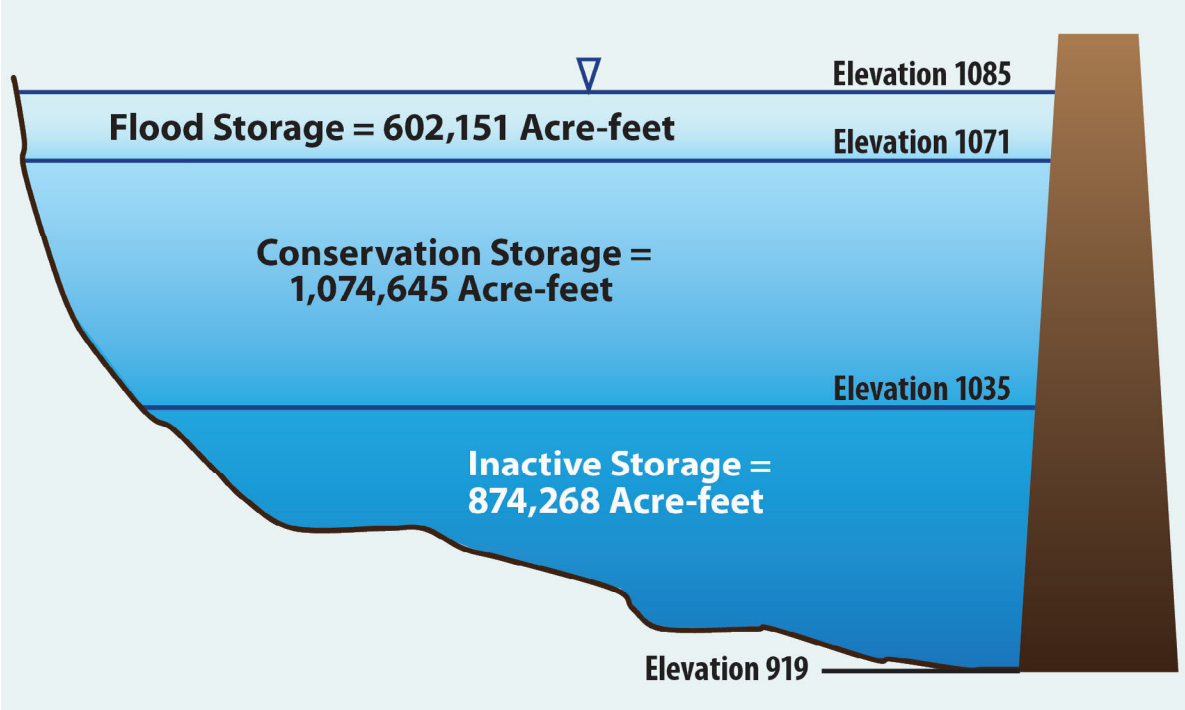


Figure 2.1-21. Storage at Lake Lanier.

The reservoir has served as a primary water supply source and discharge location for several municipalities, including the cities of Cumming and Gainesville, and Gwinnett County. Lake Lanier waters are designated as *recreation* in GAEPD's water quality classification system. It has the highest annual recreational visitation of all the USACE lakes in the ACF Basin—more than 6.5 million visitors in 2012 (USACE 2016b)—and its shoreline is highly developed.

The Lake Lanier guide curve (Figure 2.1-22) establishes the top of the conservation pool at elevation 1,071 ft during the late spring and summer months (May–September) and 1,070 ft during the remainder of the year. However, the lake level can fluctuate significantly from the guide curve over time, dependent primarily upon basin inflows (BIs) but also influenced by project operations, evaporation, withdrawals, and return flows. The record high elevation for the reservoir under flood conditions was elevation 1,077.2 ft (April 1964) and the lowest level was 1,050.8 ft, experienced in December 2007 under extreme drought conditions. Under dry conditions when BIs are reduced, project operations are adjusted to conserve storage in Lake Lanier while continuing to meet project purposes in accordance with four action zones as shown on Figure 2.1-22 and as discussed in sections 2.1.1.2.2 and 5.2.2.

In 2004, rehabilitation of the three hydroelectric power generation units was completed. The goal of the project was to restore lost reliability and efficiency to the plant. Consideration was also given to improving water quality discharged from the dam. Several techniques were considered to increase low dissolved oxygen (DO) waters being discharged from Buford Dam. Ultimately, all the units have vents for air entrainment into water being released. Because of the peaking power operations, downstream releases and tailwater elevations can vary substantially over a 24-hour period. Figure 2.1-23 depicts a typical weekly pattern of flows immediately downstream of the project. During peak hydroelectric power generation periods, stages increase by about 3.5–5 ft immediately below the dam, over river levels during off-peak periods.

The 13.25-ft-diameter flood control sluice outlet is at the base of Buford Dam. The invert elevation of the sluice is 919 ft. The discharge capacity of the sluice (at pool elevation 1,070 ft) is 11,030 cfs. The total reservoir outflow capacity (spillway design capacity) under flood operations is 40,400 cfs at pool elevation 1,100 ft, which would be 15 ft above the emergency spillway crest elevation of 1,085 ft.

In the original design for Buford Dam, it was determined that the Standard Project Flood would be contained within the allocated flood pool (i.e., the pool elevation would not exceed elevation 1,085 ft). Subsequent revisions in computing the Standard Project Flood indicate that the pool would peak at elevation 1,086.78 ft, or 1.78 ft over the fixed emergency spillway. If a flood near that magnitude or larger occurred and the pool rose above the top of the flood pool (elevation 1,085 ft), the power plant and the flood control sluice would begin operating at full capacity as soon as flow over the spillway became imminent. When the dam was designed, reservoir operation for the spillway design flood assumed the power plant to be inoperative, with discharge over the spillway and through the sluice only. In actual operation, turbine discharge would supplement the spillway and sluice discharge. Any discharges that exceed downstream channel capacity would cause flooding, and affected parties would be notified accordingly. At pool elevations below 1,085 ft and as inflows fall to an amount equivalent to the downstream channel capacity, the combined releases through the sluice and turbines would be reduced to the downstream channel capacity. As long as flood waters are in storage above elevation 1,070 ft, continued emphasis would be placed on rapidly evacuating that flood storage.

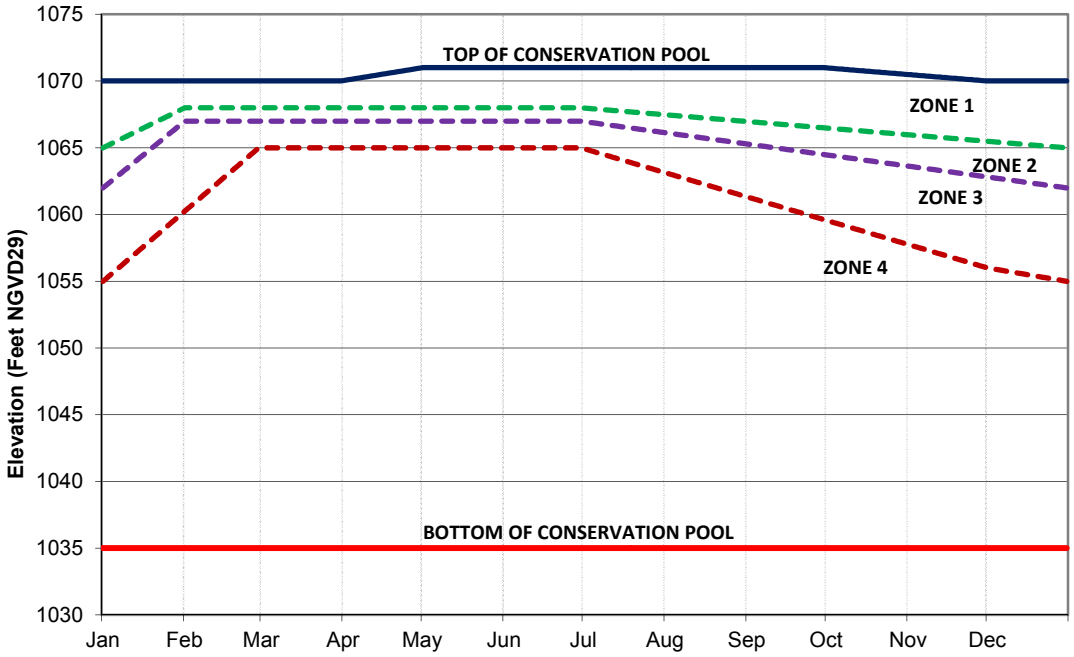


Figure 2.1-22. Lake Lanier/Buford Dam Water Control Action Zones.

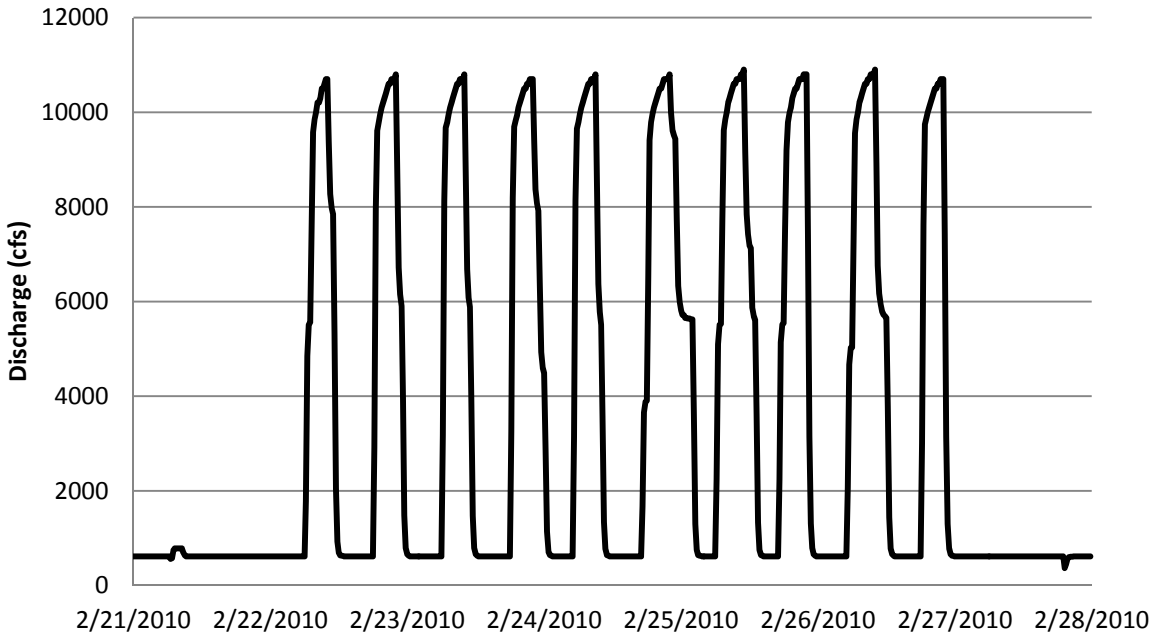


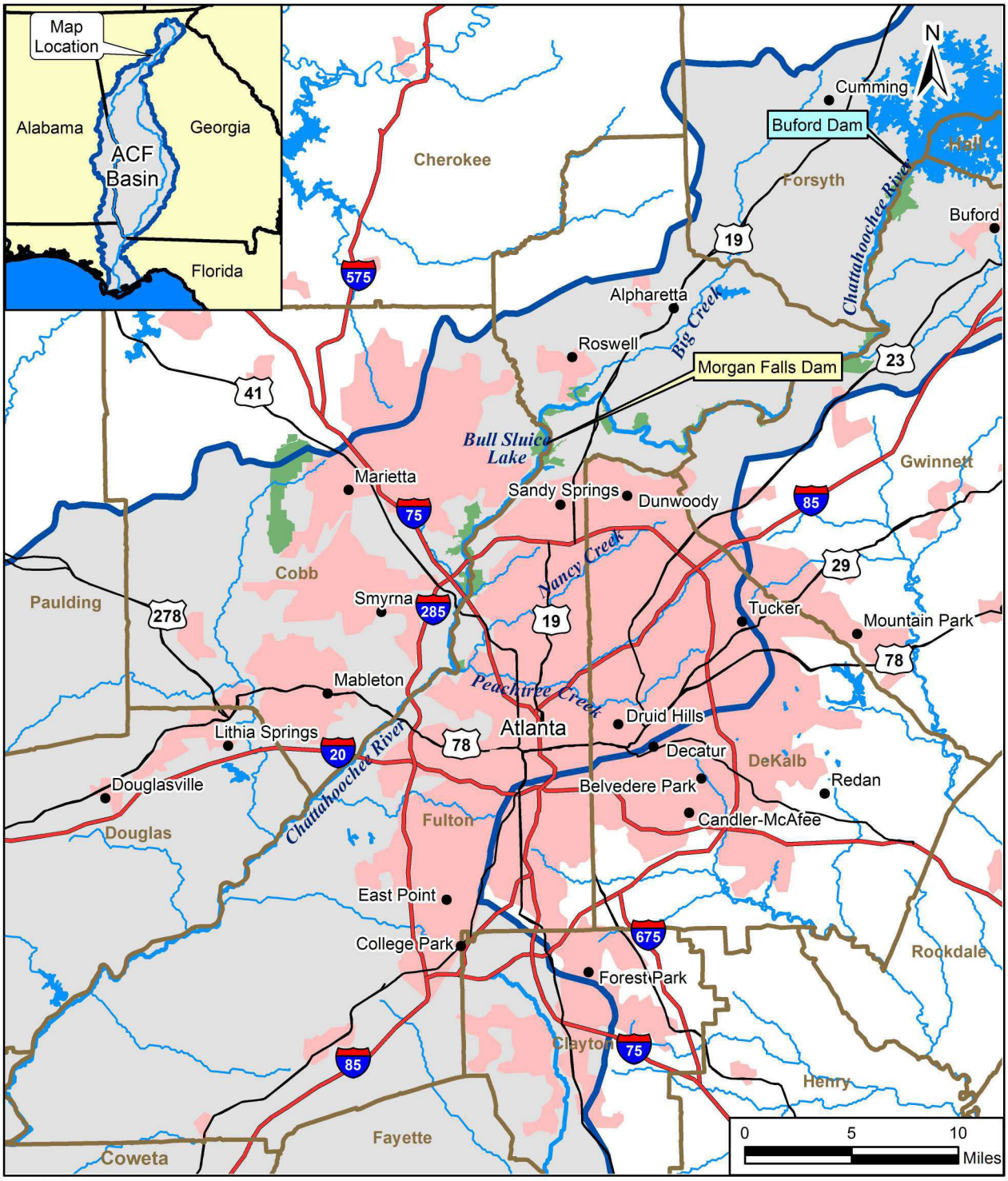
Figure 2.1-23. Chattahoochee River Discharge at USGS Gage 02334430 at Buford, GA, Directly Downstream of Buford Dam/Lake Lanier.

Minimum flow requirements from Buford Dam have evolved over the period since project completion. The current plan, referred to as the *interim modified plan*, was developed in 1986 and is described in more detail in section 2.1.1.2.4.6. It established the *Chattahoochee River Management System* (CRMS), under which USACE, when possible and practical, endeavors to make releases specifically required for water supply and to maintain the 750 cfs minimum in-stream flow at Peachtree Creek after accounting for water supply withdrawals at Atlanta. Georgia Power Company (GPC) agreed to continue to use Morgan Falls Dam (Bull Sluice Lake), about 30 mi downstream of Buford Dam, to reregulate Buford Dam releases to help meet that target. Pursuant to the CRMS, to ensure minimum downstream flows when accounting for water supply withdrawals downstream of Buford Dam, USACE has made releases of greater than 600 cfs through the large generating units, including on weekends, which are generally considered to be off-peak for hydroelectric power.

In addition, between 1973 and 1989, USACE entered into agreements according to which water supply providers made direct withdrawals from Lake Lanier. Although those contracts (apart from two relocation agreements entered into with the cities of Buford and Gainesville as compensation for relocation of existing facilities incidental to the construction of Buford Dam) expired in 1990, withdrawals have continued since then. These agreements are described in more detail in section 3.3.3.

2.1.1.1.6.2 Bull Sluice Lake and Morgan Falls Dam

Morgan Falls Dam impounds Bull Sluice Lake and is located on the Chattahoochee River 30 mi below Buford Dam at RM 315. A general map depicting Morgan Falls Dam is provided as Figure 2.1-24. The dam impounds a 7-mi reservoir that has a surface area of 580 ac at elevation 866 ft. The total reservoir storage volume is about 2,450 ac-ft, of which about 2,250 ac-ft is usable. The maximum generating capacity of the project is 16.8 MW. The dam was constructed in 1904 and has since experienced a significant amount of sediment deposition. This sedimentation has created broad and shallow pools and wetlands, which are attractive for recreation and fishing in the lake. The reservoir has low flow velocities, moderate algal productivity, and dispersed aquatic vegetation.



LEGEND

- ACF Basin Boundary
- County Boundary
- City
- Urban Area
- Interstate
- U.S. Route
- Surface Water
- National Park Service Land
- USACE Dam
- Nonfederal Dam

Morgan Falls Dam/ Bull Sluice Lake

Figure 2.1-24

GPC operates the Morgan Falls project as a modified run-of-river project to reregulate peaking flows from the USACE upstream Buford Dam for power generation, drinking water supply, and assimilation of treated wastewater in Metro Atlanta. The project currently operates under Federal Energy Regulatory Commission (FERC) License No. P-2237, issued on May 22, 2008 (FERC 2014b). Operations at Morgan Falls Dam are an integral part of the CRMS. Reregulation of Buford Dam releases at Morgan Falls Dam are necessary to meet the minimum continuous flow target at Peachtree Creek for water quality purposes. Figure 2.1-25 depicts a typical weekly pattern of flows about 12 mi downstream of the Morgan Falls project at Peachtree Creek. The effects of the reregulation of river flows at Morgan Falls Dam are apparent when compared to discharge patterns from Buford Dam for the same time period (Figure 2.1-23).

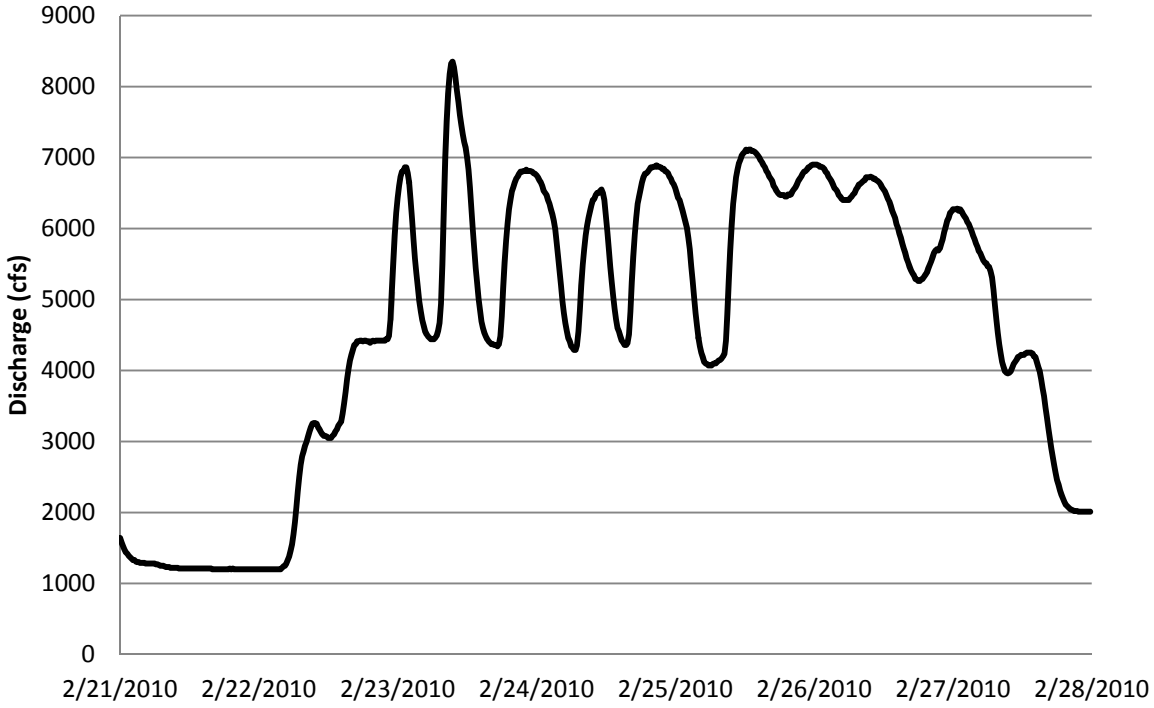


Figure 2.1-25. Chattahoochee River Discharge at USGS Gage 02336000 at Atlanta, GA.

2.1.1.1.6.3 West Point Dam and Lake

West Point Dam and Lake is a USACE multipurpose project on the Alabama-Georgia state line near West Point, Georgia, at Chattahoochee RM 201.4. The headwaters of West Point Lake are about 120 mi downstream from Morgan Falls Dam, and the Chattahoochee River is free flowing across that distance. The drainage area above the dam is 3,440 sq mi, and the size of the reservoir is 25,864 ac. The project was completed in 1975. A general map depicting West Point Dam and Lake is provided as Figure 2.1 26. The West Point Dam and Lake is a multiple-purpose project, originally authorized by the Flood Control Act of October 23, 1962 in accordance with House Document 570, 87th Congress, to be operated in conjunction with the other federal works of improvement in the ACF Basin for the authorized system purposes. West Point Dam is operated to provide benefits for authorized purposes, including flood risk

management, hydropower, navigation, fish and wildlife recreation[1], general recreation, fish and wildlife conservation, and water quality.[2] In addition, the City of LaGrange, Georgia, makes water supply withdrawals directly from the reservoir pursuant to relocation agreements entered into at the time of construction of the West Point project.

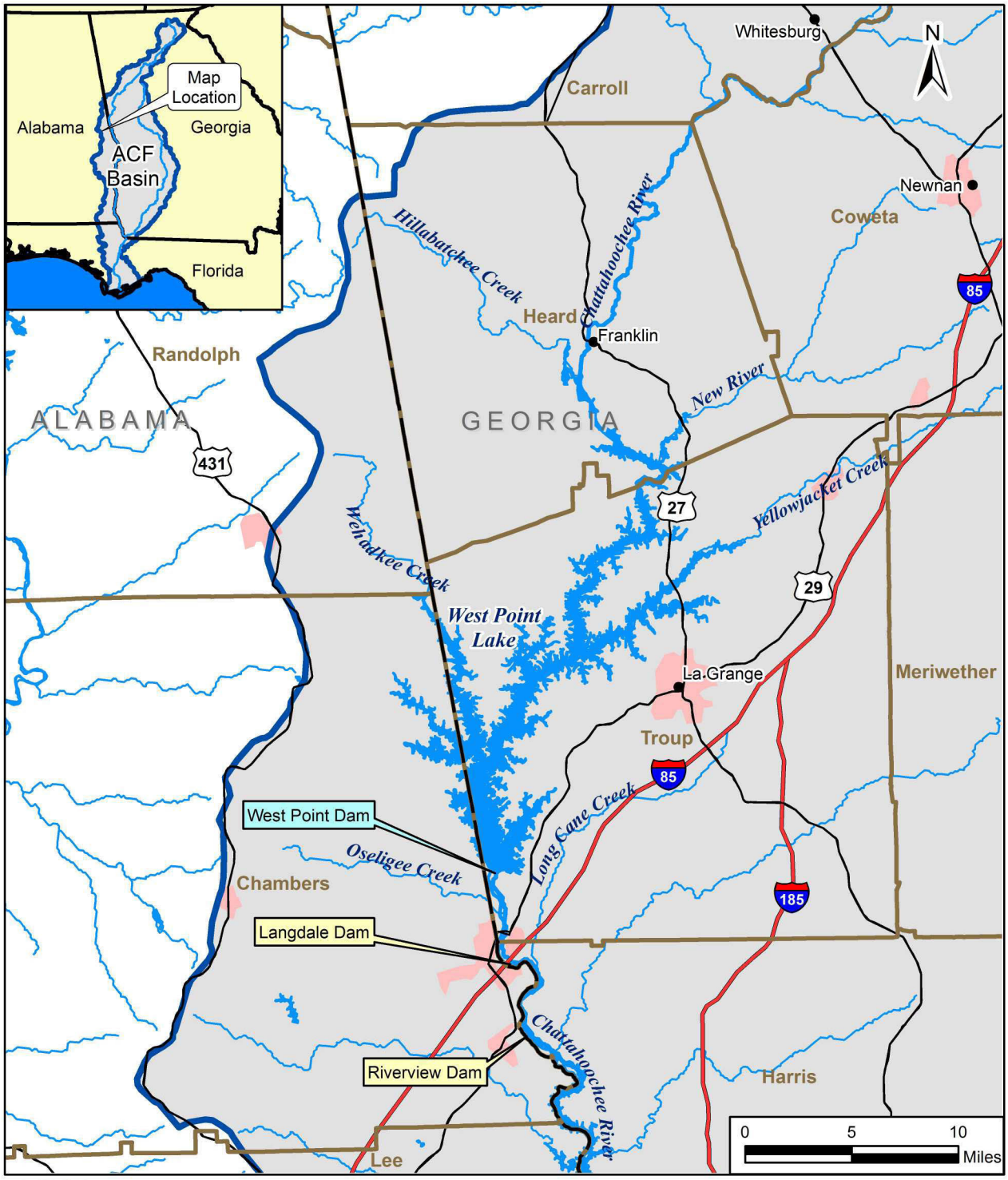
The authorized project provides for a gravity-type concrete dam 896 ft long with earthen embankments at either end 1,111 ft long on the east end and 5,243 ft long on the west end. The total length of the dam and spillway is 7,250 ft. The main dam consists of a concrete nonoverflow section, 185 ft long on the west side, and an earthen embankment retaining wall on the east side, as well as a gravity concrete spillway 350 ft long, including piers and abutments, with six tainter gates, each 50 ft by 41 ft. A monolith intake-powerhouse section and erection bay 321 ft long is constructed directly west of and adjacent to the spillway.

At the top of the conservation pool (elevation of 635 ft), the reservoir provides a total storage of 604,527 ac-ft, of which 306,131 ac-ft (to 620 ft) and 298,396 ac-ft is inactive storage (Figure 2.1-27). The total storage at maximum flood pool (elevation 641 ft) is 774,798 ac-ft. During the critical flood season, the reservoir is operated with a maximum conservation pool elevation of 628 ft to provide additional flood risk management storage. West Point Lake has a surface area of 25,864 ac at elevation of 635 ft. The power installations consist of one 3-MW generating unit and two units of 44 MW each, for a total of 91 MW.

The West Point Lake guide curve (Figure 2.1-28) establishes the top of the conservation pool at elevation 635 ft from June through October, transitioning to elevation 628 ft from December through mid-February. However, the lake level may fluctuate significantly from the guide curve over time, dependent primarily upon BIs but also influenced by project operations and evaporation, as well as withdrawals and return flows in the basin above the dam. The record high elevation for the reservoir under flood conditions was elevation 639.9 ft (in May 2003) and the lowest level was 619.7 ft (in November 1985). Under dry conditions when BIs are reduced, project operations are adjusted to conserve storage in West Point Lake while continuing to meet project purposes in accordance with four action zones as shown on Figure 2.1-28 and as discussed in sections 2.1.1.2.2 and 5.2.2. Flood flows captured in the reservoir are generally released slowly over subsequent weeks, unless additional flood flows are expected. Power releases during the low flow season augment flows at the GPC projects along the Chattahoochee River. As a by-product of operation for project purposes, the flows provide for navigation on the Apalachicola River below Jim Woodruff Lock and Dam during the winter and also provide water for M&I needs in the Columbus, Georgia, area.

[1] The term "fish and wildlife recreation" as used in House Document 570, 87th Congress, the authorizing document for the West Point project, refers to the nature of the quantifiable benefits derived from fish and wildlife conservation features of the project.

[2] In November 1973, West Point Lake was identified by the Chief of Engineers for development as a recreational demonstration project. It was developed to provide a wider variety of recreational facilities and opportunities for the public than normally provided at USACE lakes. Design Memorandum 37, *West Point Lake, Chattahoochee River, Alabama and Georgia, Master Plan* dated April 1981, defined several additional facilities in the initial development program by USACE. The demonstration project took into account the varying seasonal nature of the reservoir guide curve and no adjustments in reservoir operations were associated with the *demonstration project* designation (USACE, 1981).



West Point Dam and Lake

Figure 2.1-26

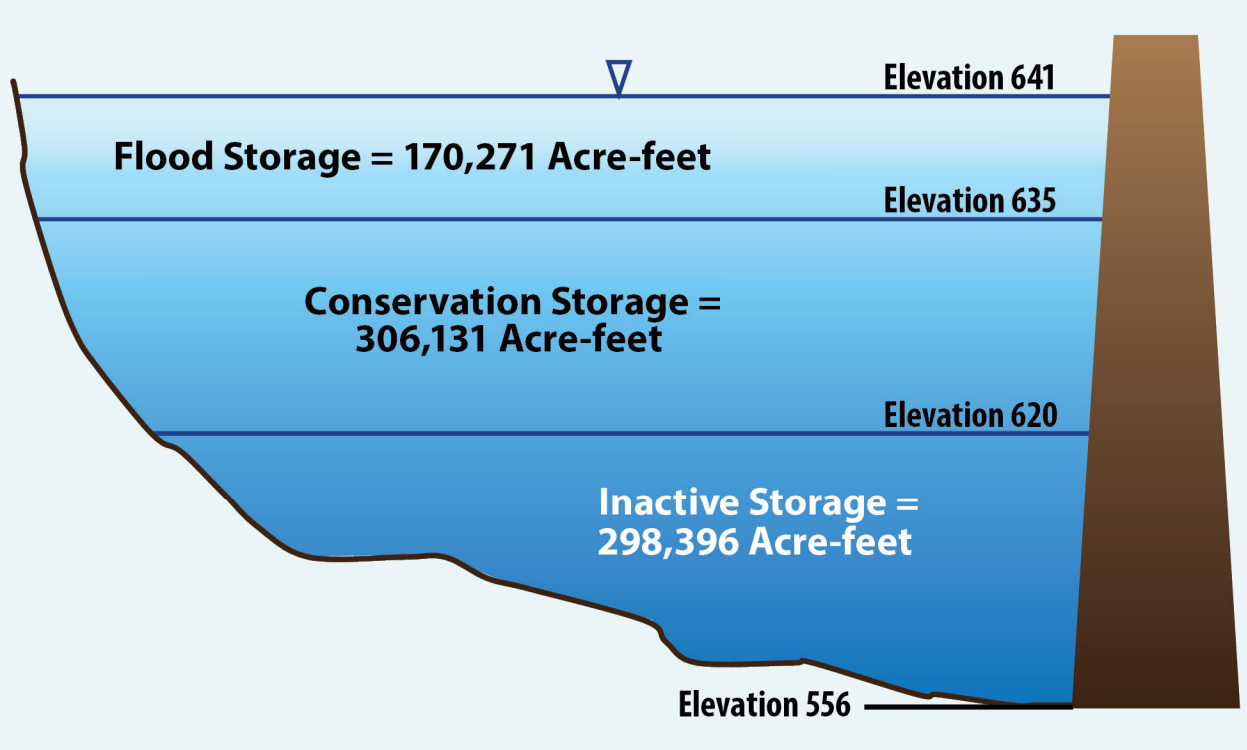


Figure 2.1-27. Storage at West Point Lake.

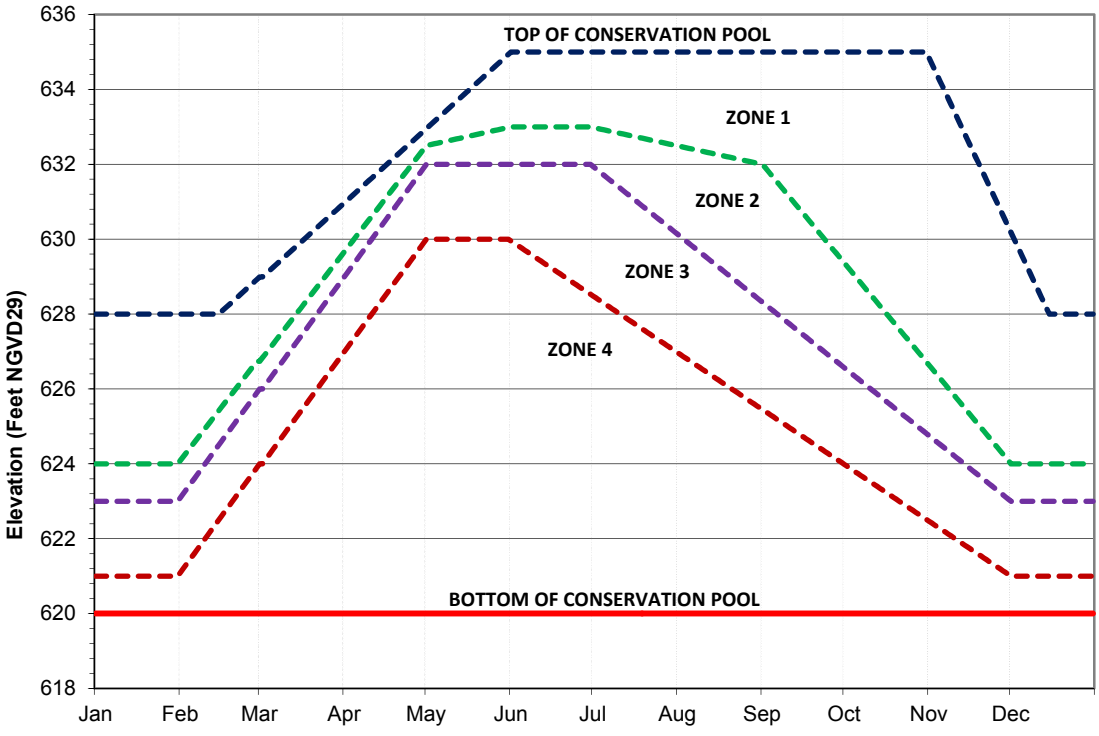


Figure 2.1-28. West Point Dam and Lake Water Control Action Zones.

A continuous minimum release of 670 cfs is required from West Point Dam to the Chattahoochee River. That minimum flow requirement is met by a small generating unit that provides a minimum, continuous, off-peak flow of 675 cfs. The main unit discharge is 18,100 cfs. The project is operated in a peaking mode, generating power from 2 to 6 hours during normal operations each weekday, depending on the conservation pool elevation. Weekend generation can occur if required to meet customer needs or other project purposes. Because of the peaking power operations, downstream releases and tailwater elevations can vary substantially over a 24-hour period. Figure 2.1-29 depicts a typical pattern of flows immediately downstream of the project over a 2-week period. During peak hydroelectric power generation periods, stages can increase by about 4 to 6 ft at the West Point gage (about 2 mi below the dam) above river levels during off-peak periods.

Generally, flood operations are initiated when West Point Lake pool level is at or above the top of conservation pool elevation and inflows to the project exceed the capacity of the turbines (approximately 18,100 cfs). Flood operations are conducted in accordance with a detailed schedule outlined in the WCM for the project. Spillway discharges will pass inflows in excess of the turbine capacity. Under flood operations, the discharge capacity of West Point Dam at the maximum flood pool (elevation 641 ft) is 249,500 cfs. The spillway design capacity for the project (at pool elevation 646.4 ft) is 423,900 cfs.

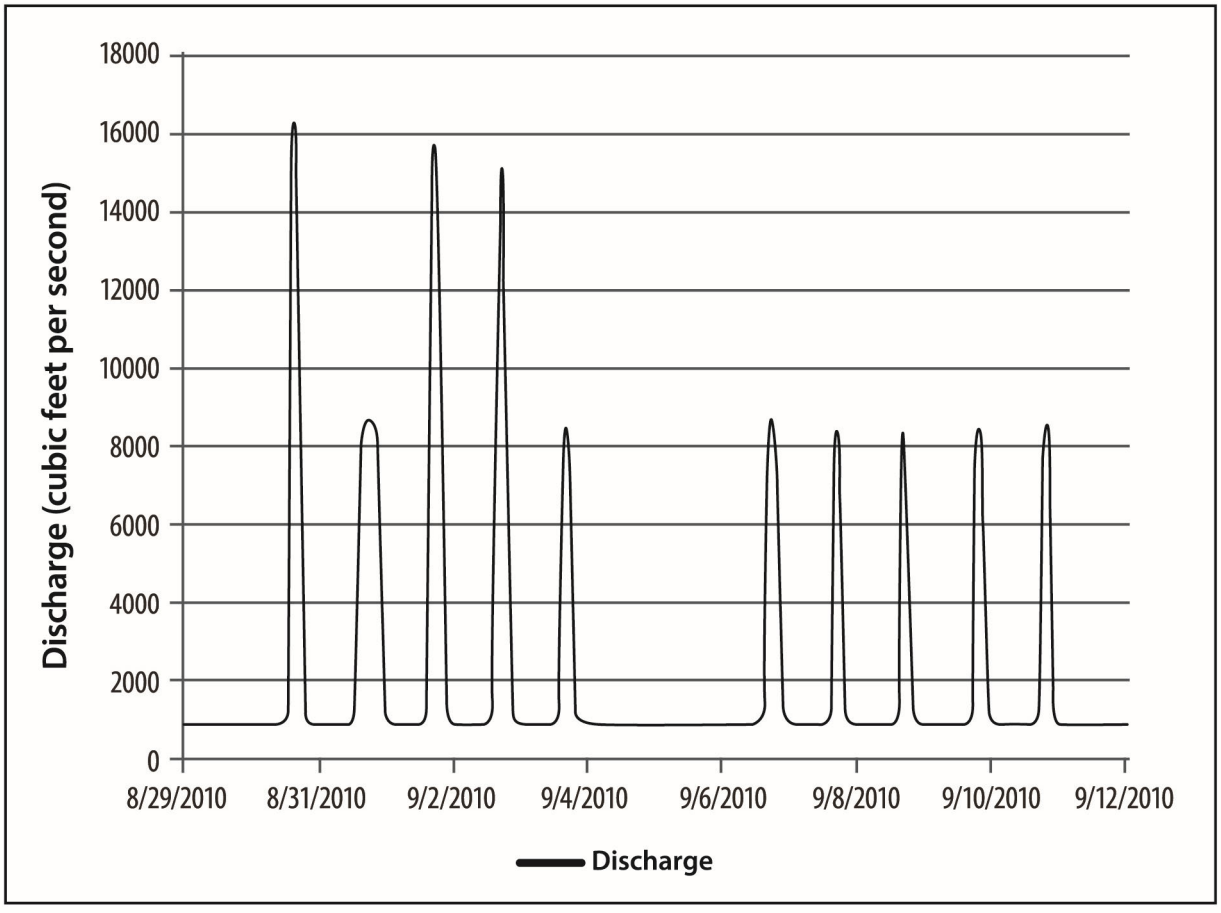
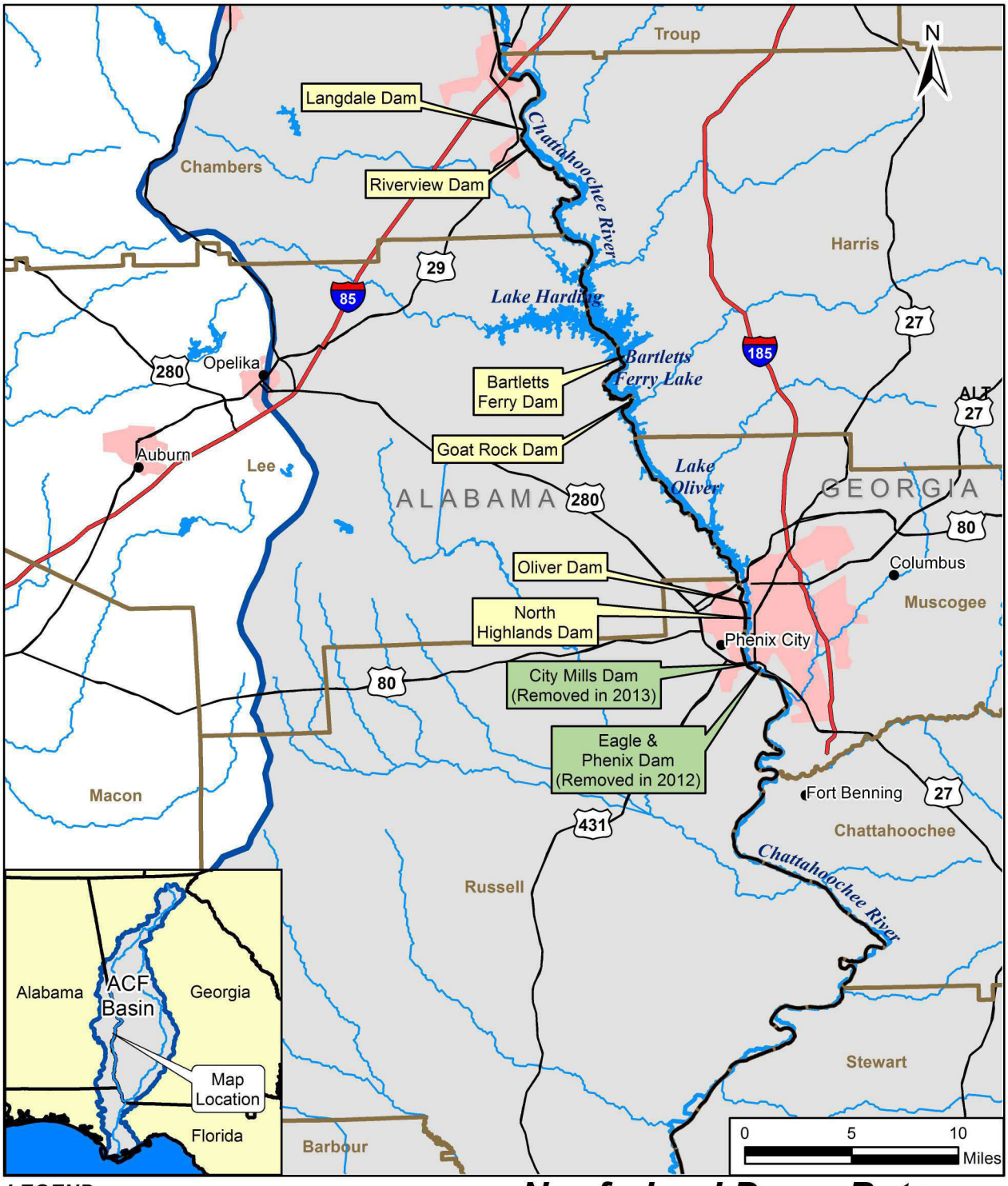


Figure 2.1-29. Chattahoochee River Discharge at USGS Gage 02339500, West Point, GA.

2.1.1.1.6.4 Nonfederal Dams between West Point Dam (RM 201) and Walter F. George Lake Headwaters (RM 160)

Below West Point Dam, a series of six hydroelectric power generation dams are located along approximately 32 mi of river. Those projects are depicted in Figure 2.1-30. The dams are part of GPC's Middle Chattahoochee Hydro Group. They are known individually as Langdale, Riverview, Bartletts Ferry, Goat Rock, Oliver, and North Highlands dams. The first two, Langdale Dam and Riverview Dam, have small reservoirs, 152 ac and 75 ac, respectively, which are unnamed. Those two projects have a hydroelectric power capacity of 1.04 MW and 0.480 MW, respectively. The four larger projects at Bartletts Ferry, Goat Rock, Oliver, and North Highlands are described in more detail below. The Middle Chattahoochee projects operate in a run-of-river-with-pondage mode, on the basis of the outflow from the West Point Dam.

- ***Lake Harding (Bartletts Ferry Dam).*** The third hydroelectric power generation dam below West Point Lake is Bartletts Ferry Dam, which impounds Lake Harding, at RM 178.0 on the Chattahoochee River. Lake Harding is also used for water supply. The reservoir is on the Alabama-Georgia state line about 20 mi northwest of Columbus, Georgia. The normal operating pool level is elevation 521 ft. The operating pool can drop as low as elevation 510 ft. The reservoir has a surface area of 5,850 ac at 521 ft elevation. The mean depth in the reservoir is 31 ft, and the maximum depth is 111 ft. The project includes a powerhouse composed of six units, which have a total generating capacity of 173 MW. The project operates to maintain a minimum flow of 1,160 cfs at Columbus (GPC 2010a; USACE, Mobile District 1998a).
- ***Goat Rock Dam and Lake.*** The Goat Rock Dam impounds a small reservoir (called Goat Rock Lake) at RM 172.3 on the Chattahoochee River. The reservoir has a surface area of 1,050 ac at elevation 404 ft. It is directly downstream of the Bartletts Ferry Dam and about 10 mi above Columbus, Georgia. GPC operates this reservoir primarily for hydroelectric power generation. The powerhouse consists of six units with a total generating capacity of 38.6 MW (GPC 2010b). The project was designed for hydroelectric power generation peaking generation, with swimming, boating, and fishing as secondary benefits. The normal operating pool level is elevation 404 ft. This project is a run-of-river facility with limited pondage. The project provides an instantaneous target minimum flow release of 800 cfs, or inflow, whichever is less, downstream of the dam.
- ***Lake Oliver (Oliver Dam).*** Lake Oliver is downstream of Goat Rock Dam at RM 163.5 on the Chattahoochee River. The reservoir serves as the primary water supply source for Columbus, Georgia. GPC operates this project as a run-of-river project, with limited storage capacity. It generally passes inflow directly downstream. The reservoir has a mean summer pool elevation of 337 ft (which is the normal operating pool level and the top of the dam) and a surface area of 2,150 ac. The operating pool level can drop as low as elevation 335 ft. The powerhouse consists of three 18-MW generating units and one small 6-MW generating unit, for a total capacity of 60 MW (GPC 2010c). The project provides an instantaneous target minimum flow release of 800 cfs, or inflow, whichever is less, downstream of the dam.
- ***North Highlands Dam and Lake.*** The North Highlands project is at RM 162.5 on the Chattahoochee River downstream of Oliver Dam. The impoundment has a water surface area of 131 ac at elevation 269 ft. It has four units with a total generating capacity of 29.6 MW (GPC 2010d). The project is operated in a run-of-river-with-pondage mode, on the basis of the outflow from the West Point Dam upstream. It provides an instantaneous target minimum flow release of 800 cfs, or inflow, whichever is less, downstream of the dam; a daily average target minimum flow of 1,350 cfs, or inflow, whichever is less, downstream of the project; and a weekly average target minimum flow of 1,850 cfs, or inflow, whichever is less, downstream of the project.



LEGEND

- ACF Basin Boundary
- County Boundary
- City
- Urban Area
- Interstate
- U.S. Route
- Surface Water

Nonfederal Dams Between West Point Dam and Walter F. George Lock and Dam

Figure 2.1-30

The six GPC hydropower dams operate under FERC licenses. Current licenses for Langdale Dam (No. P-2350) and for Riverview Dam (No. P-2341) were issued on May 24, 1993 (FERC 2014b). The current FERC license for Bartletts Ferry Dam has an expiration date of December 14, 2014, and relicensing for the project is pending (FERC 2014b). Project operations for Goat Rock Dam, Oliver Dam, and North Highlands Dam are covered in a single FERC license issued December 27, 2004 (FERC 2014b). Minimum flow targets prescribed for these projects, as described above, are included in the FERC licenses.

In addition, two small run-of-river dams at Columbus, Georgia, located downstream of the North Highlands Dam, have recently been removed for ecosystem restoration and recreation purposes. They were the City Mills Dam (RM 161.2), built in 1863 and formerly operated by City Mills, and the Eagle-Phenix Dam (RM 160.4), built in 1834 and formerly operated by Eagle and Phenix Mill. These dams had small reservoirs (approximately 110 and 52 ac, respectively). Both dams were removed for aquatic ecosystem restoration under the USACE section 206 program in cooperation with the City of Columbus and other partners. The Eagle-Phenix Dam was removed in 2012, and the City Mills Dam was removed in 2013. Both dams had hydroelectric power generation facilities, but they were inoperative prior to the dam removals. Removal of the dams restored more than 2 mi of free-flowing fall line riverine habitat between the North Highlands Dam and the headwaters of Walter F. George Lake (Paine 2012).

2.1.1.1.6.5 Walter F. George Lock and Dam and Lake

Walter F. George Lake, also locally known as Lake Eufaula, is created by the Walter F. George Lock and Dam on the Chattahoochee River. Walter F. George Lock and Dam is located about 85 mi downstream of Columbus, Georgia, at Chattahoochee RM 75.0 and about 181.5 mi upstream of Apalachicola Bay. The drainage area above Walter F. George Lock and Dam is 7,460 sq mi. Walter F. George Lock and Dam and Lake is a multiple-purpose project, originally authorized by the RHA of 1945 (under the original name of Fort Gaines) to be operated in conjunction with the other federal works of improvement in the ACF Basin for the authorized system purposes. Walter F. George Lock and Dam is operated to provide benefits for authorized purposes including hydropower, navigation, fish and wildlife conservation, recreation, and water quality. The project was completed in 1963. A general map depicting Walter F. George Lock and Dam and Lake is provided as Figure 2.1-31.

The project consists of a concrete dam, gated spillway, and single-lift lock, with earthen embankments at either side. The nonoverflow section of the dam includes a powerhouse and an intake structure. It is 200 ft long, with the deck of the powerhouse section at elevation 208 ft. The gated spillway is 708 ft long with a fixed crest at elevation 163 ft. The two earthen embankments, almost equal in length, have a total length of 12,128 ft, with crest elevation at 215 ft and a maximum height of about 68 ft. The power installation at the reservoir has recently been rehabilitated (project complete in 2010). The installation consists of four generating units of 42 MW, for a total of 168 MW. The lock, which has usable chamber dimensions of 82 ft by 450 ft, has a lift of 88 ft with the normal upper pool elevation at 190 ft over the upper sill at normal pool elevation. In June 2016, the USACE, Mobile District issued Navigation Bulletin No. 16-34 stating that the Walter F. George Lock was inoperable and would remain closed for the foreseeable future due to extensive structural damage to the lower gates and lack of funding to make the needed repairs (USACE, Mobile District 2016).

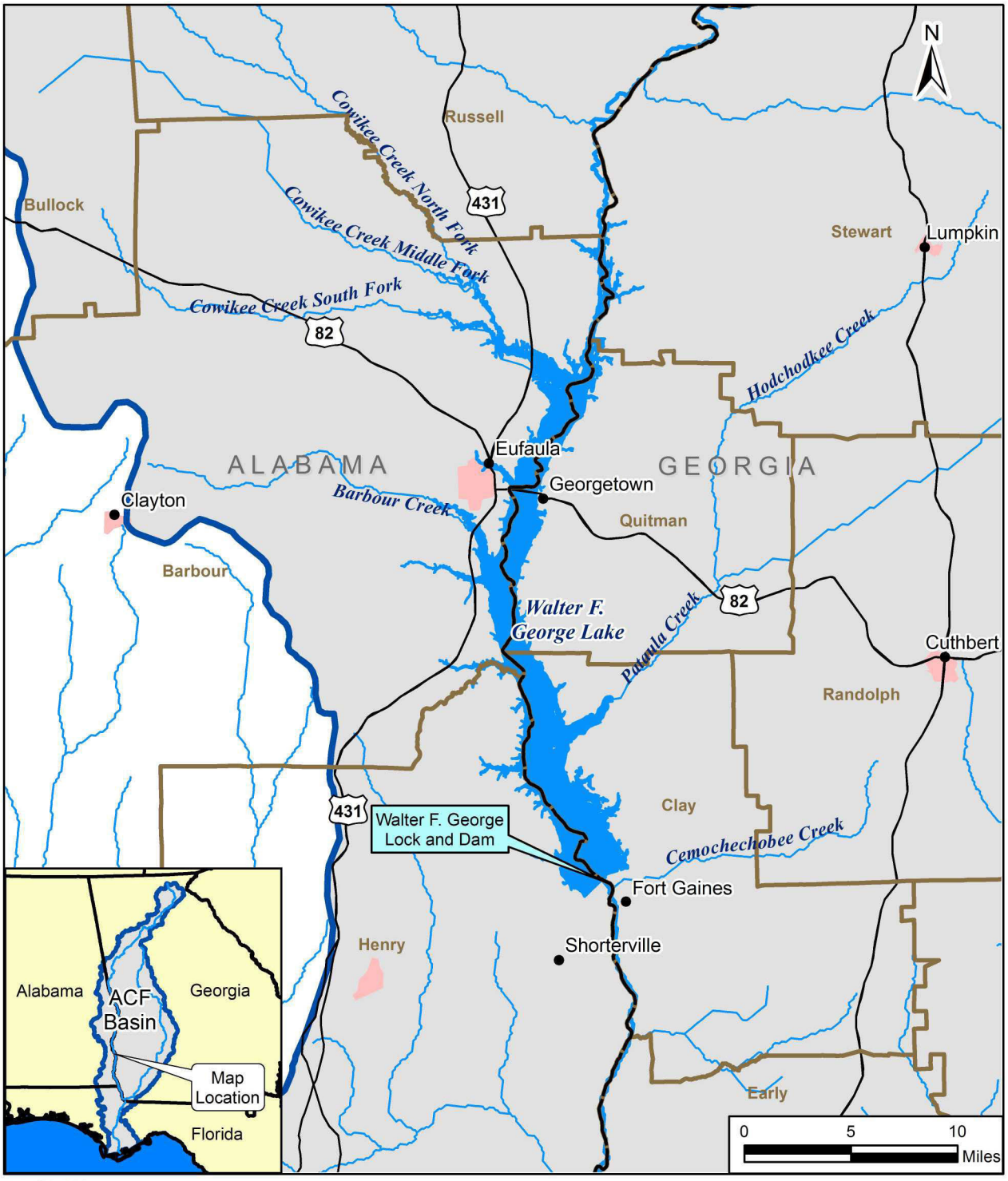
At the full pool elevation of 190 ft, the reservoir provides a total storage of 884,572 ac-ft. This value is about 5.3 percent lower than the previously reported total storage value of 934,400 ac-ft, which was based upon surveys performed in the early 1960s. The current total storage value is based upon surveys performed in 2009. About one percent of the decrease in the total storage value is attributable to sedimentation (see section 2.2.2.4.1.3) and about 4.3 percent of the decrease is attributable to the differences in historic and modern bathymetric survey methods. Of the total storage value of 884,572 ac-ft, 232,800 ac-ft is conservation storage and 651,772 ac-ft is inactive storage (Figure 2.1-32).

There is no dedicated flood storage at this project. Walter F. George Lake is the largest reservoir in surface area in the ACF Basin, with 41,800 ac at elevation 190 ft, the top of the summer conservation pool.

The Walter F. George Lake guide curve (Figure 2.1-33) establishes the top of the conservation pool at elevation 190 ft from June through September, transitioning to elevation 188 ft from December through April. The bottom of the conservation pool is at 184 ft. The lake level may fluctuate significantly from the guide curve over time, dependent primarily upon BIs but also influenced by project operations and evaporation, as well as withdrawals and return flows in the basin above the dam. The record high elevation for the reservoir under flood conditions was elevation 194.7 ft (in March 1990) and the lowest level was 183.2 ft (in April 1965). Under drier conditions when BIs are reduced, project operations are adjusted to conserve storage in Walter F. George Lake while continuing to meet project purposes in accordance with four action zones as shown on Figure 2.1-33 and as discussed in sections 2.1.1.2.2 and 5.2.2.

USACE operates this reservoir as a peaking facility with normal 5-day operation. It also has the potential for weekend operation to coincide with customer schedules. Weekend generation can occur if required to meet customer needs or other project purposes. The number of hours of generation per day depends on the available storage, system hydroelectric power and navigation flow requirements, and other factors. The penstock capacity is 26,000 cfs with all four hydroelectric power units in operation. There is no requirement at Walter F. George Lock and Dam for a continuous minimum flow. Because of the peaking power operations, downstream releases and tailwater elevations can vary substantially over a 24-hour period. Figure 2.1-34 depicts typical river stages that may occur immediately below the lock and dam over a two-week period. During peak hydroelectric power generation periods, tailwater stages can increase from 1.2 ft (with one unit in operation) to as much as 10 ft (with all four units in operation) above the normal downstream water surface elevation of approximately 102 ft during off-peak periods.

When the Walter F. George pool level is at or above elevation 190 ft and inflows to the project exceed the capacity of the turbines (approximately 26,000 cfs), flood operations are initiated in accordance with a schedule outlined in the WCM for the project. Spillway discharges will handle inflows in excess of the turbine capacity. Under flood operations, the discharge capacity of Walter F. George Lock and Dam at the standard project flood level (elevation 200.1 ft) is 269,000 cfs. The spillway design capacity for the project (at pool elevation 206.6 ft) is 653,000 cfs.



Walter F. George Lock and Dam and Lake

Figure 2.1-31

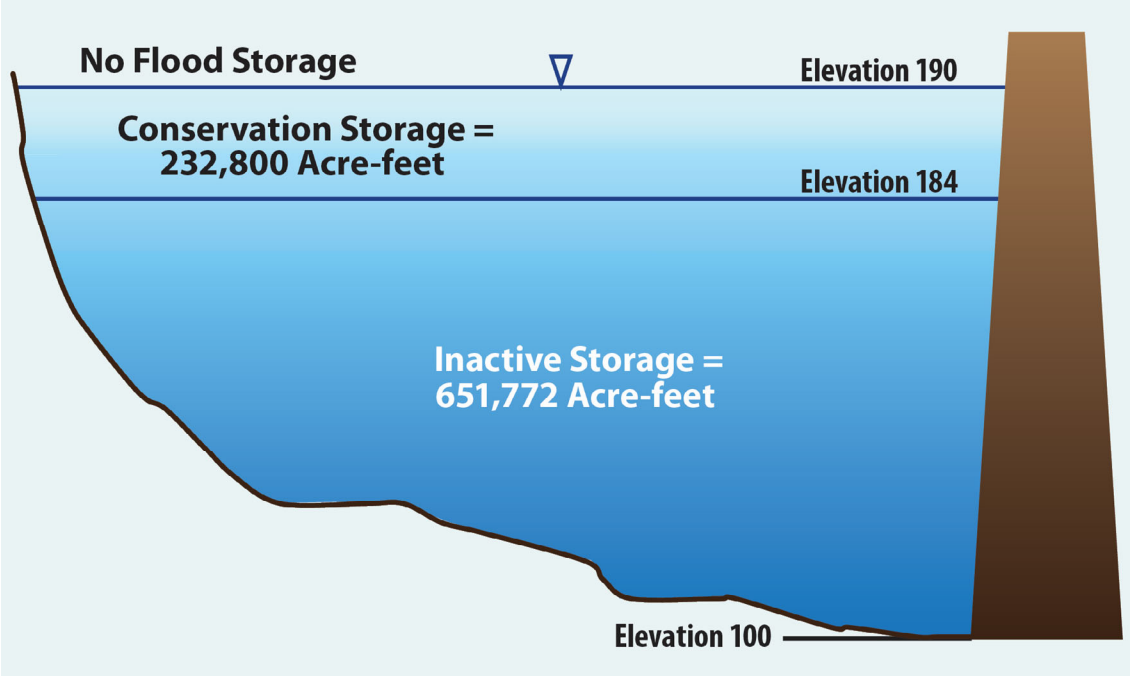


Figure 2.1-32. Storage at Walter F. George Lake.

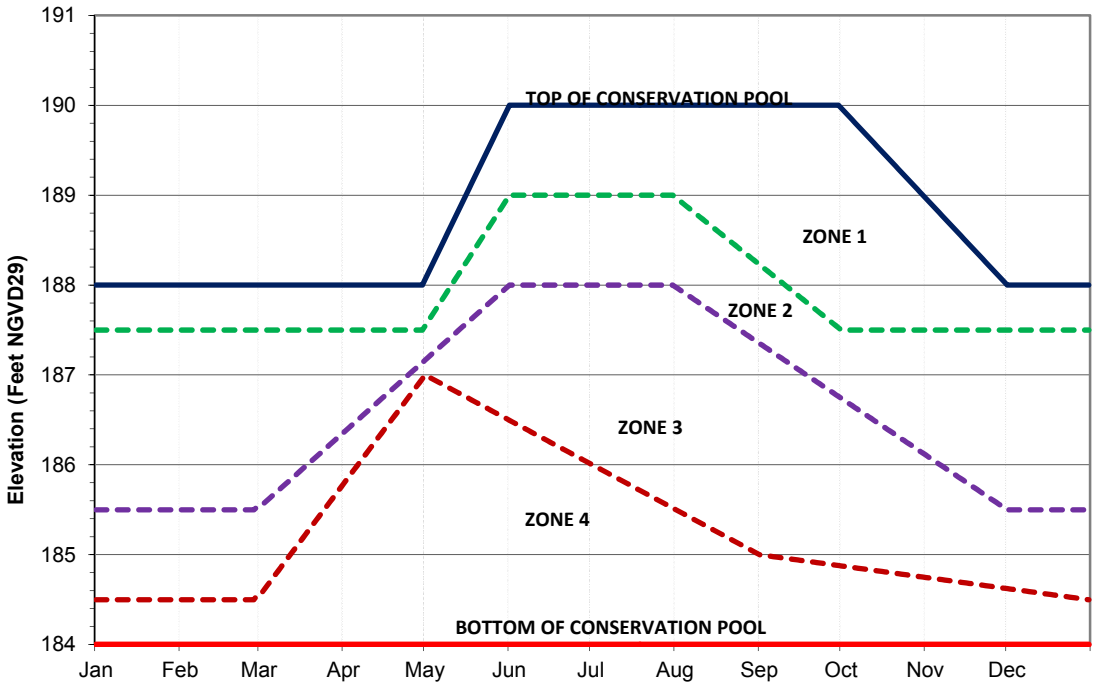


Figure 2.1-33. Walter F. George Lake Water Control Action Zones.

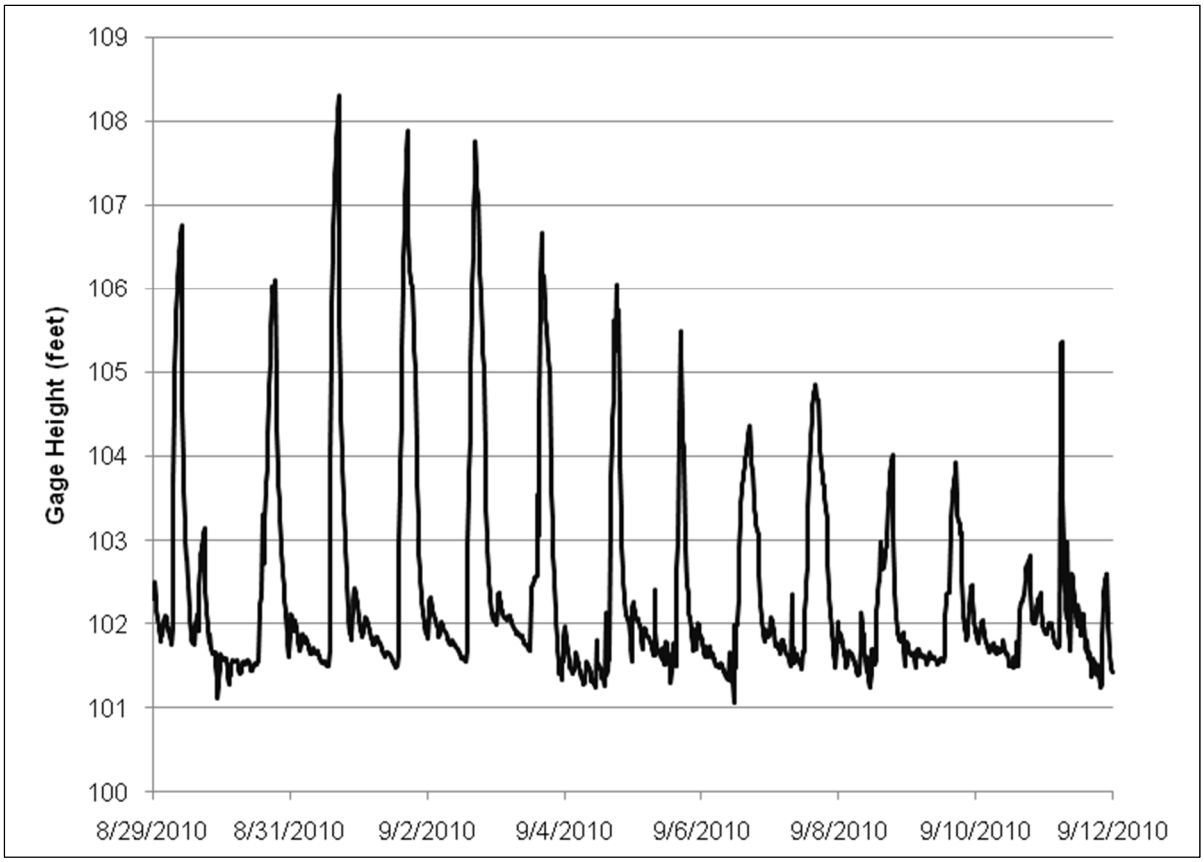
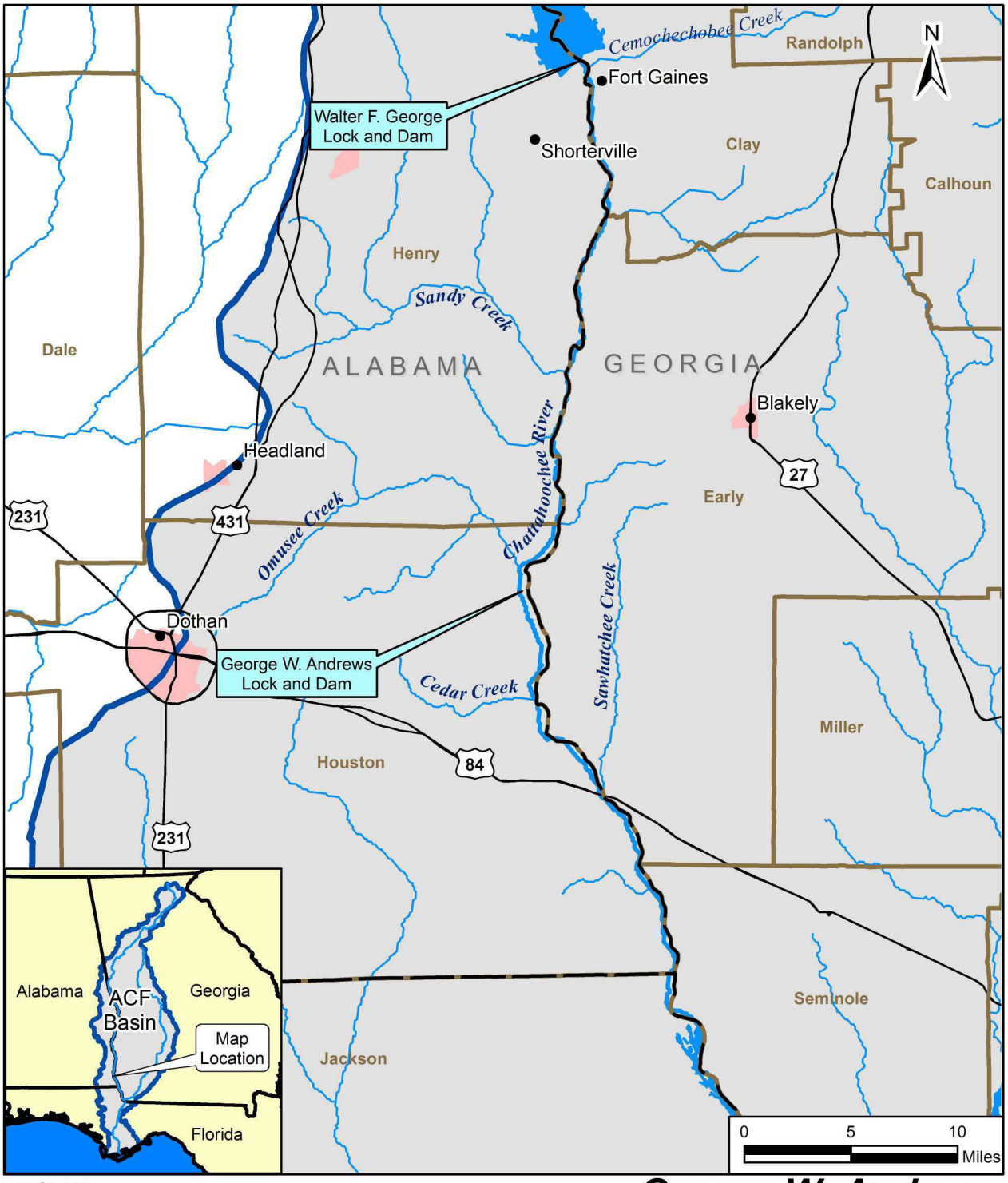


Figure 2.1-34. Chattahoochee River Stage at USGS Gage 02343241 below Walter F. George Lock and Dam at Fort Gaines, GA.

2.1.1.1.6.6 George W. Andrews Lock and Dam and Lake George W. Andrews

The George W. Andrews Lock and Dam project is located at Chattahoochee RM 46.5, about 153 mi upstream of Apalachicola Bay and about 28.3 mi downstream of Walter F. George Lock and Dam. The lock and dam are about 2 mi south of Columbia, Alabama, and about 17 mi east of Dothan, Alabama. The George W. Andrews Lock and Dam project was originally authorized under the RHAs of 1945 and 1946 (under the original name of Columbia Dam) to be operated in conjunction with the other federal works of improvement in the ACF Basin for the authorized system purposes. The project is operated to provide benefits for authorized purposes, including navigation, fish and wildlife conservation, recreation, and water quality. The project consists of a concrete fixed-crest spillway 340 ft long extending into the right bank with crest at elevation 102 ft, a concrete gate spillway adjacent to the lock 280 ft long with crest at elevation 82 ft, a single-lift lock with usable chamber dimensions of 82 ft by 450 ft, and a maximum lift of 25 ft. Depths are 13 ft over the lower sill and 19 ft over the upper sill at a normal pool elevation of 102 ft. In June 2016, the USACE, Mobile District issued Navigation Bulletin No. 16-34 stating that the George W. Andrews Lock was inoperable and would remain closed for the foreseeable future due to excessive sedimentation in the lock approach and around the lock gates and the lack of funding to remove the sediment (USACE, Mobile District 2016). The drainage area above the lock and dam is 8,210 sq mi, and the size of the reservoir is about 1,540 ac. A general map depicting George W. Andrews Lock and Dam is provided as Figure 2.1-35.



George W. Andrews Lock and Dam and Lake George W. Andrews

Figure 2.1-35

The project acts as a run-of-river project, principally for navigation, to provide navigable depths upstream to the Walter F. George Lock and Dam. The reservoir has a 9-ft-deep by 100-ft-wide navigation channel extending over its entire length. Because of its long, narrow shape, the reservoir resembles a large river more than a lake. Limited recreation facilities are also available at the project.

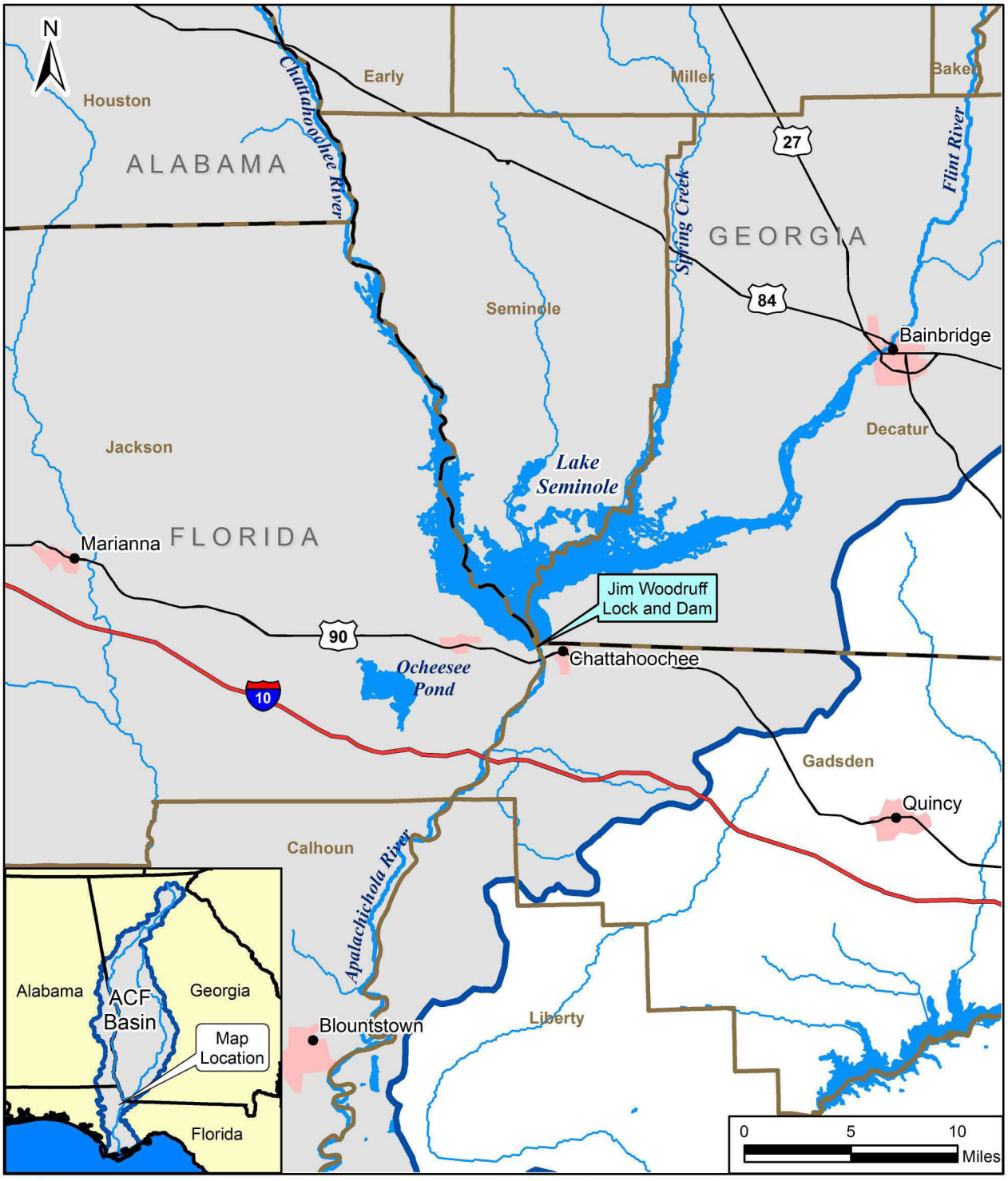
While the Lake George W. Andrews normal pool is at elevation 102 ft, pool elevations can temporarily increase under higher flow conditions. The lock becomes inoperable under flood conditions when the river stage at the project rises to elevation 114 ft, which occurs about 0.4 percent of the time. The reservoir has no conservation storage and no federal hydroelectric power facility. The George W. Andrews project has limited capacity to reregulate inflows from peaking power operations at the Walter F. George powerhouse.

When inflow to the Walter F. George project exceeds its full power plant capacity (26,000 cfs) and power releases are supplemented by spillway discharges into Lake George W. Andrews, the George W. Andrews Lock and Dam spillway will be operated to pass the inflow to the project. When flows at the George W. Andrews Lock and Dam reach approximately 43,600 cfs, all gates are open clear, the headwater will be about elevation 102 ft, and the tailwater elevation will be about 100 ft. For flows greater than 43,600 cfs, the pool elevation will rise with increase in flow. The gates will remain in the full open position until the headwater crests and then recedes to elevation 102.5 ft, after which the gates will be operated to slow the rate of fall and stabilize the pool at elevation 102 ft until peaking operations are resumed at the Walter F. George powerhouse. The record high elevation at the Andrews project location under flood conditions was elevation 128.3 ft (about 203,000 cfs) on March 18, 1929, which was before the project's construction. The headwater elevation at the project reached 120.67 ft on December 28, 2015. The standard project flood peak flow at the project is 293,100 cfs, and the spillway design flow is 630,000 cfs.

From May 1983 to the present, various hydroelectric power interests in the private sector have taken steps to acquire a license from FERC for nonfederal hydroelectric power development at the George W. Andrews Lock and Dam. To date, these initiatives have not led to a FERC license. In 2010, two competing preliminary permit applications for nonfederal hydroelectric power development were on file and under consideration by FERC: (1) Robertson Energy Group, LLC (FERC Project No. P-13081), initially filed on November 19, 2007 (FERC 2010a); and (2) Alabama Municipal Electric Authority (AMEA) (FERC Project No. P-13719), filed on April 29, 2010 (FERC 2010b). On December 21, 2010, FERC issued a preliminary permit and granted priority to file a license application to the AMEA and denied the competing application for preliminary permit by the Robertson Energy Group, LLC (FERC 2010c). The AMEA requested a 3-year extension to their preliminary permit in September 2013, which was subsequently denied by FERC on November 21, 2013 (FERC 2013). The AMEA preliminary permit expired on November 30, 2013. Subsequently, Mid-Atlantic Hydro, LLC applied for a preliminary permit from FERC. On June 19, 2014, FERC issued a preliminary permit to Mid-Atlantic Hydro, LLC, for purposes of studying the feasibility of nonfederal hydropower development at Andrews Lock and Dam (FERC 2014a). The preliminary permit is in effective for 3 years, expiring in June 2017.

2.1.1.1.6.7 Lake Seminole and Jim Woodruff Lock and Dam

The Jim Woodruff Lock and Dam project is located on the Apalachicola River at 106.4 mi above its mouth, about 1,000 ft below the confluence of the Chattahoochee and Flint rivers and 1.6 mi northwest of Chattahoochee, Florida. The reservoir, Lake Seminole, is the furthest downstream in the ACF Basin. It extends about 46.5 mi upstream along the Chattahoochee River to the vicinity of Columbia, Alabama, and about 47 mi upstream along the Flint River, or 17 mi above Bainbridge, Georgia. Jim Woodruff Lock and Dam was completed in 1957. The drainage area above the dam is 17,164 sq mi at the normal pool elevation of 77 ft, and the reservoir has a surface area of 37,500 ac. A general map of Jim Woodruff Lock and Dam and Lake Seminole is provided as Figure 2.1-36.



LEGEND

- ACF Basin Boundary
- County Boundary
- City
- Urban Area
- Interstate
- U.S. Route
- Surface Water
- USACE Dam

Jim Woodruff Lock and Dam/ Lake Seminole

Figure 2.1-36

Jim Woodruff Lock and Dam is a multipurpose project originally authorized under the RHAs of 1945 and 1946 to be operated in conjunction with the other federal works of improvement in the ACF Basin for the authorized system purposes. The project is operated to provide benefits for authorized purposes including hydropower, navigation, fish and wildlife conservation, recreation, and water quality. In addition, USACE has consulted with the USFWS regarding effects on threatened and endangered species downstream of Jim Woodruff Lock and Dam and determines minimum releases from Jim Woodruff Lock and Dam consistent with a USFWS Biological Opinion (BO) and a 2012 Revised Interim Operations Plan (RIOP) (discussed in more detail in section 2.1.1.2.4.4).

The project consists of a concrete open-crest spillway 1,634 ft long on the right bank, with crest at elevation 79 ft; a single-lift lock with usable chamber dimensions of 82 ft by 450 ft, with a maximum lift of 33 ft and a depth over the sills of 14 ft; a gated spillway 766 ft long with the bridge at elevation 107 ft, or about 67 ft above the streambed elevation; a powerhouse with an intake section constituting a portion of the dam; a nonoverflow earthen section 506 ft long to accommodate the switchyard and substation; and an overflow dike section 2,130 ft long on the left bank, with crest at elevation 85 ft.

The power installation at the project consists of three units with a total of 43.35 MW. The reservoir level is normally maintained near elevation 77 ft. Pondage of 0.5 ft above and below that elevation is used to reregulate flows into the reservoir from upstream projects that operate as peaking hydroelectric power generation plants. The reservoir level is maintained at elevation 77 ft by passing inflows through the spillway gates or through the powerhouse. A federally authorized 9-ft-deep, 100-ft-wide navigation channel provides for commercial river transportation from the Gulf Coast through Lake Seminole upstream to Columbus, Georgia, on the Chattahoochee River and to Bainbridge, Georgia, on the Flint River.

The project has no dedicated conservation storage or flood storage. The record high elevation for the reservoir under flood conditions was elevation 78.7 ft (in April 1960) and the lowest level was 74.2 ft (in November 1978).

When the reservoir inflow exceeds the discharge capacity of the turbines (about 18,000 cfs for the three units), the excess will be released through the gated spillway up to its capacity to prevent the pool from rising above elevation 77.8 ft at the dam. When forecasts indicate expected inflows in excess of 100,000 cfs, the pool will be lowered to elevation 77.0 ft in advance of the flood peak and held at that level until all usable spillway gates are fully open. The gated spillway will discharge up to 203,600 cfs. Discharges above about 108,000 cfs will cause the power plant to be nonproductive because of the high tailwater conditions. All outflows will be through the spillway for higher flow. When the inflow exceeds 203,600 cfs, all usable gates will be fully open, and there will be no control over the outflow. The pool will rise as long as the inflow exceeds the discharge capacity of the spillway, including the free-overflow section. The gates will remain fully open until the pool drops back to elevation 77.0 ft, when they will be operated as necessary to maintain the pool at or below elevation 77.0 ft. When the flow recedes to 100,000 cfs, the gates will be gradually closed to bring the pool back to elevation 77.5 ft over a 1- to 2-day period. Operation of the lock will be discontinued during flood periods when the headwater exceeds elevation 81 ft, which is 1 ft below the top of the upstream approach walls, and the tailwater will be at elevation 79.2 ft. The estimated discharge at that time would be 260,000 cfs, which has an expected recurrence interval of once in 95 years (for approximately 20 days duration).

2.1.1.1.6.8 Lake Blackshear and Warwick Dam

Lake Blackshear is the farther upstream of the two reservoirs on the Flint River. The Warwick Dam, which is located at Flint RM 134.7 near Warwick, Georgia, impounds the Flint River to create Lake Blackshear. The dam was built in 1930 and is owned and operated by the Crisp County Power Commission (CCPC) for hydroelectric power generation. The general location of the reservoir is

shown on Figure 2.1-37. The project consists of two earthen embankments, each about 30 ft high, on either side of a spillway and powerhouse facility. The north embankment is about 3,400 ft, and the south embankment is about 650 ft. The spillway/powerhouse facility is about 550 ft long. Lake Blackshear borders five counties, and the surface area is approximately 8,700 ac at the normal full pool elevation of 237 ft. The reservoir has 77 mi of shoreline, an average depth of 11 ft, and an average width of three-quarters of 1 mi. The drainage basin above the dam is approximately 3,770 sq mi and begins at Hartsfield-Jackson Atlanta International Airport just south of Atlanta, Georgia.

The project operates under FERC License No. P-659 issued on November 28, 2008 (FERC 2014b). The hydroelectric power generation project is licensed to operate in a run-of-river mode. The power plant at the dam consists of four units with a total licensed capacity of 15.2 MW. In the last 70 years, the reservoir has not only served Crisp County with power but has also become a valuable recreational and wildlife facility in southwest Georgia (CCPC 2010). The Crisp County steam plant is a major user of water from Lake Blackshear, but it also returns the thermal discharge back to the lake.

2.1.1.1.6.9 Lake Worth and Flint River Dam

GPC owns and operates the Flint River Dam (also called Lake Worth Dam or Albany Dam), which impounds a small run-of-river reservoir named Lake Worth. The project is in the vicinity of Albany, Georgia, at the Flint River's confluence with Muckalee Creek and Kinchafoonee Creek. The general location of the reservoir is shown on Figure 2.1-37. The project was constructed in 1908 for hydroelectric power generation and operates under FERC License No. P-1218, which was issued on September 30, 1999 (FERC 2014b). The hydroelectric power generation facility has three units with an installed capacity of 5.4 MW. The reservoir has a surface area of 1,400 ac and about 36 mi of shoreline at the normal elevation of 182.3 ft (GPC 2010e).

2.1.1.1.6.10 Other Reservoirs in the ACF Basin

In 2002, USACE conducted a preliminary survey of existing reservoirs in the ACF Basin in Alabama and Georgia. The survey provided information on the number, location, and approximate size of the smaller reservoirs within the basin that are off the mainstem rivers (generally reservoirs other than federal or major power company reservoirs), identifying a total of 411 reservoirs in the ACF Basin in the two states that are 20 ac or larger (USACE, Mobile District 2002a). The impoundments serve a variety of different purposes, including water supply for livestock and irrigation; fish and wildlife conservation; recreation; M&I water supply; and other localized uses. The Florida portion of the ACF Basin was not included in the survey, and it is not likely that there would be enough reservoirs of sufficient size to add appreciably to the totals from Alabama and Georgia. Hundreds of other smaller ponds and impoundments are scattered across the ACF Basin.

In the ACF Basin in Alabama, 25 reservoirs larger than 20 ac were identified during the survey. The total surface area of these reservoirs was about 1,900 ac, with an average reservoir size of about 77 ac. In the ACF Basin in Georgia, 386 reservoirs were identified. The total surface area of the reservoirs was about 23,800 ac, with an average reservoir size of about 62 ac (USACE, Mobile District 2002a). This summary does not include reservoirs on the mainstem rivers (Apalachicola, Chattahoochee, and Flint rivers) that are otherwise specifically discussed in this document. While the preliminary survey may not have identified and included every impoundment within the basin, it was detailed enough to provide a reasonably complete summary of the more noteworthy surface water impoundments in the ACF Basin.

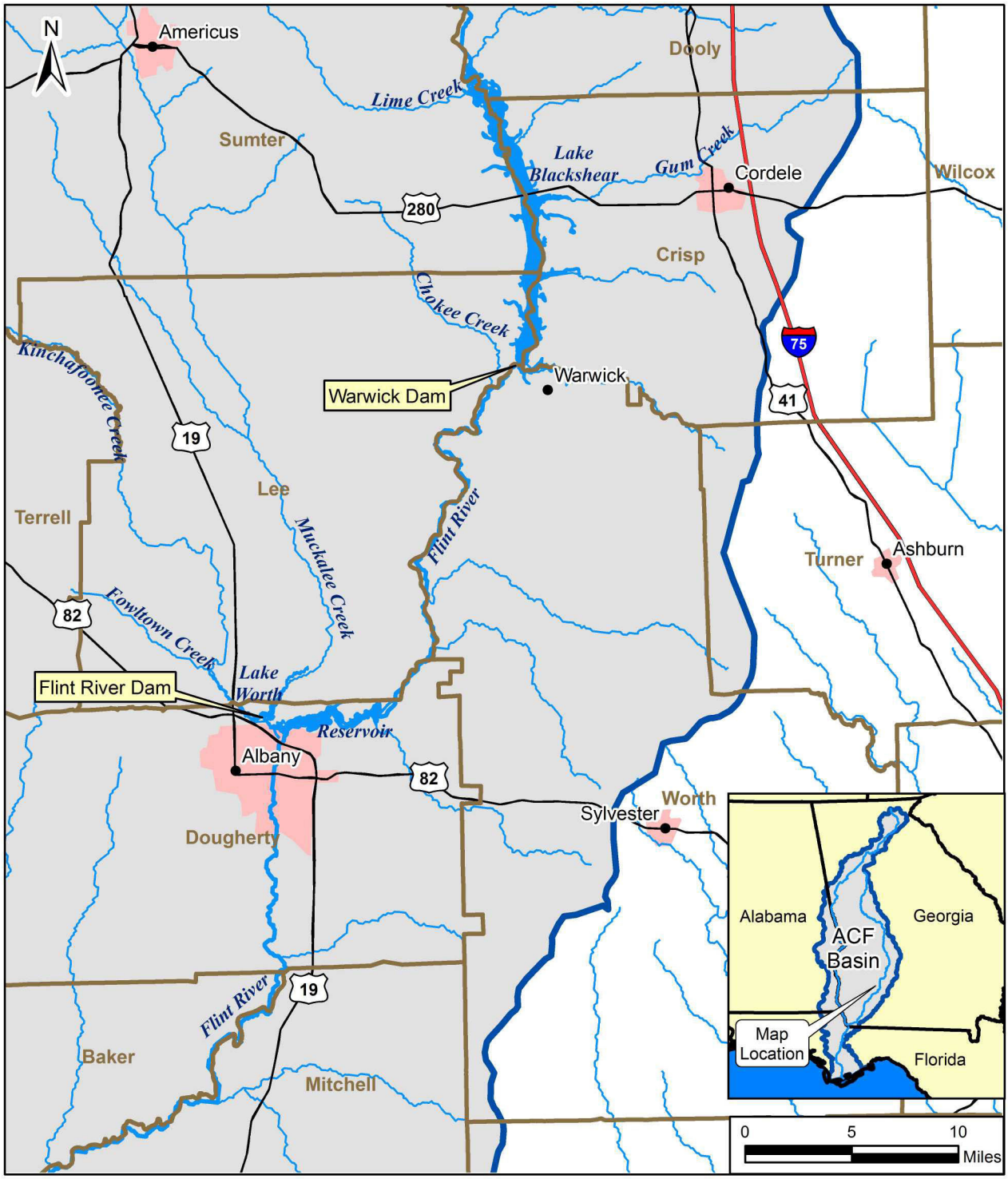

N
Americus
Dooly
Lime Creek
Sumter
Lake Blackshear
Gum Creek
Cordele
Wilcox
280
Crisp
Chokee Creek
Kinchafoonee Creek
75
Warwick Dam
Warwick
41
19
Lee
Terrell
Muckalee Creek
Flint River
Turner
Ashburn
82
Fowltown Creek
Lake Worth
Flint River Dam
Reservoir
Albany
82
Worth
Sylvester
Dougherty
Alabama
Georgia
ACF Basin
Map Location
Florida
19
Flint River
Baker
Mitchell
0
5
10
Miles
LEGEND
ACF Basin Boundary
County Boundary
City
Urban Area
Interstate
U.S. Route
Surface Water
Nonfederal Dam
Flint River Basin

Figure 2.1-37

USACE issues Department of the Army (DA) permits for potential reservoir projects under section 404 of the Water Pollution Control Act of 1972, as amended, which is also known as the Clean Water Act (CWA), and section 10 of the RHA of 1899. Table 2.1-4 summarizes the DA permits (or pending DA permit actions) for proposed nonfederal reservoirs in the ACF Basin since 1988 (Johnson 2010). The locations of the reservoirs within the ACF Basin are shown on Figure 2.1-38. These reservoirs are in the upper Flint and upper Chattahoochee River basins in Georgia. They have generally been pursued for the primary purpose of water supply, but they may also serve other purposes, such as recreation. These projects represent the substantial reservoir projects in the basin over the last 20 years with respect to reservoir size, yield, and costs. No similar reservoir projects have recently been pursued in the Alabama or Florida portions of the ACF Basin (House 2010). Table 2.1-4 might not include all DA permit actions for impoundments across the ACF Basin, as a number of other smaller, minor impoundments may have been constructed for a variety of local purposes between 1990 and 2010 that, collectively, do not rise to the level of these projects.

Table 2.1-4.
Nonfederal Reservoir Projects in the ACF Basin (not on the Mainstem Rivers) with DA Permits under Section 404 of the CWA issued since 1988, or with a Pending DA Permit

River Basin	Stream	Project Name	County	Yield (mgd)	Size (ac)	Status
Chattahoochee	Dog River	Dog River Reservoir	Douglas (GA)	15.89	260	Permitted 1988 Constructed 1992
Chattahoochee	Yahoola Creek	Lake Zwerner (renamed in 2009)	Lumpkin (GA)	5.7	132	Permitted 1992 Constructed 2004
Chattahoochee	Snake Creek	H.C. Seaton Reservoir	Carroll (GA)	13	650	Permitted 1994 Constructed 2001
Chattahoochee	Dog River	Dog River Reservoir Expansion	Douglas (GA)	23	256	Permitted 2004 Constructed 2009
Chattahoochee	Flat Creek	Glades Reservoir	Hall (GA)	72.5	850	Permit Pending (application temporarily withdrawn—Apr 2016)
Chattahoochee	Bear Creek	Bear Creek Reservoir	Fulton (GA)	7.0 (Phase 1) 16.44 (Phase 2)	440	Permit Pending (application withdrawn—Sep 2015)
Flint	Rush Creek	Rush Creek Reservoir	Talbot (GA)	2	80	Permitted 1991 Constructed 1998
Flint	Horton Creek	Horton Creek Reservoir	Fayette (GA)	18	770	Permitted 1992 Constructed 1996
Flint	Shoal Creek	Shoal Creek Reservoir	Clayton/ Henry (GA)	8.4	400	Permitted 1992 Constructed 1999
Flint	Still Branch	Still Branch Reservoir	Pike (GA)	35	476	Permitted 2001 Constructed 2008
Flint	Line Creek	Lake McIntosh	Fayette (GA)	10.4	650	Permitted 2007 Constructed 2012

Note: ac = acres.

Two of the reservoirs identified in Table 2.1-4 have been proposed and are not constructed: Bear Creek Reservoir and Glades Reservoir. As described in more detail below, DA permits under section 404 of the Clean Water Act were requested in 2009 and 2011, respectively. Both permit applications have subsequently been temporarily withdrawn, Bear Creek in late 2015 and Glades in early 2016. However, the local government proponents of these proposed projects maintain that they intend to continue pursuit of the DA permits and construction of the project upon developing additional information and resolving specific project related issues.

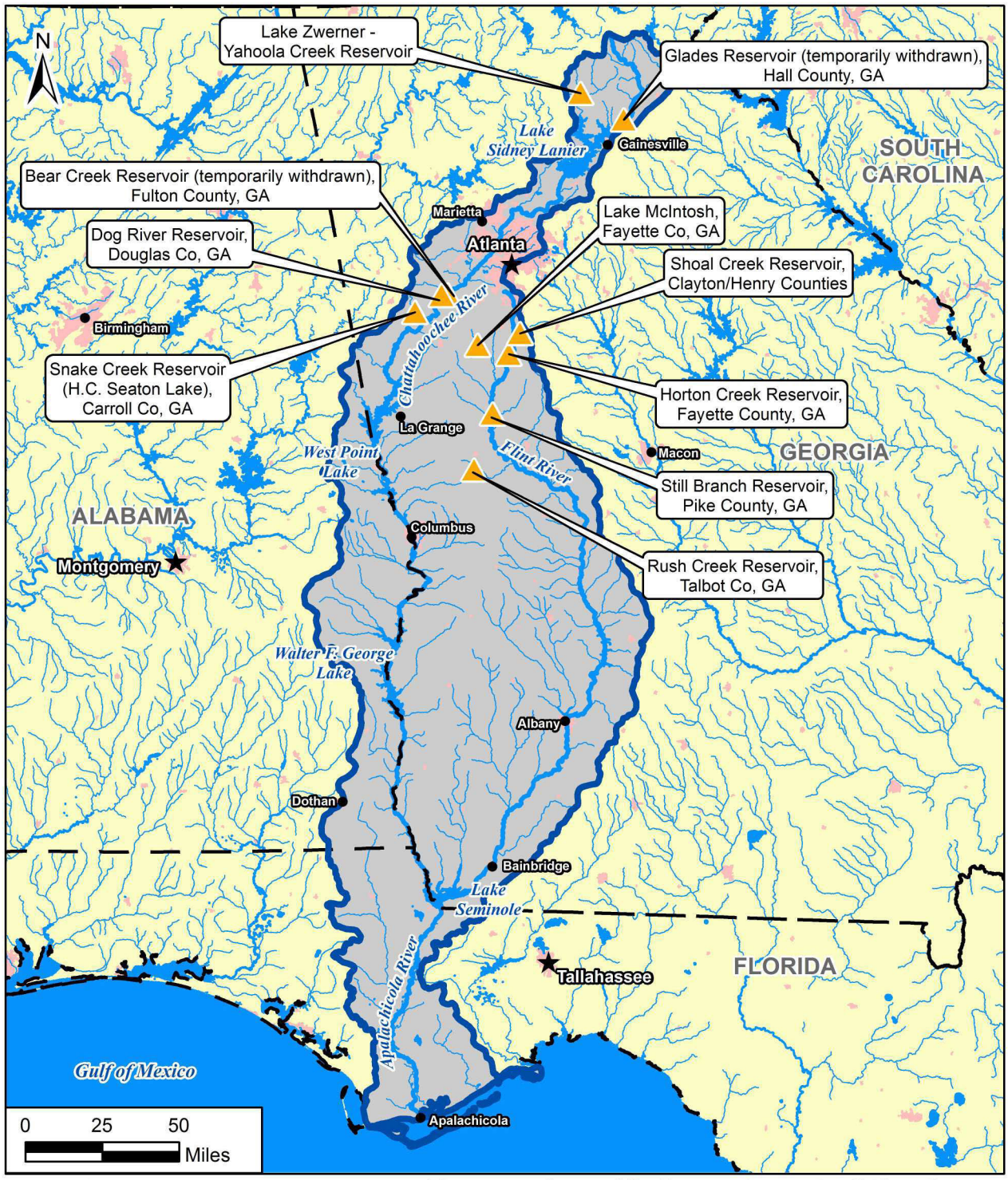
- **Bear Creek Reservoir.** The South Fulton Municipal Regional Water and Sewer Authority (SFMRWSA) has proposed to build a 440-ac pump-storage reservoir on Bear Creek in south Fulton County for water supply to serve the three member cities of Fairburn, Palmetto, and Union City. The proposed project would be located along Campbellton-Redwing Road (Highway 70), approximately 8 mi north of the Fulton-Coweta County line. The site is northwest of the City of Palmetto (USACE, Savannah District 2009). The general location of the proposed reservoir is shown on Figure 2.1-38.

  The proposed Bear Creek Reservoir would provide the year 2050 water demand of 16.44 mgd for the authority. Water for the reservoir would be provided by local inflow and by pump from the nearby Chattahoochee River. Water from the reservoir would be pumped to a proposed water treatment plant to be constructed adjacent to the reservoir along Highway 70. As currently proposed by the SFMRWSA, project construction would be phased commensurate with increasing demand over time (SFMRWSA 2014). The phased implementation, updated in response to a GAEPD request in 2013, would occur as follows (Schnabel Engineering 2014):

  – Phase I—Construct dam and reservoir that will yield up to 7 mgd from inflows from Bear Creek and basin runoff; construct 5.4-mgd water treatment plant; no supplemental pumping from Chattahoochee River or any other source for phase I.
  – Phase II—Construct a pump station upstream of the Bear Creek confluence with the Chattahoochee River with a maximum capacity of 13.9 mgd; pump water from the Chattahoochee River directly to the reservoir to achieve the required yield up to 16.44 mgd; expand water treatment plant to meet the projected 2050 demand.

  In 2008, the GAEPD formally certified the need for a reservoir in south Fulton County capable of supplying the region's water needs through 2050. The project has also been endorsed by the MNGWPD as one of six water-storage projects currently under way within the district. In February 2009, the SFMRWSA filed an application for a DA permit under section 404 of the CWA with USACE, Savannah District. The DA permit would allow the SFMRWSA to move forward to construct a reservoir that would ultimately yield the projected 2050 water demand of 16.44 mgd for residents of south Fulton County. By subsequent letter dated September 8, 2015, the applicant (SFMRWSA) temporarily withdrew the DA permit application for Bear Creek Reservoir. The future of the DA permit application and the project is uncertain.

  The extent to which the proposed Bear Creek Reservoir operations were considered in the modeling work for the Master WCM update and the WSSA is discussed in detail in section 4.1 and in the HEC-ResSim modeling report in appendix E.



Reservoirs with Department of the Army Permits (or Permits Pending) in ACF Basin since 1988

Figure 2.1-38

- **Glades Reservoir.** The Hall County Board of Commissioners, Hall County, Georgia, has proposed to construct a water supply reservoir project in Hall County to operate as part of the public water supply system. The proposed Glades Reservoir would be a pumped-storage facility located on Flat Creek about 0.8 mi upstream of its confluence with the Chattahoochee River at the headwaters of Lake Lanier. The proposed Glades Reservoir would be located approximately 12 mi northeast of Gainesville, Georgia, northeast of US 23/365, near the US 23/365 and State Route (SR) 52 intersection. The general location of the Glades Reservoir project is shown on Figure 2.1-38. The drainage area for the proposed Glades Reservoir is about 17.6 sq mi. The proposed dam would impound an approximately 850-ac reservoir at a normal pool elevation of 1,180 ft and provide 11.7 billion gallons of water storage capacity. The proposed project would also include an intake/pumping station, and 4.5-mi pipeline for withdrawing and pumping water from the Chattahoochee River to the proposed reservoir. The proposed intake/pumping station would be about 6.5 RMs upstream from the confluence of Flat Creek and the Chattahoochee River (USACE, Savannah District 2014).

  The proposed Glades Reservoir would store water pumped from the Chattahoochee River upstream of Lake Lanier, as well as natural streamflow from Flat Creek. Water would be pumped from the river to the reservoir for storage only when a minimum in-stream flow (approximately 120 cfs) could be maintained in the Chattahoochee River. As currently proposed by Hall County, reservoir operations to meet water supply demands would involve releases from Glades Reservoir to Lake Lanier, via Flat Creek, for withdrawal (at the same rate of release) from Lake Lanier at one or more of the existing water intakes in the lake. Under current USACE policy, this proposed operation would require a reallocation of conservation storage in Lake Lanier to water supply storage. Hall County's DA permit application under section 404 of the CWA, prior to the June 2011 opinion of the U.S. Court of Appeals for the 11th Circuit, presumed that a water supply storage reallocation at Lake Lanier would not be forthcoming (per the July 2009 U.S. District Court order) and consequently incorporated a plan for the necessary infrastructure to transmit water from Glades Reservoir directly to existing water treatment facilities in lieu of moving water to those facilities via discharges to Lake Lanier. Absent a future reallocation of Lake Lanier storage, Hall County would presumably revert to this previous proposal. As indicated by Hall County in the DA permit application for the project, the safe yield for the proposed Glades Reservoir is estimated to be 72.5 mgd on an annual average daily basis. The project, as proposed, was expected to meet Hall County's projected water supply need through 2060, based on population projections available at the time when the project was planned and the draft EIS for the Master WCM update was published (USACE, Savannah District 2014).

  Implementation of the proposed Glades Reservoir project in Hall County was specifically discussed in the January 11, 2013, letter from the Governor of Georgia to the Assistant Secretary of the Army for Civil Works, subject: Georgia's Water Supply Request. Regarding proposed operations at Glades Reservoir for water supply, the affidavit attached to the Governor's letter stated:

  > Based on reasonable assumptions regarding operation of Glades Reservoir, EPD projects a 30-40 mgd yield from Glades Reservoir. EPD plans to work with the Corps and the reservoir sponsors to ensure that the Glades reservoir serves as a net benefit to the system yield, provided that the Corps will be able to meet water supply needs of 705 mgd from Lake Lanier (Office of Governor, State of Georgia 2013). (Note: These statements were based on estimates of year 2040 demands per the State of Georgia.)

  In December 2015 and January 2016, the GAEPD provided additional information to USACE regarding the future water supply needs of Metro Atlanta, including information to confirm that the GAEPD certification of need for Glades Reservoir to meet future water supply needs was

rescinded. Consequently, as a result of this additional information, the future of the proposed Glades Reservoir project for water supply or for some alternate purpose is uncertain. Subsequently, Hall County temporarily withdrew the application for a DA permit for Glades Reservoir in April 2016.

The extent to which the proposed Glades Reservoir operations were considered in the modeling work for the Master WCM update and the WSSA is discussed in detail in sections 4.1, 5.1.2, and 5.1.3.8, and the HEC-ResSim modeling report (appendix E).

Calhoun Creek Reservoir. In early 2013, the City of Dawsonville, Georgia, advanced a proposal for a 590-ac water supply reservoir, which would lie within the City of Dawsonville, Dawson County, and Lumpkin County. This project is in the early stages of development. To date, no application for a DA permit under section 404 of the CWA for the project has been submitted to USACE, Savannah District. Therefore, the project was not included in Table 2.1-4. The proposed reservoir would store about 10.6 billion gallons of water at a full pool elevation of 1,350 ft. Because of the small drainage area above the proposed dam site, the principal sources of water to fill the reservoir would be withdrawals from both the Etowah River (Alabama-Coosa-Tallapoosa [ACT] Basin) and the Chestatee River (ACF Basin) to maximize the reservoir's reliable safe yield. Based on utilization of both sources, the proposed project estimated to yield 47.5 mgd.

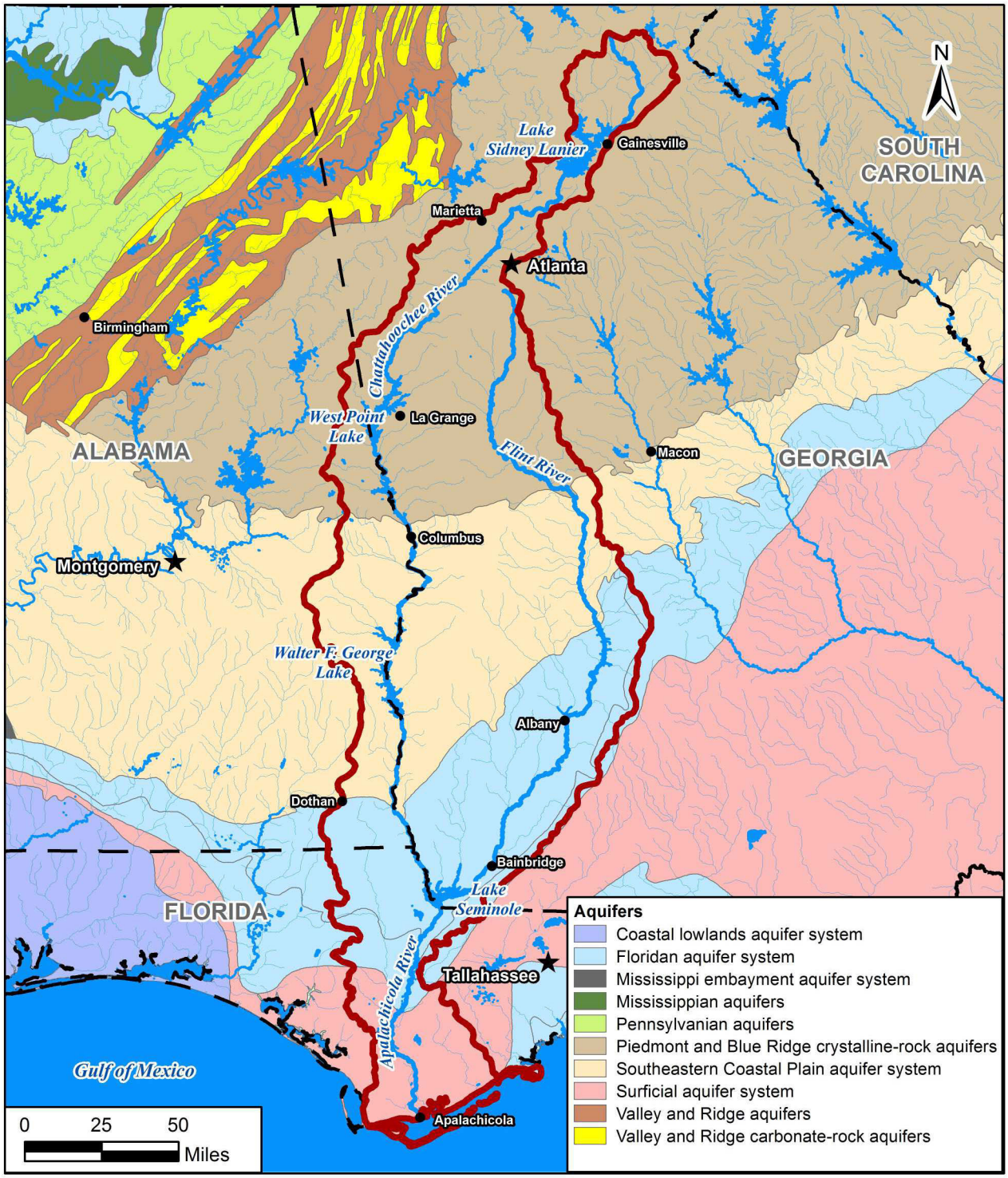
As conceived, the reservoir would be able to release water into both the Etowah and Chestatee rivers for downstream water supply withdrawal, even though the reservoir would be located in the Etowah River basin (City of Dawsonville 2013). While the reservoir project proposal is still in the early in the stages of development, the City of Dawsonville submitted an application to Georgia Environmental Finance Authority (GEFA) in April 2013 for direct state investment funding under the Governor's Water Supply Program (GWSP) for acquisition of real property associated with the proposed reservoir (City of Dawsonville 2013). The proposed project was not selected for 2013 GWSP funding. Additionally, the Calhoun Creek Regional Reservoir Authority has a pending application with GAEPD for a surface water withdrawal permit for the proposed reservoir. The application specifically proposes withdrawals of up to 75 mgd (daily maximum) and 45 mgd (monthly average) from the Etowah River but did not identify specific withdrawal requirements from the Chestatee River. The application is presently considered inactive by the GAEPD as the applicant has not responded to multiple requests for additional information, with the last request made by GAEPD in June 2014 (Shaaban 2016).

Because of the highly preliminary nature of the potential Calhoun Creek Reservoir proposal, it was not considered in the HEC-ResSim model for the Master WCM update and the WSSA.

2.1.1.1.7 Groundwater

The major aquifers in the ACF Basin include the surficial aquifer system, the Upper Floridan aquifer system, the Claiborne aquifer, the Clayton aquifer, the Providence aquifer, and the crystalline rock aquifer (Figure 2.1-39).

Groundwater in the ACF Basin generally flows from northwest to southeast, with some variation in local flow. Near major stream channels, and in areas of major water withdrawals, the flow is vertically upward and downward, but is mainly perpendicular to the stream channel, which demonstrates good hydraulic connection between groundwater and surface water. Rivers and streams in the southern half of the basin are deeply incised into the underlying aquifers and can receive substantial amounts of groundwater. For example, the Upper Floridan aquifer is hydraulically connected to the Flint River and, consequently, groundwater discharge contributes more significantly to baseflow in the Flint River than in the Chattahoochee River. Groundwater discharge to the Chattahoochee River is roughly 20 percent of the amount discharged to the Flint River (Frick et al. 1996).



Major Aquifers

Figure 2.1-39

The Blue Ridge and Piedmont are underlain by a metamorphic and igneous crystalline rock aquifer. The crystalline aquifer is overlain by a regolith of soils and saprolite of varying thicknesses, from 10 to 150 ft. The crystalline rocks have less than 2 percent primary porosity and little permeability. Most groundwater is stored in the saprolite, which has porosities of 20 to 30 percent. Water is transmitted from the saprolite to the crystalline bedrock via fractures that have formed in the rock from differential weathering at joints, faults, and quartz veins (Chapman and Peck 1997a). The volume of water stored in the saprolite is controlled by the porosity and thickness, while the volume of water stored in the bedrock is controlled by the degree of fracturing. The surface water drainage basins directly overlay the groundwater basins, and the two are interconnected; pumping of the groundwater reduces streamflow at a 1:1 ratio (GAEPD 1997).

The crystalline rock aquifer is used for private water supplies and livestock watering and may yield quantities of water suitable for public or industrial supply. The groundwater supply in the crystalline aquifer is typically not sufficient to meet M&I supply demands (Chapman and Peck 1997a, 1997b; GAEPD 1997). Well yields are highly variable and are dependent on the number and type of intersections of cracks and fractures in the bedrock. Wells typically yield 1–25 gallons per minute (gpm), but the yield can range from 0 gpm in wells with no fracture intersections to 700 gpm in wells with primary fracture intersection (Chapman and Peck 1997a, 1997b).

Water quality in the crystalline aquifer is typically suitable for drinking. The high clay content in the saprolite prevents pollutants from migrating into the bedrock aquifer, but there can be localized elevated concentrations of iron, manganese, sulfate, and nitrates from the minerals in the weathering rocks (Chapman and Peck 1997a; GAEPD 1997). For example, a drilling experiment in Cobb County, Georgia, yielded wells with high sulfate content that were not suitable for drinking water. The weathering can also produce acidic water, which can corrode copper lines, and radon gas from the natural radioactive decay of uranium in the rocks (Chapman and Peck 1997a).

The Southeastern Coastal Plain aquifer system comprises numerous semiconfining to confining units. The aquifers are difficult to distinguish from each other and are often mapped as one unit. The Claiborne aquifer crops out at the Fall Line and is confined in southwestern Georgia. It is composed of sand and sandy limestone from the Eocene age, and yields are typically less than 100 gpm. The Claiborne aquifer supplies water in southwestern Georgia and is composed of Paleocene sand and limestone. Well yields range from 100 to 700 gpm. Several layers of interbedded aquifers are within the Upper Cretaceous sediments, including the Providence aquifer. The Providence aquifer is one of the most prominent aquifers in the Upper Cretaceous sediment and is the deepest of the principal aquifers in the Southeastern Plains. It serves as the major source of water in the northern section of the Southeastern Plains, and wells in the aquifer yield 100 to 300 gpm. The Upper Cretaceous aquifers are composed of sand and gravel, and the layers are contained in clay and silt, which function as confining beds (GAEPD 1997).

Long-term heavy pumping from the Claiborne, Clayton, and Upper Cretaceous aquifers has resulted in significant water-level declines in the Albany, Georgia, area. The recharge area of the Clayton aquifer is small, and pumping rates have greatly exceeded recharge rates (GAEPD 2006).

The Upper Floridan aquifer, in the lower portion of the ACF Basin, stores and transmits large quantities of water. It is unconfined and semiconfined and is composed of a sequence of carbonate rocks that vary in thickness and transmissivity. Variations in transmissivity, from 2,000 to 1.3 million square feet (sq ft) per day, are caused by the size and distribution of the limestone and its openings and proximity to streams (USACE, Mobile District 1998a). Limestone thickness can range from 100 to 1000 ft (Edmiston 2008), and the greater thicknesses have higher transmissivity. Openings are often largest at bedding planes and fractures, and near streams due to acceleration of opening development by the surface water (USACE, Mobile District 1998a). One of the thickest and most productive limestone formations, the Ocala Limestone, is found in the karst topography of the Dougherty Plains (GAEPD 1997; FLDEP 2002).

Groundwater flow in the Floridan aquifer is from north to south, but flow direction can vary locally depending on the vicinity of streams and large groundwater withdrawal pumps. Rivers and streams in the Coastal Plain and Southern Piedmont are often incised into the aquifer and receive groundwater discharge from the aquifer (Edmiston 2008). In the Upper Floridan aquifer, groundwater levels rise and fall seasonally and with precipitation levels. Groundwater levels are often the lowest in the summer due to groundwater pumping for irrigation, increased evapotranspiration, and decreased rainfall (Mayer 1997).

The Surficial aquifer system is a shallow, unconfined water-table aquifer in Florida. It is recharged through rainfall, and seasonal precipitation patterns directly affect groundwater levels. Groundwater levels are also affected by prolonged droughts, water withdrawals, and evapotranspiration (FLDEP 2002). Flows in the Apalachicola River also affect groundwater levels, but this impact is less pronounced as proximity to the river is decreased (USACE, Mobile District 1998a). The aquifer has low permeability and is not a primary source of water supply; it is typically used only for isolated domestic wells (USACE, Mobile District 1998a). Because the surficial aquifer is primarily fed by rainwater, it is susceptible to contamination (Edmiston 2008).

As part of the ACF Basin Comprehensive Study in the 1990s, USGS conducted groundwater modeling in the Upper Floridan aquifer to investigate the long-term, or steady-state, effects of groundwater pumping on streamflow (Torak and McDowell 1996). A major assumption built into the model runs was that groundwater withdrawal from the Upper Floridan aquifer was steady and continuous, and would allow steady-state conditions to be established in the stream-reservoir-aquifer flow system. Results of this modeling suggested that, under these conditions, the effect of pumping 1 gallon (gal) of groundwater from the Upper Floridan aquifer would be about a 0.6-gal reduction in the groundwater contribution to streamflow. That is, reductions in streamflow caused by groundwater withdrawal occurred in a 0.6-to-l ratio of the amount of groundwater pumped under steady-state conditions. However, it should be noted that the model assumed that groundwater withdrawals occurred under conditions in which steady state had been reached in the flow system, and steady-state conditions could be established only after the aquifer had been given an adequate amount of time to fully respond to the long-term effects of continuous groundwater withdrawal at a constant rate. In areas of the basin north of the Fall Line, the ratio was 1 to 1 (i.e., for every 1 gal of groundwater withdrawal, there was a 1-gal reduction in river flow). In the Coastal Plain (the area below the Fall Line and north of the extent of the Upper Floridan aquifer), the ratio was found to be 0 to 1 (i.e., groundwater withdrawal had no effect on surface water flows) (USACE, Mobile District 1997).

In reality, the effects of groundwater withdrawal on surface water are transient (i.e., neither steady nor continuous) because groundwater is not pumped at a continuous rate long enough to allow the system to fully respond. Other transient effects on the flow system are caused by changes in hydrologic boundaries with time, such as lateral and vertical flows into and out of the basin by recharge, vertical leakage, and regional flow. Therefore, because groundwater withdrawals fluctuate according to time of day, seasonal variations, weather conditions (e.g., drought), and a wide variety of economic factors, the stream-reservoir-aquifer water system never actually reaches the steady-state conditions necessary to create the 0.6-to-1 effect from groundwater pumping on streamflow. This is further confirmed by the actual hydrologic effects that have been observed historically. Aquifer response to groundwater withdrawal is not instantaneous. Instead, aquifer response lags in time behind changes to the pumping rate due to hydraulic storage properties in the aquifer and semiconfining units of the affected flow system. Major water-bearing units in the lower ACF Basin do not exhibit long-term declines in water levels during drought conditions. During the droughts of the early and late 1960s, 1980–1981, and 1986–1988, water levels declined to record or near-record levels, but they recovered to predrought conditions with the return of normal precipitation (Torak and McDowell 1996).

Surface water features have variable effects on groundwater levels in the lower ACF Basin. Despite the potential for hydraulic connection between the Upper Floridan aquifer and Flint River, sudden changes in river stage for short durations do not necessarily cause corresponding water level changes in the aquifers. Surface water impounded behind dams does, however, locally affect groundwater levels. For example, at Lake Seminole, the pool elevation is maintained at an elevation of about 77 ft year-round, which causes the water levels nearby in the adjacent aquifer and overlying semiconfining unit to be nearly constant. However, it should be noted that groundwater levels in the Upper Floridan aquifer near Lake Worth are influenced by regional flow from the north.

Downstream from Lake Seminole, the stage of the Apalachicola River influences groundwater levels in the floodplain. Observation wells across the floodplain near Blountstown and Sumatra, Florida, indicate that groundwater levels depend on the river stage; however, water level fluctuations in the river are dampened in the floodplain by movement of water through the floodplain soils.

2.1.1.1.8 Estuarine Conditions

The Apalachicola Bay is a wide, shallow estuary along the Gulf Coast and is oriented east to west. The Gulf of Mexico enters the bay on the east side, and the Apalachicola River enters the bay on the west side. Water movement is from east to west and velocities are typically less than 1.5 cfs, except at passes on the west side of the bay, where velocities can range from 3.3 cfs to 11.5 cfs as water leaves the bay. Salinity is heavily influenced by flow from the Apalachicola River, decreasing both north to south and east to west as freshwater input from the river increases (Edmiston 2008).

The Apalachicola Bay is in a tidal transition area in the Gulf of Mexico. Tides within the bay are a mix of semidiurnal tides and diurnal tides, and the mixing produces one to five tides daily. Larger tidal variation is found in the eastern bay near the mouth to the Gulf of Mexico due to a stronger diurnal signal. The tidal range in the bay is normally 1–2 ft, but it can be as high as 3 ft. Strong winds can alter water movement, obscuring tidal effects and mixing shallow water in the bay (FLDEP 1998).

Mean annual discharge from the Apalachicola River to the bay is approximately 25,000 cfs, but minimum and maximum flow average 9,300 cfs and 200,000 cfs, respectively. Low flows occur in the summer and fall, and high flows occur in the winter and spring (FLDEP 1998). Freshwater inflow to the bay is determined by water releases from Lake Seminole (Jim Woodruff Lock and Dam) and inflows from tributaries to the Apalachicola River below the dam. Releases from Jim Woodruff Lock and Dam are the dominant influence on freshwater inflows. Of the approximately 20,000 sq mi contributing to the bay, only about 2,400 (or about 12 percent) are in Florida, causing rainfall amounts in the Chattahoochee and Flint River basins to heavily influence freshwater inflow into the bay (Edmiston 2008). During normal rainfall periods, the Chattahoochee River tends to contribute twice as much flow to the Apalachicola River as the Flint River; during drought periods, the Flint River tends to contribute more flow to the Apalachicola because of groundwater contributions. Releases from Jim Woodruff Lock and Dam are highly variable but, as discussed in section 2.1.1.2.4.4, the minimum release from the lake is 5,000 cfs (except under extreme drought conditions, when it can be as low as 4,500 cfs).

Approximately 247,000 ac encompassing the Apalachicola Bay and lower portion of the Apalachicola River are designated as the Apalachicola National Estuarine Research Reserve (ANERR). ANERR is one of 25 sites designated by the National Oceanic and Atmospheric Administration (NOAA) as a research reserve. The Reserve program is a federal/state partnership with the Florida Department of Environmental Protection (DEP) as the state program administrator. The ANERR is a consortium of management entities with various state and federal agencies assigned lead role management within the reserve. National Estuarine Research Reserves (NERRs) have been established to provide opportunities for long-term estuarine research and monitoring, estuarine education and interpretation, resource management, and learning upon which to base more informed coastal management decisions.

Recreation is a critical aspect of water use in Apalachicola Bay. Within the ANERR, there are national wildlife refuges, aquatic preserves, state forests and parks, and water management areas. Many of the recreational areas within the ANERR can be accessed only by boat because the reserve has restricted vehicle traffic. Much of the nonestuarine habitat is forested floodplain and wetlands with very few roads, although some parking lots are provided at popular recreation sites. Recreational activities include boating, freshwater and saltwater fishing, camping, birding, hiking, picnicking, swimming, sailing, hunting, shelling, and canoeing and kayaking. Recreational fishing has become more important in the area with the advent and increase of the tourism industry; it contributes over $35 million annually to the local economy (Edmiston 2008).

Several navigation projects are operated within the Apalachicola Bay and River. One, the ACF navigation project, begins at the confluence of the Apalachicola and Jackson rivers and extends to Columbus, Georgia, on the Chattahoochee River and to Bainbridge, Georgia, on the Flint River. A 9-ft-deep by 100-ft-wide federal navigation channel is authorized in the Apalachicola River, and annual dredging maintained the channel through the late 1990s. Commercial navigation use of the river has declined significantly since 2000 and currently, is nearly nonexistent. Issues related to providing conditions suitable for commercial navigation on the Apalachicola River are discussed in more detail in section 2.1.1.2.4.3.

The Gulf Intracoastal Waterway navigation project extends from the eastern part of the bay to the west. The waterway is a 12-ft-deep and 125-ft-wide channel that follows the coastline from Florida through Texas. Dredged material from this channel is principally placed in open water sites. Some dredged material placement locations are controversial due to potentially negative impacts on wildlife. Several other shallow-draft navigation channels are located within Apalachicola Bay, and they are primarily used by oyster boats and shrimp boats. Dredging occurs at these channels every 2 to 15 years (yr) (Edmiston 2008).

2.1.1.2 Water Management and Use in the ACF Basin

USACE projects in the ACF Basin were constructed and are operated to meet federally authorized project purposes. Water control objectives and operational guidelines to meet the authorized project purposes at USACE reservoirs in the ACF Basin are recorded in WCMs. An individual project-specific WCM has been prepared for each of the reservoir projects at some point after it was constructed and placed into operation (see section 3.4), which includes specific water control plans for the project. The original Master WCM for the basin as a whole was completed in 1958. The WCMs were developed in thorough consideration of all project purposes and cover a full array of all foreseeable hydrologic conditions, from flood to drought. This section summarizes the authorized project purposes and associated current water management activities for USACE projects in the ACF Basin, as described in the draft Master Manual, in existing individual project water control plans, and in other documents as specifically noted (USACE, Mobile District 1989).

2.1.1.2.1 Authorized Project Purposes—USACE Reservoirs

The ACF project has been authorized by Congress in several legislative acts.

- Section 2 of the RHA of 1945 (Public Law [P.L.] 79-14) approved the general plan recommended in House Document 342, 76th Congress, for development of the Apalachicola, Chattahoochee, and Flint Rivers in Georgia and Florida. The recommended plan authorized two locks and dams to provide for navigation and power: one at Fort Benning and one at the confluence of the Chattahoochee and Flint Rivers. Additionally, the plan included navigation-power dams with locks at four sites on the Chattahoochee River between Fort Benning and the junction; three storage-power dams on the upper Chattahoochee River; and three storage-power reservoirs on the Flint River.

- A modification to the 1945 general plan was authorized by section 1 of the RHA of 1946 (P.L. 79-525), in accordance with the report of the Chief of Engineers dated May 13, 1946 (House Document 300, 80th Congress), to include Buford multipurpose reservoir (Lake Lanier), the Fort Benning Lock and Dam, and the Upper Columbia and Jim Woodruff multipurpose developments. The project's navigation feature was to be provided by dredging, channel contraction works, construction of a series of locks and dams, and flow regulation by the upstream reservoirs. The 1946 amendment provided that, in the Apalachicola River portion of the project, "…local interests furnish free of cost to the U.S., as and when required, all rights-of-way, spoil-disposal areas, easements and other lands required for the provision and maintenance of a navigation channel in the Apalachicola River…".
- Further modifications authorized by Congress in 1953 (House Committee Public Works Resolution adopted May 19, 1953) substituted the George W. Andrews and Walter F. George Locks and Dams in lieu of authorized projects formerly identified in the 1945 general plan at different locations on the Chattahoochee River as the Upper Columbia multipurpose project and Fort Benning Lock and Dam.
- P.L. 84-841, enacted July 30, 1956 (1956 Act), granted USACE authority to enter into an agreement with Gwinnett County, Georgia, for the allocation of 11,200 ac-ft of storage for regulated water supply.
- The Flood Control Act of October 23, 1962 (P.L. 87-874), authorized West Point Lake in accordance with House Document 570, 87th Congress, for flood risk management, hydroelectric power generation, navigation, recreation, water quality, and, fish and wildlife conservation.
- Other operational objectives for the ACF projects derive from authorities that generally apply to all USACE reservoirs, including the following:
  - Fish and wildlife conservation (Fish and Wildlife Coordination Act [FWCA] of 1958 [P.L. 85-624] and the Endangered Species Act of 1973 [ESA] [P.L. 93-205])
  - Recreation (Flood Control Act of 1944 [P.L. 78-534])
  - Water quality (Federal Water Pollution Control Act of 1972 and its amendments, including the Clean Water Act of 1977 and the Water Quality Act of 1987)
  - Water supply (Water Supply Act [WSA] of 1958 [P.L. 85-500])

The following paragraphs describe the authorized purposes for which the ACF project is operated.

Flood Risk Management. Heavy rains produce floods, which can raise a lake level several ft overnight. When floods are over, it is important to prepare the reservoir to store floodwaters for the next flood event. When a flood event occurs, releases from the dam are curtailed or minimized until downstream conditions allow or if the reservoir reaches its capacity to hold floodwaters. When conditions allow, USACE releases water to evacuate the floodwaters as quickly as possible to prepare for the next potential flood event.

Not all USACE projects are designed to manage flood risk, and no dam can eliminate risk from every flood. Some major floods will eventually exceed the flood capacity of a dam. Typically, in a major flood, the dam will help reduce the peak flow of the flood and help reduce the amount of risk or damage that might have occurred if the dam was not there. In the ACF Basin, Buford Dam and West Point Dam were authorized specifically for flood control. Terminology used within USACE to refer to this project purpose has changed over time. USACE currently uses the term *flood risk management* rather than *flood control*, recognizing that floods cannot be controlled, but the risks associated with flooding can be managed through the operation of USACE reservoir projects.

Hydroelectric Power Generation. Water power plays an important part in providing reliable and relatively inexpensive energy. Most hydroelectric power generation is peaking power. The generators are turned on when the most, or peak, demand for power occurs. Hydroelectric power generation can start quickly, making it an important safety feature of an electric system.

Under the provisions of section 5 of the Flood Control Act of 1944 (P.L. 78-534) and other acts, power generated at USACE projects, which USACE determines to be surplus to project needs, is delivered to the Secretary of Energy for marketing. Buford Dam, West Point Dam, Walter F. George Lock and Dam, and Jim Woodruff Lock and Dam are authorized for hydroelectric power generation. The Southeastern Power Administration (SEPA), an agency of the Department of Energy (DOE) markets hydroelectric power from the USACE lakes in the ACF Basin to a number of electric cooperatives and municipal retail suppliers of power, referred to as *preference customers*.

Navigation. Navigation was one of the earliest uses of the nation's southeastern rivers. Native Americans and early European settlers used the rivers for transportation and commerce. Keeping rivers clear for navigation was one of the first USACE missions. Today's commercial barge lines still use rivers to move significant quantities of bulk materials by barge. In the ACF Basin, all five federal projects (i.e., Buford Dam, West Point Dam, Walter F. George Lock and Dam, George W. Andrews Lock and Dam, and Jim Woodruff Lock and Dam) are authorized to support navigation. Locks were constructed at the Walter F. George, George W. Andrews, and Jim Woodruff projects to facilitate navigation upstream to Columbus, Georgia, on the Chattahoochee River and to Bainbridge, Georgia, on the Flint River.

As stated above, the original plan for navigation provided for a minimum flow in the Apalachicola River, which together with dredging, would ensure adequate navigation depth. In drier months, water may be taken from reservoirs to augment natural river flow. Augmentation can often result in the decline in reservoir levels. At the present time, USACE is unable to perform dredging in the Apalachicola River for reasons described in detail in section 2.1.1.2.4.3. Accordingly, navigation on the Apalachicola River occurs only during seasonal periods, in the winter and early spring months, when adequate natural flows support the required navigable depths. Other special shipments can occur on an emergency basis, but they are scheduled and managed by coordinating with stakeholders to minimize fluctuating lake and river level effects.

Fish and Wildlife Conservation. Fish and wildlife conservation is an authorized purpose of the entire ACF Basin in accordance with the FWCA of 1958 (P.L. 85-624), as amended. The FWCA of 1958 directs that equal consideration be given to fish and wildlife resources and that measures to conserve those resources may be incorporated, along with other project features, into water resources development projects. The FWCA of 1958 stipulates, however, that for projects authorized prior to the FWCA of 1958 date of enactment—such as the ACF Basin project—modification of operations shall be compatible with basic project purposes. In addition to the general fish and wildlife conservation purpose relevant to all the USACE ACF Basin projects, West Point Dam and Lake was specifically authorized for fish and wildlife recreation, as described in more detail in section 2.1.1.1.6.3. The authorized fish and wildlife conservation project purpose applies directly to lands and waters associated with the USACE reservoirs; USACE has historically interpreted this authority to focus on the reservoir and the tailrace of the projects. Under the current ACF Basin reservoir project authorizations, the authorized lands and waters associated with the USACE reservoirs is defined as those lands and waters extending from the headwaters of Lake Lanier to the intersection of the Apalachicola River and the Gulf Intracoastal Waterway (river mile 5.9). Alternatively, under the current authorization, USACE must address fish and wildlife conservations actions outside of federally authorized lands and waters if USFWS or NMFS determines it to be necessary to address the adverse effects of project operations on federally listed endangered or threatened species. In the biological opinion, appendix J of the final EIS, the USFWS concluded that effects to estuarine invertebrate production are insignificant because the PAA provides slightly beneficial effects from increasing the number of freshwater pulses and increasing the number of days greater than or equal to

16,200 cfs in the winter. USFWS also anticipate only minor changes in salinity regimes and estuarine habitat due to the WCM. Accordingly, USACE is not authorized to modify for the purposed of fish and wildlife conservation. Modifying the reservoir releases solely to benefit fish and wildlife resources or to improve habitat conditions at remote downstream areas such as Apalachicola Bay would require specific separate authorization from Congress and is therefore outside of the scope of analysis for this project. USACE recognizes the importance of keeping a healthy population of fish and sustainable terrestrial habitats. Each year, in coordination with USFWS and state fishery agencies, USACE works to keep lake levels stable during the spring fish spawn period and to provide necessary releases to support fish spawning in downstream river reaches during designated periods. At other times of the year, USACE cooperates by manipulating releases and lake levels to improve fisheries, in both the reservoirs and the downstream river reaches. All USACE reservoirs in the ACF Basin support important fisheries and are operated accordingly, consistent with other project purposes. In addition to fishery management, operations include aquatic plant control and waterfowl management activities. The various basin projects have specific operations for fish and wildlife conservation, which are described in the individual WCMs for the projects.

Beginning in 2006, USACE has consulted with USFWS under section 7 of the ESA on operation of ACF Basin projects. Operational parameters at Jim Woodruff Lock and Dam have been established through the ESA consultation, including minimum flow releases, as set forth in the 2012 RIOP. Specific activities under the RIOP are described in detail in section 2.1.1.2.4.4.

Recreation. With a large economic expansion due to local and interstate tourism, recreation at USACE lakes has become a very important resource. Recreation (general recreation and fish and wildlife recreation) is one of the original congressionally authorized purposes for West Point Dam and Lake. At the other four federal ACF Basin projects, recreation facilities are authorized by the Flood Control Act of 1944. This act authorizes USACE "...to construct, maintain, and operate public park and recreational facilities at water resource development projects under the control of the Secretary of the Army…" Further, the Federal Water Project Recreation Act of 1965 (P.L. 89-72), as amended, established the development of recreation potential at federal water resource projects as a full project purpose. The ACF projects do not have any reservoir storage specifically allocated for recreation. Accordingly, although recreation is an authorized project purpose, it is secondary (relative to storage operation) to project functions for which the reservoir storage was formulated (EM 1110-2-3600, p. 2-29).

Water Quality. Federal projects operate to sustain or improve water quality conditions, consistent with other specifically authorized project purposes. Three of the dams in the ACF Basin have minimum release obligations: Buford Dam, West Point Dam, and Woodruff Lock and Dam. The minimum flow requirements at Buford and West Point dams are based on the original project authorization. As noted above, the minimum flow releases at Jim Woodruff Lock and Dam are necessary to comply with USACE's ESA requirements as set forth in the 2012 RIOP. The releases from the three dams help to ensure healthy aquatic life, even when treated or used waters are added at downstream points. Project operation can influence water quality as it relates to temperature, DO, and nutrients and can help benefit water quality purposes on downstream lakes and river reaches.

Water Supply. Much of the M&I water supply in the ACF Basin comes from surface water in streams, rivers, and reservoirs. Even in the worst droughts in history, streams and rivers provided sufficient flow to accommodate domestic and M&I water supply needs. However, cities and industries have grown and become more dependent on reservoir storage for a dependable water supply. Federal projects in the ACF Basin do not currently include allocations of storage for water supply. Additionally, as a by-product of operating the federal projects for other purposes, downstream users may receive an incidental water supply benefit.

In connection with the initial construction of Lake Lanier and West Point Lake, USACE entered into relocation agreements authorizing direct withdrawals from those reservoirs, in compensation for the federal taking of preexisting intake facilities or lands. There are relocation agreements with the cities of Buford and Gainesville, Georgia, at Lake Lanier and with the City of LaGrange, Georgia, at West Point Lake.

The accommodation of additional water supply withdrawals from Lake Lanier and from the Chattahoochee River downstream are discussed in sections 2.1.1.2.4.6 and 3.3. The 11th Circuit Court of Appeals determined in 2011 that release of water from Buford Dam to accommodate downstream water supply withdrawals for Metro Atlanta needs is a project purpose authorized by the RHA of 1946. In the ruling, the court also affirmed that reallocation of water supply storage withdrawals directly from Lake Lanier, except for withdrawals covered by the relocation agreements, would be addressed in accordance with the provisions of the WSA of 1958. A more complete discussion of the 11th Circuit Court of Appeals opinion can be found in section 3.5.2.8.2.

2.1.1.2.2 ACF Regulation Master Manual—Overview

The initial Master Manual for the ACF Basin was completed in February 1958, shortly after completion of the Jim Woodruff Lock and Dam and shortly before Buford Dam was fully completed and in service. Therefore, the 1958 Master Manual essentially summarized natural basin characteristics and did not include a comprehensive explanation of the interrelationships of the projects or a systemwide water control plan. However, the 1958 Master Manual stated that "full consideration will be given to all water uses, such as flood control, navigation, power and water supply" (USACE, Mobile District 1958). In discussing the interrelationship of the ACF Basin projects, the 1958 Master Manual stated that the operating plan for the existing projects together with the contemplated projects would be operated as "an integrated and mutually interrelated system that will make the most complete practical use of the water resources of the basin" (USACE, Mobile District 1958).

With the completion of the WCM for Buford Dam in 1959, the USACE interpretation of congressional intent was reflected in both the Master Manual and the operating manual for Buford Dam, "ensuring an adequate water supply for Metro Atlanta by releases from Buford Dam" (Stockdale 2012). The 1959 WCM for Buford Dam confirmed the intended operation of the dam for downstream water supply stating, "[t]he increased flow in dry seasons also provides for an increased water supply for [M&I] uses in the metropolitan area of Atlanta…" (USACE, Mobile District 1959). Additionally, the WCM stated, "the Buford project will be operated as a peaking plant for the production of hydroelectric power generation with minimum releases during the daily and week-end off-peak periods which will be sufficient, with local inflows added, to supply Metro Atlanta with not less than 600 cfs. During low-water periods such regulation will provide increased flow downstream for navigation, water supply, pollution abatement and other purposes" (USACE, Mobile District 1959).

Since completion of all the federal projects in the ACF Basin and as operating experience has been gained, the regulation plans for the reservoirs have evolved. Operational adjustments are detailed in the WCMs for the individual projects, which have been designated as appendices to the 1989 draft update to the Master Manual for the entire ACF Basin.

Jim Woodruff Lock and Dam was completed in 1957, when the ACF Basin was entering a *normal* period of hydrometeorological conditions, during which sufficient flows were generally available to meet all basin requirements. This period lasted throughout the 1960s and 1970s. Drought episodes were experienced with uncommon frequency and severity during the 1980s. The summer of 1980 through the fall of 1981 marked the beginning of this trend, with the most severe basinwide event during the decade occurring in 1986 (see section 2.1.1.1.1.2). As that decade progressed, it became increasingly apparent

that previously established operational procedures were not adequate to appropriately respond to severe drought conditions.

On the basis of those experiences, USACE, Mobile District responded to requirements for drought contingency planning as defined in ER 1110-2-1941 (September 1981). The *Interim Drought Management Plan for the ACF Basin* provided generalized guidance for drought management actions and established interagency coordination procedures (USACE, Mobile District 1985). A *Drought Management Strategy for the ACF Basin* specifically addressed circumstances in the acute 1986 drought and provided useful strategies and guidelines for addressing management of USACE projects in the ACF Basin during subsequent water shortage periods (USACE, Mobile District 1986). Individual project WCM updates and supplementary documentation developed since then, including experience from the significant droughts of 1998–2002 and 2006–2008, contain more detailed descriptions of water control actions invoked during droughts.

As indicated above, purposes for which the federal projects in the ACF Basin are operated include flood risk management, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water supply, and water quality. Fish and wildlife conservation, recreation, water quality, and water supply are considered purposes under general legislation, including the Flood Control Act of 1944; Federal Water Project Recreation Act of 1965; Water Pollution Control Act of 1972, as amended; WSA of 1958; FWCA of 1958; and ESA. The exception is West Point Lake, where fish and wildlife recreation is an additional specifically cited purpose in the congressional authorization. USACE policy states that legally authorized purposes recognized after project construction receive appropriate consideration when making water control decisions just as the project purposes that were specified in the original project authorizations do.

ACF Basin water control operations do not consistently prioritize one project purpose over another but consider all project functions equally and account for the full range of hydrologic conditions from flood to drought. Because actions taken at the upstream portion of the basin affect conditions downstream, the federal projects in the ACF Basin are operated as a system rather than as a series of individual, independent projects. The balancing of water control operations to meet each of these purposes varies between the individual projects and time of year. Operation of the projects is usually performed in a manner that represents a consideration of the oftentimes competing purposes and, whenever possible, reservoir operations are managed to accommodate these purposes in a complimentary fashion. For example, flood waters are evacuated to the greatest extent practicable through the powerhouse turbines to produce electricity. In addition to specific purposes for which these projects are operated, over the years a variety of activities (e.g., M&I water supply, in-stream recreation, water quality) have become dependent upon the operational patterns of the projects.

Traditionally, the federal projects in the ACF Basin have been operated to control hydroelectric power generation requirements during the summer months when energy demands are high, while navigation needs dominate during the fall, low flow months. Whenever rainfall has caused water levels to rise excessively, flood risk management operations override other project functions. During extreme drought conditions, water supply and water quality requirements have been the major operating concerns. During the extreme drought period beginning in 2006, federally listed threatened and endangered species conservation also became a priority consideration in managing the system. This water management approach recognizes that extreme droughts can produce situations where trade-offs are required. For example, in extreme droughts, project operations directed primarily at water supply, water quality, and/or endangered species conservation might receive higher consideration than other purposes, such as hydroelectric power generation, navigation, and recreation. As described above, USACE strives to operate the reservoirs of the ACF Basin in a balanced manner to meet all of the project purposes. The relative importance (priority) of project purposes varies from project to project depending on water level and storage conditions in each reservoir.

2.1.1.2.3 ACF Water Control Objectives and Guidelines—General

This section summarizes current water management practices for the ACF Basin, which will remain in effect pending an updated and approved Master WCM prepared by USACE. Future specific congressional direction or an agreement among the states on a water allocation formula could dictate further revision of the Master Manual.

The water management practices for the ACF Basin described in this section are detailed in the following documents:

- Draft ACF Water Control Plan, dated 1989
- Project WCMs for Buford (1991), West Point (1984), Walter F. George (1993), George Andrews (1996), and Jim Woodruff Lock and Dam (1985) (USACE, Mobile District 2010b)
- RIOP and Environmental Assessment (EA) (June 2008), as modified by the May 2012 RIOP/EA
- South Atlantic Division Regulation (SADR) PDS-O-1, *Project Operations, Lake Regulation and Coordination for Fish Management Purposes* (May 31, 2010) and draft *Reservoir Regulation and Coordination for Fish Spawn Management Purposes Standard Operating Procedure* (SOP), (USACE, Mobile District SOP 1130-2-9) February 2005
- CRMS as described in the ACF Basin Master Reservoir Regulation Manual, appendix B, Buford Dam (Lake Sidney Lanier) Chattahoochee River, GA, February 1991

The reservoirs in the ACF Basin are managed and operated in accordance with authorized project purposes and as an integrated system of water resource projects in which each reservoir has a role to play. Operations at each project are coordinated with the other projects to best meet authorized purposes and balance frequently competing water resource requirements. The balancing of water control operations to meet each of these authorized purposes varies between the individual projects and time of year (USACE, Mobile District 2010b). Many interests and conditions must be continually considered and balanced when making water control decisions for the basin. Flexibility must be maintained to address the short-term needs of one project function without jeopardizing the long-term requirements of another.

Many factors must be evaluated in determining project or system operation, including project requirements, time of year, weather conditions and trends, downstream needs, and the amount of water remaining in storage. The guidelines are not limited to a specific hydrologic condition, and, therefore, the Master Manual differs from a flood risk management or drought plan; however, the plan is broad enough that it can fulfill requirements for a drought plan.

2.1.1.2.4 ACF Basin Water Control Objectives and Guidelines by Project Purpose

The following sections describe the water control objectives and guidelines for specific project purposes for USACE projects in the ACF Basin.

2.1.1.2.4.1 Flood Risk Management

The objective of flood risk management operations (formerly referred to as flood control) is to impound excess flows, thereby reducing downstream river levels below flood stage. Whenever flood conditions occur, operation for flood risk management takes precedence over all other project functions. Only Buford and West Point dams have storage allocated for flood risk management operations. During the principal flood season, December through April, the regulation plan at Walter F. George Lake provides for lower lake levels to ensure lower peak stages throughout the reservoir during major floods. George W. Andrews and Jim Woodruff lock and dams operate to pass inflows.

The timing of flood peaks in the ACF Basin is of considerable importance in determining the effectiveness of reservoir operations for flood risk management and the degree to which such operations can be coordinated. During a flood event, excess water above the guide curve is evacuated (released) consistent with other project needs as soon as downstream waters have receded enough that releases from the reservoirs will not increase the natural maximum flood heights downstream. This timely evacuation is necessary so that consecutive flood events will not cause floodwaters to exceed allocated storage capacities and endanger the integrity of the dam. Both turbines and spillways are used, as necessary, to evacuate floodwaters.

Project performance at the Lake Lanier and West Point projects for flood risk management is determined by the extent to which the allocated flood storage in those reservoirs (above the top of the conservation storage) is managed during flood events, regardless of the elevation of the reservoir within the conservation storage at the beginning of each flood event. Flood risk management operations are not initiated until pools levels reach or approach the top of the conservation pool during a flood event. If reservoir levels within the conservation pool would be lower under one water management plan scenario compared to another, the water management plan producing the lower pool level under the same hydrologic conditions might provide slightly higher overall storage capacity to manage a specific flood event. However, that occurrence would not appreciably alter how flood risk management operations would be conducted once the reservoir level rises into the allocated flood storage zone.

Because flooding usually occurs in the winter and spring when rainfall and runoff are more plentiful and hydroelectric power generation demands are lower, the guide curve operation generally reflects this situation by specifying a lower elevation during this time period. Transitions between the seasonal levels are gradual to moderate increases or decreases in outflow. By drawing down the pool in late fall, either specifically for flood risk management as at the West Point project or coincidentally for other purposes, additional storage is gained for containing floodwaters.

For flood risk management purposes, releases are reduced or terminated at Buford Dam, except for the small hydropower unit, as soon as it appears that downstream river stages will exceed flood stage. Key gaging stations in the vicinity are closely monitored to determine when floodwaters have begun to recede so that flood storage in the reservoir can be expeditiously evacuated in a manner consistent with other project functions without exacerbating downstream flooding. Projects on the middle and lower river pass flood waters once the pool has reached the top of the conservation pool. West Point and Walter F. George dams operate according to specified flood risk management plans, as outlined in their WCMs. Spillway gates are opened if necessary to assist the turbines in passing these flows.

Even though the traditional flood season spans several months, discrete incidences of flooding should have insignificant long-duration effects if pool elevations are maintained close to guide curve elevations. No pool is allowed to remain above its guide curve for any appreciable length of time without prior approval of a temporary deviation or variance by USACE, South Atlantic Division.

2.1.1.2.4.2 Hydroelectric Power Generation

Hydroelectric power generation is a small but key feature in meeting the power demands of the region, with the plants providing a power source that meets a portion of the region's peak demands for electric power. Peaking capability on short notice is greatly valued for power grid reliability. Hydroelectric power generation is instantaneously available to meet extreme increases in power demand or to replace unexpected interruptions in thermal generation. The power generated by USACE projects in the ACF Basin is marketed by SEPA. SEPA markets power on the basis of a system that comprises a large geographical area to a number of cooperatives and municipal retail suppliers of power, referred to as *preference customers.* Projects within SEPA's Georgia-Alabama-South Carolina system include Buford, West Point, and Walter F. George on the Chattahoochee; four projects in the Alabama, Coosa, and

Tallapoosa River Basin; and three projects in the Savannah River Basin. The 10 powerhouses in this system have been operated most of the time as *peaking plants* in an integrated fashion to produce an aggregate hydroelectric power generation supply for the system. As a result, power generation demands have been balanced among the projects weekly to enhance the long-term generating capability of the entire system. By integrating the operation of these projects, the total utility and marketability of power produced for the entire system is greatly increased and the adverse effects on the reservoirs are more balanced. When the system obligation cannot be met, the SEPA arranges for supplemental power or purchases from other sources, or both.

The storage projects (i.e., Buford, West Point, and Walter F. George) generally provide at least 2 hours of generation a day, 5 days a week at powerhouse capacity throughout the year, as long as sufficient conservation storage is available. The amount of generation per day is governed by a preset guide curve and action zones for each reservoir, with diminishing energy generation with declining storage. Minimum generation provides the release that would normally meet downstream water supply and water quality demands, as well as the capacity specified in SEPA's marketing arrangement. During the summer and early fall (July through October), typical operation provides minimum generation of 4 hours a day at a project if the pool level is above Zone 3, as identified in Figure 2.1-22 (Buford), Figure 2.1-28 (West Point), and Figure 2.1-33 (Walter F. George). This increase assists in meeting the high energy demands during that period. Minimum releases can also be increased if local inflows below the project are insufficient to meet water quality/water supply requirements. Additional generation solely to meet system hydroelectric power generation demands does not occur.

The Jim Woodruff (Lake Seminole) project is operated as a run-of-river plant and is dependent on releases from the upstream impoundments on the Chattahoochee River and from the Flint River. Unlike projects with appreciable conservation storage, run-of-river hydroelectric power generation facilities do not follow a guide curve, nor do they fluctuate or redistribute flows. The output of the plant varies with changes in the inflow entering Lake Seminole. The Jim Woodruff is a 1-project system, and the power it generates is marketed by SEPA to seven preference customers in the northern part of Florida to provide a specific minimum capacity and weekly energy. When that obligation cannot be met, the SEPA arranges for supplemental power or purchases from other sources, or both.

Droughts experienced over the basin in the past 35 years have revealed that, during extended low flow seasons, operation of the federal projects in the ACF Basin for hydroelectric power generation production to meet the SEPA contract requests does not provide enough flexibility to adequately meet other authorized purposes. During these times, water taken from storage during the high-energy-demand months (June–September) would draw the pools down to such an extent that recreation would be affected in the lakes and less storage would be available late in the year to meet other release requirements, such as navigation or water quality. In such instances, hydroelectric power generation has been curtailed, as necessary, to balance the entire system operation.

2.1.1.2.4.3 Navigation

The existing authorized navigation project includes a 9-ft by 100-ft navigation channel from Apalachicola, Florida, to Columbus, Georgia, on the Chattahoochee River, and to Bainbridge, Georgia, on the Flint River. Hydraulic and sedimentation characteristics of the Apalachicola River have been such that, despite maintenance dredging, the controlling channel depth has typically been less than 9 ft during a large portion of the normal low flow period of the summer and fall each year. Groundings have been frequent, and barge loadings have been reduced considerably at times in the past to avoid grounding delays. This section describes authorized and historical operations in support of navigation in the ACF Basin through 1998, followed by a brief description of current water management operations specifically related to navigation.

Historical Operations (through 1998). The following overview of historical operation for navigation is summarized from a USACE, Mobile District information paper, *Navigation on the Apalachicola River* (USACE, Mobile District n.d.). The Blountstown, Florida, gage, approximately 29 mi downstream of Jim Woodruff Lock and Dam, has been historically used as the critical point of reference for the channel depth availability. With the performance of adequate maintenance dredging and snagging, a stage reading of 5 ft generally translated to a 9-ft channel during the late spring and early summer from 1970 through 1998. With the removal of additional shoals during late summer and early fall, a 9-ft channel could be provided by lower flow conditions and a correspondingly lower stage. Because of inadequate depths, navigation had to be suspended temporarily during extreme drought years. Over the period 1970–1998, a 9-ft channel was available only about 62 percent of the time, and a 7.5-ft channel was available 82 percent of the time. In dry years, a 7.5-ft channel might be available only 25 percent of the time.

Flow is the primary factor that influences the degree to which authorized project depths in the Apalachicola River navigation channel are achieved. The original design of the project documented that a discharge from Jim Woodruff Lock and Dam of 9,300 cfs together with dredging would provide a 9-ft channel. By the mid-1980s the required discharge with dredging to provide a 9-ft channel was estimated to be 11,000 cfs. By 1995, the predredging flow requirement to provide a 9-ft navigation channel had increased to 16,000 cfs.

The increasing flow requirements to achieve the authorized navigation channel depth and a range of navigation depths in the Apalachicola River are attributable to (1) channel degradation and (2) flow diversion through Chipola Cutoff. Degradation of the upper third of the Apalachicola River streambed has historically occurred as a result of the construction of Jim Woodruff Lock and Dam. This is a typical response of a river system following construction of a dam in that sediment is trapped upstream by the dam and, consequently, the downstream river channel erodes and gets deeper and wider, requiring increasingly more flow to achieve the same channel depth. In the lower reach of the Apalachicola River between RMs 39.0 and 42.0, a section of the river channel divides, creating an island. The navigation channel is on one side of the island while, on the other side, an opening to the adjacent Chipola River called the Chipola Cutoff allows Apalachicola River water to flow into the Chipola River. The Chipola Cutoff has been widening over the years and allowing more flow to enter the Chipola River, requiring greater discharges from Jim Woodruff Lock and Dam into the Apalachicola River to achieve the various navigation channel depths.

Three reaches of the Apalachicola River have historically presented major maintenance problems, in terms of high annual dredging quantities, multiple dredging events per year, and the lack of adequate disposal area capacity. They are Corley Slough, between RMs 35.0 and 37.0; Chipola Cutoff, between RMs 39.0 and 42.0; and the Blountstown Reach, which extends from RM 76.0 to RM 81.0. The quantity of dredged material removed from the three river sections has accounted for almost 40 percent of all maintenance dredging on the Apalachicola River. The navigation problems associated with shoaling in these reaches are particularly aggravated during low flow periods.

Following discussions with navigation users during and after the 1986 drought, USACE developed a technique to provide for a planned period of navigation called a *navigation window*. This technique involved temporarily storing sufficient water in West Point Lake, Walter F. George Lake, and Lake Seminole that was then released over a 10-day to 2-week period at a rate to provide for navigable depths (at least a 7.5-ft channel) in the Apalachicola River. This technique was employed beginning in 1990 and continued throughout the decade. Beginning in the mid-1990s, navigation windows were scheduled in advance, approximately one per month during the low-water months, to provide the waterway users a predictable, reliable channel. Because channel conditions were deteriorating, navigation windows were used with increasing frequency to as many as six a year, generally between May and December. While the use of navigation windows proved successful in providing for navigation on the system, the effects on downstream fisheries and other environmental resources and on recreational use in

the upstream reservoirs from fluctuations of lake levels necessary to accommodate releases for navigation windows created increasing controversy over the technique.

In accordance with the Water Pollution Control Act of 1972, as amended, USACE obtained water quality certifications from Florida for maintenance dredging in the Apalachicola River, beginning in 1979. Over the years, conditions placed on the certification imposed increasing restrictions on the usage of dredged material disposal area, and required an extensive monitoring program and the reopening of sloughs along the river. Those actions limited dredged material disposal capacity and increased the costs of channel maintenance. In response to the limitations, new management techniques (e.g., mechanical redistribution) were developed to provide for additional dredged material disposal capacity. Mechanical redistribution was initiated in 1987 and involved the mechanical grading of material from a within-banks disposal area into the river during high flows to facilitate transport of the dredged sediment downstream with the river bedload. Mechanical redistribution was certified in Florida's water quality certification in 1991, subject to a monitoring program.

Historically, when it became apparent that, due to diminishing inflows to the system, downstream flows and depths had to be reduced, navigation bulletins were issued to project users. These notices were issued as expeditiously as possible to give barge owners and other waterway users sufficient time to make arrangements to either light-load or remove their vessels before action was taken at Woodruff to reduce releases.

Available storage was normally used to extend some level of navigable depth throughout the year. Pondage at Lake Seminole was used hourly and daily to regulate the river. Because Walter F. George Dam is farther upstream and its releases have to travel about 75 RMs through Lake George W. Andrews and Lake Seminole before affecting navigation, its storage provided daily and weekly regulation of flows. Still farther upstream, West Point Lake assisted weekly and monthly regulation. As the furthest upstream location, Lake Lanier storage was used on a monthly time scale. Navigation flows could often be provided by just the lower projects (West Point and Walter F. George), but in general, flow regulation for navigation required the integrated use of all the resources in the basin. Even then, flow regulation capability could not provide full navigation channel availability for all circumstances. Special releases of short duration were made to assist navigation. When making reductions in outflows, a stair-step approach was typically used so that stages dropped no more than 1 ft a week and navigators could be notified of the impending reductions.

Through most of the 1990s, the navigation channel on the ACF Basin was used consistently and frequently by commercial traffic. The authorized navigation channel downstream of Jim Woodruff Lock and Dam was maintained in reasonably reliable condition by way of maintenance dredging, snagging, and training works, combined with flows from upstream that were generally sufficient to meet navigation needs. During that period, annual tonnage ranged from 550,000 to 640,000, and annual traffic ranged from 900 to 1,200 trips (USACE, Mobile District 2006).

Current Operations for Navigation (1999–Present). Navigational use of the ACF waterway declined precipitously during 1999 and has not recovered. The navigation channel downstream of Jim Woodruff Lock and Dam was only partially dredged in 1999 due to a shortage of dredged material disposal capacity. Water quality certification for maintenance dredging of the Apalachicola River portion of the navigation channel, issued in October 1999 by the Florida DEP, placed significant conditions and constraints on the practice, including prohibiting the continued use of mechanical redistribution of dredged material. No dredging was conducted in 2000 and only minimal dredging was conducted in 2001, principally due to extreme drought and low-water conditions, coupled with the environmental constraints associated with water quality certification. The use of navigation windows for providing navigable depths was also discontinued in 2001. The navigation project was not maintained in 2002–2005, principally due

to the lack of navigation traffic, environmental conditions and constraints on dredging activities, and consequently, funding constraints (USACE, Mobile District 2006).

The significant drops in both traffic and tonnage, especially between 2001 and 2005, reflected the unreliability of the Apalachicola River due to a lack of maintenance dredging. During that time, many companies began moving their cargoes by truck and rail, a more expensive, but more reliable, means of transportation (USACE, Mobile District 2006).

In March 2004, USACE, Mobile District, applied for a 5-year renewal of the section 401 water quality certification for maintenance dredging of the authorized navigation channel in the Apalachicola River. After an extended period of coordination and negotiation, the Florida DEP formally denied the Mobile District's request on October 11, 2005 (USACE, Mobile District 2006). No maintenance dredging on the Apalachicola River, or appreciable navigation use of the ACF navigation system, has occurred since that time. In June 2012, the Mobile District applied to the Florida DEP for a permit to continue to conduct routine maintenance snagging to remove tree snags from the navigation channel in the Apalachicola River portion of the project. The request did not include any proposed dredging activity. The snagging permit was issued to USACE, Mobile District on November 27, 2013, and is in effect for 10 years from the issue date, or November 27, 2023 (FLDEP 2013a). Minimal navigation dredging occurred in 2010 on the Chattahoochee River upstream of Jim Woodruff Lock and Dam to facilitate navigation on that portion of the ACF waterway, but no dredging has been conducted since that time. Currently, no water management activities are routinely being undertaken in the ACF Basin specifically to support navigation. Additionally, in June 2016, the USACE, Mobile District issued Navigation Bulletin No. 16-34 stating that (1) the Walter F. George Lock would remain closed for the foreseeable future due to extensive structural damage to the lower gates and lack of funding to make the needed repairs and (2) the George W. Andrews Lock would remain closed for the foreseeable future due to excessive sedimentation in the lock approach and around the lock gates and the lack of funding to remove the sediment (USACE, Mobile District 2016).

Although navigation is an authorized purpose of the federal projects in the ACF Basin, BIs are not sufficient at all times to allow those projects to provide for flows downstream of Jim Woodruff Lock and Dam to support navigation channel depths (currently estimated at 20,600 cfs for a 9-ft channel). Additional limiting factors include the lack of commercial navigation use/demand and the inability to secure the necessary water quality certification from the Florida DEP to perform the required maintenance dredging and other operational activities for the navigation channel downstream of Jim Woodruff Lock and Dam. Limited use of special releases to assist with critical navigation requirements (in the form of a brief navigation window) have been addressed on a case-by-case basis. Such special releases, when requested, are coordinated with Florida, Alabama, and Georgia; federal resource agencies; and key stakeholders.

Water management for navigation, as authorized, could be resumed at any point in the future depending on sufficient demand for a reliable navigation channel and resolution with the State of Florida of any channel maintenance issues in the Apalachicola River as necessary to provide navigable channel depths.

2.1.1.2.4.4 Fish and Wildlife Conservation

The ACF Basin USACE reservoirs (i.e., Lanier, West Point, Walter F. George, Andrews, and Seminole) operate to support fish and wildlife conservation pursuant to the authority in either the FWCA of 1958 or the ESA. In addition, as described in section 2.1.1.1.6.3, the authorizing document for West Point Dam specifically includes fish and wildlife recreation as a project purpose (House Document 87-570). Generally, reservoir operations for fish and wildlife conservation consist of either maintaining pool elevations during fish spawns or making special releases to minimize the possibility of fish kills. Special drawdowns for specific environmental purposes may be specified from time to time, but only after

coordination with state and federal resource agencies and others, as appropriate. Although the possibility of requiring water control actions may extend throughout a season, the actual actions are usually of short duration. In addition to fishery management, operations include aquatic plant control, waterfowl, and other terrestrial habitat management. The various projects in the basin have specific operations for fish and wildlife, which are described in the individual project WCMs. Specific fish and wildlife conservation activities on USACE ACF Basin projects are addressed in more detail in the following paragraphs.

Fish Spawning. USACE SADR 1130-2-16 (March 30, 2001) and Mobile District Draft SOP 1130-2-9 (February 2005) were developed to address reservoir regulation and coordination for fish management purposes. SADR 1130-2-16 has been updated and renumbered as SADR PDS-O-1 (May 31, 2010), *Project Operations, Lake Regulation and Coordination for Fish Management Purposes.* It specifically applies to operations at Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole in the ACF Basin as well as other reservoirs in USACE, South Atlantic Division. The draft Mobile District SOP (1) identifies designated periods of time within which operations to support fish spawning will be conducted at specific projects and on the Apalachicola River, (2) establishes protocols for coordination between USFWS, state fisheries personnel, and USACE, and (3) provides for development of an annual plan for special water management operations by USACE (in coordination with USFWS and state fisheries agencies) that would balance impacts and benefits to both reservoir and riverine fisheries during the spring spawning period. A major goal of the SOP is not to lower lake levels more than 6 inches in elevation during the reproduction period to prevent stranding or exposing fish eggs. The protocols in these documents are consistent with the requirements for other project purposes.

Tailrace DO Levels. Reservoir stratification develops seasonally when surface water becomes warmer and less dense than deeper water, generally summer to late fall in the Southeast. This results in temperature-dependent density differences that prevent mixing and form isolated layers of water, each with their own distinct chemistry. Among the more common concerns is the depletion of oxygen in the deeper layers of lakes when stratified. Below the thermocline, DO is insufficient to support most aquatic life. When water is released from the lower regions of the reservoirs through hydroelectric power generation units and/or sluice gates during periods of reservoir stratification, low DO conditions may be experienced for a short distance downstream of dams, potentially causing stress in the tailrace fishery and occasional fish kills.

While DO levels downstream of Buford Dam and West Point Dam are depressed at times as a result of hydroelectric power generation when the lakes are stratified, there have been no recurring instances of fish distress or mortality in the dam tailrace areas as a result of low DO conditions. Section 2.1.1.2.4.6 describes measures taken over the years to improve DO conditions below Buford Dam. The Walter F. George Lock and Dam project has experienced recurring instances of stress in the tailrace fishery and occasional fish kills due to low DO. Accordingly, USACE has implemented a SOP, established in 1988 and updated in 1993, to address conditions at the Walter F. George project when low DO values are observed in the tailrace. The SOP calls for spillway gates to be opened in accordance with a specific protocol until DO readings return to an acceptable level (USACE, Mobile District 1993a). Spillage siphons have also been constructed on the dam that can be used in lieu of spillway gate discharges (Smallwood 2010).

Fish Passage. In most years since the spring of 2005, USACE has operated the lock at Jim Woodruff Lock and Dam between March and May to facilitate downstream-to-upstream passage of Alabama shad (*Alosa alabamae*) and other anadromous fishes (those that return from the sea to the rivers where they were born to breed) in cooperation with pertinent state and federal agencies. In general, two fish locking cycles are performed each day between 0800–1600 hours, one in the morning and one in the afternoon. Studies are ongoing to determine the most appropriate technique and timing for the locks, but the number of lock cycles per day will not change.

Management of Project Lands. The 11,184-ac Eufaula National Wildlife Refuge (NWR) is operated by USFWS in cooperation with USACE in the upper reaches of Walter F. George Lake within Barbour and Russell counties, Alabama, and Stewart and Quitman counties, Georgia. The refuge has an extensive system of pumps, dikes, and water control structures for water-level management in off-reservoir wetland areas. The refuge provides important habitat for migratory waterfowl and other birds, habitat for federally listed threatened and endangered species, and recreation and environmental education for the public. More detailed information on the refuge and its operation is in section 2.5.5.1.1.

USACE manages much of the project land around its ACF reservoirs for the benefit of fish and wildlife resources, consistent with other project purposes. In some cases, project lands can be managed by state agencies (i.e., wildlife management areas or state parks) or local interests through leases. Additionally, GADNR operates a fish hatchery on the Chattahoochee River immediately below Buford Dam. USACE coordinates project operations with the fish hatchery staff. For more information, see section 2.5.5.2.

Endangered Species Conservation Downstream of Jim Woodruff Lock and Dam. Historically, no minimum flow release rate for fish and wildlife purposes was established for the Apalachicola River downstream of Jim Woodruff Lock and Dam. Reservoir releases (varying seasonally) produced from normal operations for hydroelectric power generation and navigation typically provided conditions in the river suitable for fish and wildlife purposes.

On March 7, 2006, USACE, Mobile District initiated formal consultation with USFWS, pursuant to section 7 of the ESA, regarding the effects of existing operations at Jim Woodruff Lock and Dam and releases to the Apalachicola River on federally listed threatened and endangered species and federally designated critical habitat. Specific species/critical habitat affected include the threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and critical habitat for the Gulf sturgeon; and the endangered fat threeridge mussel (*Amblema neislerii*), the threatened purple bankclimber mussel (*Elliptoideus sloatianus*), the threatened Chipola slabshell mussel (*Eliptio chipolaensis*), and the critical habitat associated with these mussel species. The interim operating plan (IOP) that resulted from the ESA section 7 consultation process was implemented in October 2006. Minimum flow provisions for Jim Woodruff Lock and Dam were part of the overall plan established in the IOP to avoid and minimize impacts on the listed species.

On the basis of further consultation between USACE and USFWS and increasingly severe drought conditions in 2007 and 2008, the IOP was modified twice. The revised IOP (RIOP) was implemented in June 2008. The principal water management objective under the IOP (and subsequent modifications) has been to minimize adverse effects to federally listed threatened and endangered species and adverse modification of designated critical habitat in the Apalachicola River. The objective makes allowances for increased storage opportunities and/or reductions in demand for storage to provide continued support to project purposes, minimize impacts to other water users, and provide greater assurance of future sustained flows for federally listed species and other users during a severe multiyear drought (USACE, Mobile District 2008a).

USACE continued to coordinate with USFWS through 2009 and into 2010 regarding the implementation of the Reasonable and Prudent Measures (RPM), and formal consultation under ESA section 7 was reinitiated between USACE and USFWS in September 2010 to address new information relative to endangered mussel species. That formal consultation was completed in May 2012 when USFWS issued a new BO for the RIOP for Jim Woodruff Lock and Dam, requiring some minor operational adjustments to the 2008 RIOP. The following summary of the RIOP is based on the description provided in the May 2012 USACE EA for the updated RIOP (USACE Mobile District 2012).

The May 2012 RIOP is governed by two basic parameters applicable to daily releases from Jim Woodruff Lock and Dam: 1) a minimum discharge in relation to average BIs (measured as daily average in cfs) and 2) a maximum fall rate (vertical drop in river stage (feet per day [ft/day]). The RIOP places limitations on refill of upstream reservoirs, but it does not require a net drawdown of composite conservation storage (discussed in more detail below) unless BI is less than 5,000 cfs.

- **Minimum discharge.** The RIOP varies minimum discharges from Jim Woodruff Lock and Dam by BI and by month, and the releases are measured as a daily average flow in cfs at the Chattahoochee gage. Table 2.1-5 shows minimum releases from Jim Woodruff Lock and Dam prescribed by the RIOP and shows when and how much BI is available for increasing reservoir storage. Except when BI is less than 5,000 cfs, the minimum releases are not required to exceed BI. The RIOP defines additional BI threshold levels that vary by three seasons: spawning season (March–May), nonspawning season (June–November), and winter (December–February). The RIOP incorporates composite conservation storage thresholds that factor into minimum release decisions. Composite conservation storage is calculated by combining the conservation storage of Lake Lanier, West Point Lake, and Walter F. George Lake. Conservation storage in each of the individual reservoirs consists of four zones, which are determined by the operational guide curve for each project. The composite conservation storage also uses the 4-zone concept (i.e., Zone 1 of the composite conservation storage represents the combined storage available in Zone 1 for each of the three storage reservoirs). Figure 2.1-40 illustrates the ac-ft of storage available for composite zones 1 through 4 throughout the year. Figure 2.1-40 also displays a fifth zone, called the Drought Zone, which is comprised of the composite inactive storage in Lake Lanier, West Point Lake, and Walter F. George Lake plus the Zone 4 conservation storage in Lake Lanier. The Drought Zone plays an important role in drought operations, as discussed in more detail below.

Table 2.1-5.
May 2012 RIOP for Jim Woodruff Lock and Dam, Apalachicola River Minimum Discharge from Woodruff Lock and Dam by Month and by Basin Inflow Rates

Months	Composite Conservation Storage Zone	Basin Inflow (cfs)	Releases from Jim Woodruff Lock and Dam (cfs)	Basin Inflow Available for Storage[a]
Mar–May	Zones 1 and 2	≥ 34,000 ≥ 16,000 and < 34,000 ≥ 5,000 and < 16,000 < 5,000	≥ 25,000 ≥ 16,000+50% BI > 16,000 ≥ BI ≥ 5,000	Up to 100% BI>25,000 Up to 50% BI>16,000
	Zone 3	≥ 39,000 ≥ 11,000 and < 39,000 ≥ 5,000 and < 11,000 < 5,000	≥ 25,000 ≥ 11,000+50% BI > 11,000 ≥ BI ≥ 5,000	Up to 100% BI>25,000 Up to 50% BI>11,000
Jun–Nov	Zones 1, 2, and 3	≥ 22,000 ≥ 10,000 and < 22,000 ≥ 5,000 and < 10,000 < 5,000	≥ 16,000 ≥ 10,000+50% BI > 10,000 ≥ BI ≥ 5,000	Up to 100% BI>16,000 Up to 50% BI>10,000
Dec–Feb	Zones 1, 2, and 3	≥ 5,000 < 5,000	≥ 5,000 (Store all BI> 5,000) ≥ 5,000	Up to 100% BI > 5,000
At all times	Zone 4	NA	≥ 5,000	Up to 100% BI > 5,000
At all times	Drought Zone	NA	≥ 4,500[b]	Up to 100% BI > 4,500

Sources: USACE, Mobile District 2012; USFWS 2012

Notes:

[a.] Consistent with safety requirements, flood risk management purposes, and equipment capabilities.

[b.] Once composite conservation storage falls below top of Drought Zone, ramp-down to 4,500 cfs will occur at a rate of 0.25 ft/day.

The RIOP operations and thresholds from March through May are intended to support Gulf sturgeon spawning activities. The 16,000 cfs minimum release is also based on evaluation of spawning and rearing needs for the host fish necessary for mussel reproduction. The RIOP operations from June through February are intended to support the federally protected mussels, host fish for mussels, and young sturgeon.

During spawning season (March–May), two sets of four basin-inflow thresholds and corresponding releases exist according to the composite conservation storage (Table 2.1-5). In accordance with RPM 2008-4 of the 2008 RIOP BO (USFWS 2008a), the spawning season also includes a special fall rate provision in order to avoid take of larval Gulf sturgeon. When the composite conservation storage is in Zones 1 and 2, a less conservative operation is in place. When the composite conservation storage is in Zone 3, a more conservative operation is in place while still avoiding or minimizing impacts on federally listed species and designated critical habitat in the river. When the composite conservation storage falls below the bottom of Zone 3 into Zone 4, drought operations are triggered, representing the most conservative operational plan. The spawning season fall rate provision is in place under normal and drought operations. Current drought operations are summarized below.

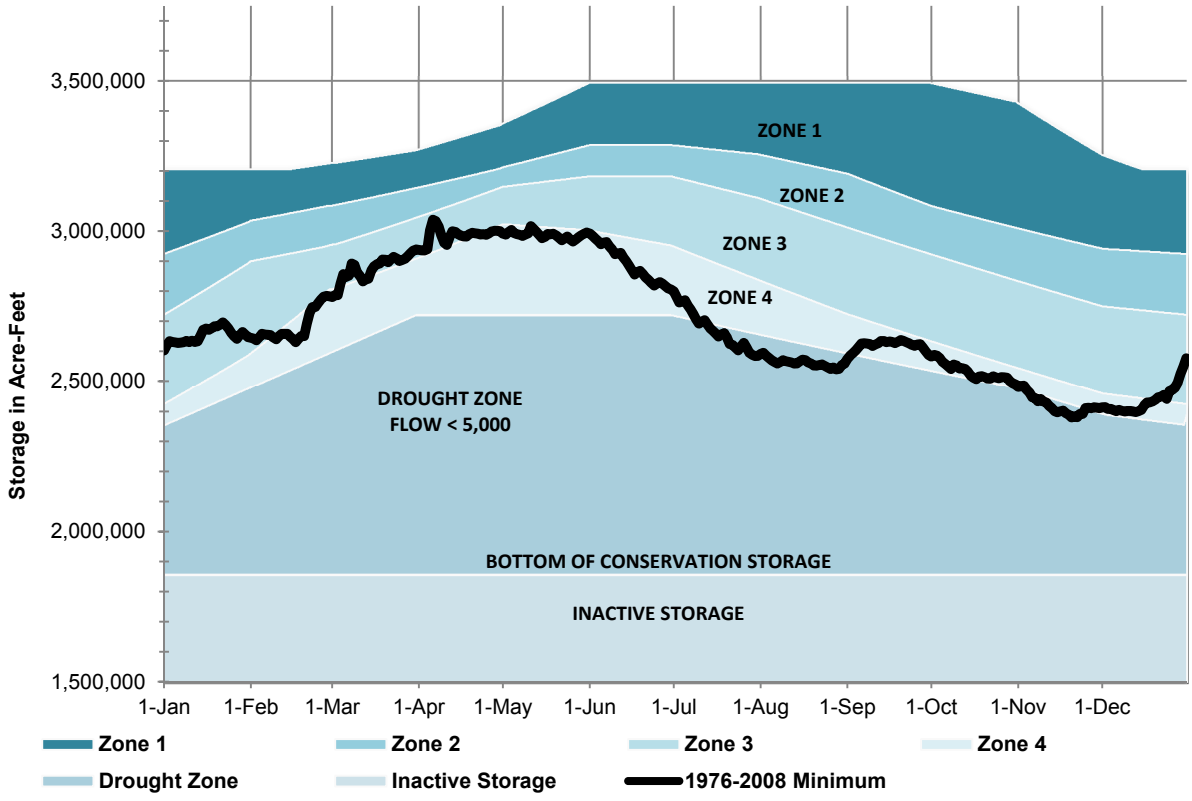


Figure 2.1-40. Basin Composite Conservation Storage and Associated Action Zones (in ac-ft).

During spawning season, the composite conservation storage is monitored daily to determine water management operations. Recently experienced climatic and hydrologic conditions and meteorological forecasts are used in addition to composite conservation storage values when determining the appropriate BI thresholds in support of water management operations.

During nonspawning season (June – November), one set of four BI thresholds and corresponding releases exists according to composite conservation storage in zones 1 through 3. When composite conservation storage falls below the bottom of Zone 3 into Zone 4, drought operations are triggered.

During the winter season (December – February), there is only one BI threshold and corresponding minimum release (5,000 cfs) while in composite conservation storage zones 1 through 3. There are no BI storage restrictions as long as this minimum flow is met under these conditions. When composite conservation storage falls below the bottom of Zone 3 into Zone 4, drought operations are triggered.

The flow rates included in Table 2.1-5 prescribe minimum, not target, releases for Jim Woodruff Lock and Dam. During a given month and BI rate, releases greater than the minimum releases in Table 2.1-5 may occur consistent with the maximum fall rate schedule, described below, or as needed to achieve other project purposes, such as hydroelectric power generation or flood risk management.

- **Maximum Fall Rate.** The fall rate, also called the down-ramping rate, is the vertical drop in river stage (water surface elevation) that occurs over a given period. Fall rates are expressed in units of ft/day, and they are measured at the Chattahoochee gage as the difference between the daily average river stage of consecutive calendar days. Rise rates are not addressed. Table 2.1-6 lists the maximum fall rates. The maximum fall rate schedule is suspended when composite conservation storage is in Zone 4 and drought operations are implemented. Unless otherwise noted, fall rates under drought operations would be managed to match the fall rate of the one-day BI. Matching the one-day BI fall rate during drought operations facilitates quicker recovery and a faster return to normal operations.

  Managing fall rates to conform to Table 2.1-6 values is a challenging undertaking at Jim Woodruff Lock and Dam when flow rates exceed the release capacity of the powerhouse (about 16,000 cfs). Releases greater than 16,000 cfs require the use of the spillway gates in addition to the powerhouse and require an operator to open or close the gates using a rail-mounted crane on the crest of the dam. The water discharge openings of the gates are not fully adjustable, and inclement weather, floating debris, and other factors may complicate the procedure of opening and closing the gates. Fall rates are more manageable when releases are less than 16,000 cfs and controlled by the powerhouse, but this control is not a precise operation. For these reasons, a lower and upper maximum fall rate is provided in Table 2.1-6 for each specific release range. When conditions allow, fall rates will generally conform to the more gradual (lower) rate in each range, consistent with safety requirements, flood risk management purposes, and equipment capabilities.

Table 2.1-6.
RIOP for Jim Woodruff Lock and Dam: Apalachicola River Maximum Fall Rate for Discharge from the Lock and Dam by Release Range for Composite Conservation Storage Zones 1, 2, and 3 [a] [b]

Approximate release range (cfs)	Maximum fall rate (ft/day)
> 30,000 [a]	Fall rate is not limited [c] [d]
> 20,000 and ≤ 30,000 [b]	1.0 to 2.0 [d]
Exceeds Powerhouse Capacity (~ 16,000) and ≤ 20,000 [b]	0.5 to 1.0 [d]
Within Powerhouse Capacity and > 10,000 [b]	0.25 to 0.5
Within Powerhouse Capacity and ≤ 10,000 [b]	0.25 or less

Sources: USACE, Mobile District 2012; USFWS 2012
Notes:
[a.] Consistent with safety requirements, flood risk management purposes, and equipment capabilities.
[b.] The maximum fall rate schedule is suspended in composite Zone 4.
[c.] For flows greater than 30,000 cfs, it is not reasonable and prudent to attempt to control the down-ramping rate, and no ramping rate is required.
[d.] Maximum fall rates must be less than 8 ft in a consecutive 14-day period when flows are less than 40,000 cfs in March, April, and May to avoid take of Gulf sturgeon eggs and larvae.

- **Drought Provisions in the RIOP.** The RIOP includes drought operations provisions (referred to as a *drought plan*). The drought plan specifies a minimum release from Jim Woodruff Lock and Dam and temporarily suspends other minimum release and maximum fall rate provisions until composite conservation storage in the basin is replenished to a level that can support them. Under the drought plan, minimum discharge is determined in relation to the composite conservation storage and not average BI. The drought plan is triggered when composite conservation storage falls below the bottom of Zone 3 into Zone 4. At that time, all the composite conservation storage zones 1 through 3 provisions (i.e., seasonal storage limitations, maximum fall rate schedule, minimum flow thresholds) are suspended, and management decisions are based on the provisions of the drought plan. The drought plan includes the option for a temporary waiver from the existing water control plan to allow temporary storage above the winter pool guide curve at the Walter F. George and West Point projects if the opportunity presents itself and/or to begin spring refill operations at an earlier date to provide additional conservation storage for future needs as well as provide support for minimum releases at Jim Woodruff Lock and Dam.

  The drought plan prescribes two minimum releases on the basis of composite conservation storage in Zone 4 and an additional zone referred to as the *Drought Zone* (Figure 2.1-40). The Drought Zone delineates a volume of water roughly equivalent to the inactive storage in lakes Lanier, West Point, and Walter F. George, plus Zone 4 storage in Lake Lanier. The Drought Zone line was adjusted in the 2012 RIOP to include a smaller volume of water at the beginning and end of the calendar year. When the composite conservation storage is within Zone 4 and above the Drought Zone, the minimum release from Jim Woodruff Lock and Dam is 5,000 cfs, and all BI above 5,000 cfs that is capable of being stored may be stored.

  Once the composite conservation storage falls into the Drought Zone, the minimum release from Jim Woodruff Lock and Dam is 4,500 cfs, and all BI above 4,500 cfs that is capable of being stored may be stored. When transitioning from a minimum release of 5,000 to 4,500 cfs, fall rates are limited to a 0.25 ft/day drop. The 4,500 cfs minimum release is maintained until composite conservation storage returns to a level above the top of the Drought Zone, at which time the 5,000 cfs minimum release is reinstated. The drought plan provisions remain in place until conditions improve to the point that the composite conservation storage reaches a level above the top of Zone 2 (i.e., within Zone 1). At that time, the temporary drought plan provisions are suspended, and all the other provisions are reinstated. During drought operations, a monthly monitoring plan

that tracks composite conservation storage to determine water management operations (the first day of each month represents a decision point) is implemented to determine which operational triggers are applied. In addition, recently experienced climatic and hydrological conditions and meteorological forecasts are used when determining the set of operations in the upcoming month.

Although the drought plan provides for flows lower than 5,000 cfs in the river, provisions that allow for reduced flows during the refill period when system storage is lower and for storage conservation measures when composite conservation storage is in Zone 4 should result in fewer occasions when these low flows are triggered or in occasions where storage shortages result in flows less than 5,000 cfs.

2.1.1.2.4.5 Recreation

Lake Lanier, with more than 6.5 million visitors in 2012 (USACE 2016b), is the most visited USACE reservoir in the southeastern United States and one of the most visited USACE reservoirs nationwide. Walter F. George and West Point lakes also rank high among most visited USACE projects. A wide variety of recreational opportunities, dependent on or enhanced by the presence of the lakes, are provided at these sites, including boating, fishing, picnicking, sightseeing, skiing, and camping. Recreation resources and facilities at the USACE projects in the ACF Basin are discussed in more detail in sections 2.4 and 2.6.6.

To maximize the potential recreational use of all the projects, USACE operates the reservoirs in the ACF Basin as a system, keeping the drawdown levels and rates balanced among the reservoirs. USACE gives those considerations greater attention during the primary recreation season of May through early September. Reservoirs are managed to maintain a steady pool at as high a level as possible, consistent with other authorized purposes, particularly during the primary recreation season. To sustain reasonable access to the reservoir during periods of declining inflows to the reservoirs, drawdowns are performed at as steady a rate as possible. There may be times during drought conditions when water releases are reduced to levels that satisfy only downstream water supply/water quality requirements. This conservation of storage generally allows the pools to be maintained at a higher level throughout the prime recreation season.

As other ACF water management objectives are addressed, lake levels might decline during prime recreation periods. Large reservoir drawdowns impact recreational use: access to the water for boaters and swimmers is inhibited; submerged hazards (e.g., trees, shoals, boulders) become exposed or nearly exposed, posing safety issues; and exposed banks and reservoir bottoms become unsightly and diminish the recreation experience. Consequently, for Lake Lanier, West Point Lake, and Walter F. George Lake, certain levels were identified in each impoundment at which recreation activities would be affected (Table 2.1-7).

- At the *Initial Impact Level* (IIL), recreation impacts are first observed (i.e., some boat launching ramps are unusable, most beaches are unusable or minimally usable, and navigation hazards begin to surface).
- At the *Recreation Impact Level* (RIL), major impacts on concessionaires and recreation are observed (i.e., more ramps are not usable, all beaches are unusable, boats begin having problems maneuvering in and out of marina basin areas, loss of retail business occurs).
- The level at which severe impacts are observed in all aspects of recreational activities is called the *Water Access Limited Level* (WAL). At this point, all or almost all boat ramps are out of service, all swimming beaches are unusable, major navigation hazards occur, channels to marinas are impassable and/or wet slips must be relocated, and a majority of private boat docks are unusable.

Table 2.1-7.
Recreation Impact Levels for Federal Projects in the ACF Basin

Project	IIL	RIL	WAL
Lake Lanier	1,066 ft	1,063 ft	1,060 ft
West Point Lake	632.5 ft	629 ft	627 ft
Walter F. George	187 ft	185 ft	184 ft

Low water action plans have been developed for Lake Lanier, West Point Lake, and Walter F. George Lake that identify the types of public notification regarding potential safety issues that will be issued at various lake levels such as press releases, telephone safety messages, marking of navigation hazards, and posting of signs warning of swimming hazards.

Because George W. Andrews and Jim Woodruff locks and dams are run-of-river projects, pool elevations normally follow a daily and weekly cycle of elevations. The fluctuations in these pools are generally minor with little impact on recreational use; however, small decreases in lake level at Lake Seminole can affect recreation use due to the shallow nature of the reservoir and large areas of standing timber navigation obstacles.

Water management operations at Buford Dam have a direct effect on downstream recreational and resource management activities in the Chattahoochee River National Recreation Area (CRNRA), operated by the NPS. CRNRA provides for river-oriented recreational pursuits between Buford Dam (Chattahoochee RM 348.3) and Peachtree Creek (RM 300.5). More specific information on the CRNRA is provided in sections 2.4 and 2.6.6. The CRNRA was established in 1978, about 20 years after Buford Dam construction was completed. The operation of Buford Dam to meet authorized project purposes is generally compatible with recreational uses of the river and adjacent lands in the CRNRA, which include activities such as rafting, canoeing, wade and tube fishing, small boat fishing, hiking, and picnicking. The regulated flows from Buford Dam provide relatively stable and dependable flows for water-based recreational uses. Immediately below the dam, periods of peak hydroelectric power generation cause rapid rise and fall in river levels, which can present safety issues for river users. USACE, CRNRA, and Georgia have worked closely together to provide public information and to implement specific safety measures to reduce risk to river users in the area immediately downstream of Buford Dam.

2.1.1.2.4.6 Water Supply/Water Quality

Background on Buford Dam Operations for Water Supply/Water Quality. To provide for water supply and in-stream flow for water quality, House Document 300 (80th Congress, 1st Session), which serves as the basis for Buford Dam (Lake Lanier) project authorization, provided that the project release "varying flows up to a maximum of 600 second-feet … from Buford so as to insure at all times a flow at Atlanta not less than 650 second-feet" (*second-feet* is synonymous with cfs). The original operational scheme adopted upon completion of the Lake Lanier project in the late 1950s provided for maximum (*peak*) hydropower generation on weekdays through one or both large turbines, with minimal (*off-peak*) hydropower generation through the small turbine on weekends. About the time that Buford became operational, the City of Atlanta and GPC jointly financed the addition of 8-ft tainter gates to Morgan Falls Dam to raise the water surface. The addition of these gates increased storage at Morgan Falls and enabled the project to reregulate releases from Buford Dam to a limited degree. The addition of gates at Morgan Falls physically modified water control mechanisms so that USACE alone would not be responsible for operating to provide the 650 cfs at Atlanta. For many years, a minimum continuous Buford release of 400 to 600 cfs, coupled with reregulation of the Chattahoochee River at the Morgan Falls project, provided the desired flow at Atlanta (USACE, Mobile District 1991).

In the 1970s, USACE began to take steps to meet growing demands for water supply in Metro Atlanta. They adjusted the operations of Buford Dam to provide increased downstream flows to meet growing water supply demands and higher downstream water quality standards. In 1974, during the initial stages of the Metropolitan Atlanta Area Water Resources Management Study (MAAWRMS) (discussed in more detail in section 3.3.1), Georgia determined that a minimum flow of 750 cfs in the Chattahoochee River downstream of Atlanta's water supply intake and just upstream of the confluence with Peachtree Creek would be necessary for the assimilation of return flows to the river. This new standard required a continuous flow of 750 cfs *after* accounting for withdrawals by Atlanta, averaging 344 cfs (222 mgd) annually at that time. The increased downstream flow target, along with increasing demand for M&I water supply in the region, raised concerns that existing operations might not continue to yield sufficient flows for downstream water quality and water supply needs.

In 1975, USACE, GPC, and the City of Atlanta agreed to an operating procedure, called the *Interim Plan*, providing for minimum flows of up to 1,256 cfs at Atlanta, enabling water supply withdrawals of up to 327 mgd, for an annual average of 230 mgd (Stockdale 2009). This plan essentially reflected existing practices at that time, without affecting project purposes or involving operational changes at Lake Lanier (Stockdale 2009).

By 1979, it became clear that the Interim Plan, which did not involve any adjustments to earlier operations, was not adequate to provide downstream flows sufficient to meet water supply and water quality needs. All parties involved agreed in 1979 to an operating procedure (the *Modified Interim Plan*) under which GPC would schedule a portion of weekly power generation at Morgan Falls Dam on the weekend. USACE committed to make operational changes so that certain minimum summer flows would be available from Buford Dam. These commitments allowed for increased water supply withdrawals (327 mgd peak withdrawals and 266 mgd annual average withdrawals) while protecting the 750 cfs in-stream flow requirement (USACE, Mobile District 1991; Stockdale 2009).

Subsequently, USACE recognized that downstream withdrawals in excess of 327 mgd provided under the *Modified Interim Plan* might exceed the amount available incidental to operation of Buford Dam under the project authority and would require a contract under separate authority. Accordingly, under the authority of the Independent Offices Appropriations Act (IOAA) (31 United States Code [U.S.C.] 9701), USACE in 1986 entered into a withdrawal contract with the Atlanta Regional Commission (ARC) providing for withdrawals of up to 377 mgd from the Chattahoochee River with payment to the U.S. government required for withdrawals exceeding 327 mgd. The contract incorporated the USACE determination that downstream withdrawals of up to 327 mgd were already available, apart from this contract, "from normal operation of the Buford project for nonwater supply purposes," and "can be provided year-round with no impact on the [Lake Lanier] Project" (Contract DACW01-9-86-145 (1986), art. 1(b)). In order for USACE to provide the river flows adequate to meet the contract terms, ARC agreed to coordinate the implementation of a water management plan, referred to as the *Chattahoochee River Management System* (CRMS), in cooperation with USACE, GPC, GAEPD, and the various water utilities. The CRMS was an exhibit included in the withdrawal contract. The CRMS provided that USACE, when possible and practical, would endeavor to make only those releases specifically required for water supply and to maintain the 750 cfs minimum in-stream flow at Peachtree Creek (when not operating for peak hydroelectric power generation). GPC agreed to continue to use Morgan Falls Dam (Bull Sluice Lake) to reregulate the Buford releases to help meet that target. This 1986 contract was intended to be an interim arrangement pending development of more permanent solutions to the Atlanta water supply needs (USACE, Mobile District 1991; Stockdale 2009).

In addition to downstream withdrawals, USACE has also accommodated water supply withdrawals directly from Lake Lanier. Two cities in Georgia, Buford and Gainesville, had been withdrawing water from the Chattahoochee River before the construction of Buford Dam. As Fifth Amendment compensation for property taken for project construction, the municipalities were allowed to relocate their

existing water supply intakes and continue to withdraw as they had before project construction up to 10 mgd (i.e., 2 mgd for Buford and 8 mgd for Gainesville) under relocation agreements with USACE.[3] In the 1970s, water supply needs were also increasing in areas around Lake Lanier such as Gwinnett County and Cumming, Georgia, and Gainesville. A separate authority, the IOAA (31 U.S.C. 9701), provided the legal basis for withdrawal contracts executed in 1973 with Gwinnett County for a maximum withdrawal of 40 mgd (later amended to an annual average withdrawal of 53 mgd); in 1978 with Cumming for a maximum withdrawal of 2.5 mgd (later amended to an annual average of 10 mgd; and in 1987 with Gainesville for an annual average withdrawal of 20 mgd, including the relocation contract amount of 8 mgd).

Pursuant to an Army General Counsel Opinion in 1986 that the IOAA was not the preferable authority for accommodating water supply needs, USACE allowed the four contracts (with Gwinnett County, Gainesville, Cumming, and ARC) to expire in 1990 with the intention of entering into new contracts for storage space at Lake Lanier to meet existing and future water supply needs for Metro Atlanta under the authority of the WSA of 1958. Since 1990, Gwinnett County, Gainesville, and Cumming have continued to satisfy their water supply needs by withdrawing from Lake Lanier without the benefit of contracts. Water supply requirements of the suppliers downstream of Buford Dam represented by the ARC continue to be met through operation of Buford Dam per the CRMS protocols, consistent with the June 2011 opinion of the Court of Appeals for the 11th Circuit and the associated June 2012 USACE legal opinion (see section 3.5.2.8) and pending the update of the Master WCM.

Water Supply Objective. Even during normal or average hydrologic conditions, various portions of the basin might experience water supply problems, chiefly in the Upper Chattahoochee River, ranging from the headwaters, through Metro Atlanta, and to the region immediately below Atlanta. The water supply needs of Metro Atlanta are met almost entirely by direct withdrawals from Lake Lanier and the Chattahoochee River downstream of Buford Dam to Peachtree Creek. Flow regulation afforded by storage in Lake Lanier has provided a dependable water supply in the reach of the Chattahoochee downstream to Atlanta. However, the supply varies according to releases made for other project demands and water availability. Releases specifically for water supply are often required from Lake Lanier on summer weekends. In winter and spring, because needs for water in the lower basin are most often met with flows from that area, the releases from Lake Lanier can often be closely matched to the actual water supply needs. Reservoir releases for other purposes have generally been adequate to meet water supply needs, but chronic seasonal low flow periods, coupled with the higher demand rates associated with such periods, often stress the available supply.

Water supply functions downstream of federal projects are usually met as a by-product of normal operation of the projects for other purposes. However, minimum releases might be required at certain projects to maintain a dependable flow and adequate depths of water above the water intake structures.

[3] Article 1f of the 1953 Gainesville relocation agreement states "The City agrees that it will not at any time remove more than 8,000,000 gallons of water from the reservoir of Buford Dam within any 24-hour period without prior written approval of the District Engineer, Mobile District…" The term *remove* has been interpreted as 8 mgd net withdrawal during any 24-hour period and specifically, to include an overall cap of 18 mgd gross withdrawals (10 mgd treated wastewater is returned to Lake Lanier), with payments from the City of Gainesville required for net withdrawals greater than 8 mgd net, up to the 18 mgd gross limit. This position, while not the only possible interpretation of the term *remove* in the 1953 agreement, is consistent with the District Engineer and Contracting Officer's determination of 1973, and the parties' apparent practice for a considerable time. This interpretation has been included in the modeling for the draft EIS. Therefore, the total withdrawals under relocation contracts are 8 mgd net for Gainesville and 2 mgd gross for the City of Buford based on the pattern and practice of interpreting the relocation contracts.

Water Quality Objective. Buford Dam, West Point Dam, and Jim Woodruff Lock and Dam all provide continuous minimum releases which, in addition to meeting other project purposes and providing associated benefits, also benefits downstream water quality. Walter F. George Lock and Dam and George W. Andrews Lock and Dam have no specific minimum flow provisions.

At Buford Dam, the small turbine is operated continuously to provide a minimum flow from the dam of approximately 600 cfs. When it is necessary to have the unit out of service, the releases are made through the sluice. Under agreements between USACE and Georgia, discharges from Buford Dam, when considered in combination with the contribution of local drainage between the dam and the City of Atlanta and reregulation by GPC's Morgan Falls Dam, are to be sufficient to provide a minimum flow rate of 750 cfs at Peachtree Creek. Reregulation of streamflows at Morgan Falls Dam to provide that required flow is often not possible without weekend releases at Buford Dam.

During periods of reservoir stratification and reservoir turnover (destratification) in the fall, releases from Buford Dam hydroelectric units or sluice gates can contain high concentrations of metals, such as iron and manganese, which can cause toxicity problems at the Buford Trout Hatchery, 2 mi downstream of the dam. The release water during summer and fall is also low in DO except during periods of peaking generation. Because of the flow velocity and turbulence immediately downstream of the dam, substantial reaeration occurs within a relatively short distance. During a major rehabilitation of all three hydropower generation units at Buford Dam during 2003 and 2004, self-aspirating turbines were installed to improve DO levels immediately downstream. However, minimal benefits to downstream DO have been recorded since the turbines were installed. As described in more detail in the Buford Dam and Lake Lanier WCM (in appendix A), USACE provided technical assistance to the hatchery in the 1980s, and the hatchery added the capability to add water-hardening chemicals to their Chattahoochee River withdrawals to address iron and manganese issues in support of hatchery operations. This practice has been discontinued as downstream conditions have improved over time, but there still may be an occasional need for short-term emergency releases of water from Lake Lanier for water quality purposes.

At West Point Dam, a small generating unit provides a continuous release of about 675 cfs. This flow provides low flow augmentation to benefit water quality and public health. As with Buford Dam, the release waters during reservoir stratification are low in DO concentration during minimum release periods.

Even though there are no specific continuous minimum flow requirements below Walter F. George Lock and Dam, USACE has an established SOP to address conditions at times when low DO values are observed below the dam (USACE, Mobile District 1993a). The SOP is discussed in more detail in section 2.1.1.2.4.4.

Because of the shallowness of the reservoir and the relative amount of storage when compared to inflow, Lake Seminole and Lake George W. Andrews do not stratify and water quality downstream of the dam does not fluctuate to the same degree as at other reservoirs in the basin. However, minimum releases of at least 5,000 cfs are maintained from Jim Woodruff Lock and Dam (except under extreme drought conditions). Those minimum flows are needed to meet environmental flow requirements for endangered species conservation, but as a by-product, they also meet the water supply and waste assimilation needs of downstream industrial users. Release protocols from Jim Woodruff Lock and Dam for endangered species conservation are discussed in section 2.1.1.2.4.4.

While operating to serve other federally authorized purposes, USACE reservoirs in the ACF Basin provide downstream flow conditions that collaterally support waste assimilation needs of numerous M&I wastewater dischargers in the basin. That collateral benefit of project operations is particularly valuable during annual low flow (summer/fall) periods and extended drought periods.

General Water Supply/Water Quality Operating Guidelines. Water management activities to support water supply and water quality involve taking water from storage, either directly from the pool or through releases for downstream interests. The primary concerns are ensuring that (1) sufficient drinking water will be available for urban needs and (2) agreements to provide in-stream flow for water quality will not be violated.

Minimum in-stream flow needs for water supply and water quality purposes are almost always met through normal operation of the projects for other purposes. The exception to this is at Lake Lanier, where weekend releases are required and often water supply/water quality requirements can control the volume of the weekly water release. When making water control decisions, USACE considers the water supply/water quality needs of the entire basin, as well as the needs of individual, isolated trouble spots. Water in upstream projects, notably Lake Lanier, is used when necessary for water quality needs at downstream points. The states or other governmental agencies may periodically request releases of short duration for water quality purposes.

Releases from projects in the system are the minimum (capacity) release for hydroelectric power generation or releases needed for basinwide water quality/water supply, whichever is greater. During some months of the year, particularly winter and spring, it may be appropriate to minimize releases at Buford Dam (Lake Lanier) to closely approach, without jeopardizing, the 750 cfs target water quality flow at Peachtree Creek. This plan is based on current water supply demands; increasing these demands may necessitate modifying the minimum releases.

Because the chances to replenish the lower reservoirs are greater than the chances to replenish those upstream, emphasis is given to drawing from storage at West Point and Walter F. George for providing minimum releases, historically approximately 5,000 cfs, and from Jim Woodruff Lock and Dam (Lake Seminole). However, releases from storage at Lake Lanier might be necessary to prevent the lower reservoirs from being drawn below minimum structural design limits.

2.1.1.2.4.7 Special Operations and Releases

Occasionally, a temporary deviation from the normal regulation of a reservoir is necessary to accommodate a special activity or need in the reservoir or downstream. Deviations generally fall into three categories: planned deviations, unplanned deviations, and emergency deviations.

Construction activity accounts for a major portion of the incidents requiring special releases (planned deviations) and includes utility stream crossings, bridge work, and improvements to recreation structures, tailrace surveying, and major construction contracts. Special releases are used to facilitate other planned activities, including lake shore cleanup operations and recreational activities (e.g., fishing tournaments), and to allow rapid water rescue training by emergency medical services personnel (which requires special high flow releases from the spillway). The need for unplanned deviations might be caused by unforeseen conditions that do not allow sufficient time to plan for the deviation, but do not involve an imminent threat to public health and safety, property, or the environment. Special releases also have been used in response to unplanned situations, including to help free grounded barges in the navigation channel downstream of Jim Woodruff Lock and Dam. Emergencies might require deviation from the approved water control plan to mitigate an imminent threat to public health and safety, property, or the environment, including water quality. Examples include dam safety issues, drowning and other accidents, failure of operation facilities, oil or chemical spills and drainage, bacterial contamination, harmful algal blooms, water or sewage treatment plant failures, and fish kills.

Special operations and planned deviations might be implemented during extreme drought conditions. For example, variances have been granted to allow early refilling to the summer pool at USACE reservoirs in the ACF Basin. The variances have occurred during dry springs to capture limited rainfall to ensure

refilling of the project summer pool levels. To the extent that hydrologic conditions in the basin will permit during drought conditions, water control regulation can assist with critical stakeholder needs throughout the basin, including water quality considerations. Short-term special operations and deviations are typically based upon coordination with project users and interested stakeholders. For example, during the 2007–08 extreme drought period, the USACE conducted biweekly drought calls for the ACF Basin with agencies, stakeholders, and the press. Based upon feedback received during the calls, short-term water management actions were considered and, when appropriate and as reservoir conditions would allow, were conducted to alleviate critical problems, including water quality concerns.

Special operations and deviations are generally coordinated in advance with the USACE, Mobile District Water Management Section. Requests for release changes are usually for a few hours or days. Before a deviation is granted, the upstream watershed conditions, potential flood threat, conditions of downstream lakes, environmental factors, and water supply and hydropower needs are considered. Processes for deviations from "normal" reservoir regulation—as defined in the Master WCM and individual project WCMs—are discussed in more detail in paragraph 7-15 of the WCM documents.

2.1.1.2.5 Water Withdrawals

2.1.1.2.5.1 Historical Water Use in the ACF Basin

Kenny et al. (2009) documented that between 1950 and 1980, there was a steady increase in water use in the United States. During that time, the expectation was that as population increased, water use would increase proportionally. Contrary to expectation, reported water withdrawals declined in 1985 and have remained relatively stable since then in spite of a steady increase in U.S. population. Changes in technology, in state and federal laws, and in economic factors, along with increased awareness of the need for water conservation, have resulted in more efficient use of the water from the nation's rivers, lakes, reservoirs, and aquifers. Estimates of water use for 2005 indicated that about 410 billion gallons per day (gpd) were withdrawn for all uses in the United States. That total varied less than 3 percent since 1985 as withdrawals stabilized for the two largest uses—thermoelectric power and irrigation. Water use trends in the southeast United States and in the ACF Basin have generally been consistent with the national trends, as reflected below.

2.1.1.2.5.1.1 Factors Affecting Water Use Patterns in the ACF Basin in 1950

When the implementation of federal water resource projects in the ACF Basin began in the 1950s, water use in the southeast United States, including the ACF Basin, was generally consistent with the predominant socioeconomic pursuits and population distribution in the region. The region's favorable climate and generally good soil conditions were responsible for the continuing predominance of an agricultural economy. According to the 1950 agricultural census, about 70 percent of the basin was classified as farm land. About 40 percent of that area (about 3.5 million ac) was cultivated, principally in the southern portions of the basin. Principal crops were cotton and peanuts, but other agricultural pursuits included cattle and poultry production, as well as raising corn, peaches, potatoes, tobacco, and vegetables (USACE, Mobile District 1959).

Manufacturing had begun to assume a significant role in the region's economy because of favorable labor conditions, cheap hydroelectric power generation, and the proximity of raw materials. The manufacture of cotton goods and other textiles became an important component of the regional economy. Large mills at and north of Columbus, Georgia, operated by hydroelectric power generation, formed the nuclei for several small industrial centers in the basin. Forest products provided materials for numerous saw mills, planing mills, and veneer mills, principally in the southern portion of the basin, and pulpwood for paper mills in the basin and across the region. Several large meat packing plants; numerous cotton gins;

canning, fertilizer, and cement plants; and turpentine stills operated in the area. Granite, fuller's earth, bauxite, clay, sand, and gravel were obtained and processed in the area. Some of the industries required large quantities of water to support their industrial processes (USACE, Mobile District 1959).

Population in the region was widely distributed and predominantly rural in nature. Few significant urban population centers were in the ACF Basin (such as Atlanta, Columbus, and Albany) having large public water supply systems. However, between 1950 and 1970, the southeast United States (including the ACF Basin and Metro Atlanta) became an increasingly important region for manufacturing, transportation, and commerce. Population in the urban centers began to grow at an accelerated rate, both from outside the region and from rural areas of the state, expanding the demand for water service from public water supply systems. As urban population centers and industry expanded, demand for thermoelectric power generation expanded in the region, dramatically increasing the demand for cooling water from surface water sources.

2.1.1.2.5.1.2 Water Use in the ACF Basin between 1970 and 1990

Marella et al. (1993) examined water use in the ACF Basin between 1970 and 1990, a period of significant economic and population growth in the region. This section provides a summary of the basinwide assessment presented in that report and a brief state-by-state summary.

Total water use in the ACF Basin increased by 42 percent, from 1,475 mgd in 1970 to 2,098 mgd in 1990. That increase, for the most part, can be attributed to (1) the increase in public supply water use, primarily in Metro Atlanta, and to (2) the increase in agricultural water use in the Dougherty Plain area in southwestern Georgia. All categories of water use, except for thermoelectric power generation, increased between 1970 and 1990. Public supply steadily increased over the 20-year period from about 140 mgd in 1970 to 480 mgd in 1990. Domestic self-supply remained relatively level, fluctuating between about 20 and 50 mgd over the 20-year period. Total commercial-industrial self-supply sharply increased from about 162 mgd to about 261 mgd during the 1970s, but the demand leveled off during the 1980s (249 mgd in 1990). Total agricultural water use in the basin dramatically increased from about 21 mgd in 1970 to about 365 mgd in 1980, then declining to about 255 mgd in 1990. Water use for thermoelectric power generation ranged from about 1,122 mgd (1970) to a peak of 1,581 mgd (1980), thereafter declining dramatically to about 1,076 mgd in 1990. During the period from 1980 to 1990, overall water use in the ACF Basin decreased by 19 percent from 2,586 mgd to 2,098 mgd, primarily because of the decrease in water used for thermoelectric power generation and agriculture irrigation. Reasons for those declines are discussed further below. Specific surface water and groundwater withdrawals in the basin between 1970 and 1990 are summarized (by water use category and on 5-year intervals) in Table 2.1-8.

Total groundwater withdrawals in the ACF Basin increased between 1970 and 1990 by nearly 214 mgd (243 percent), largely as a result of an increase in groundwater use for agriculture and principally in southwestern Georgia. Major changes to irrigation techniques/practices during the latter half of the 1970s resulted in substantial increases in agricultural water use in southwestern Georgia. Withdrawals of groundwater from the principal aquifers (primarily the Floridan aquifer system) increased by nearly 80 mgd in the Dougherty Plain area in Georgia between 1977 and 1980. However, between 1980 and 1990, the amount of groundwater withdrawn for irrigation purposes decreased because of a decline in irrigated acreage and an increase in irrigation efficiencies.

Table 2.1-8.
ACF Basin Water Withdrawals by Principal Water Use Categories (1970–1990) (in mgd)

Water Use	Source	Year				
		1970	1975	1980	1985	1990
Public Supply	Groundwater	39.84	43.86	69.05	54.14	64.54
	Surface water	99.66	233.47	261.48	370.93	421.20
Self-supplied domestic	Groundwater	30.37	20.47	48.10	33.95	32.96
	Surface water	0.00	0.01	0.00	0.00	0.00
Self-supplied commercial-industrial	Groundwater	10.44	25.52	21.88	26.63	27.93
	Surface water	151.80	208.15	239.57	226.54	220.50
Agricultural	Groundwater	7.14	16.81	256.06	190.12	177.25
	Surface water	13.38	17.46	108.91	83.42	77.75
Thermoelectric power generation	Groundwater	1.40	0.30	0.00	0.74	0.37
	Surface water	1,120.80	1,569.10	1,580.94	1,232.44	1,075.27
Total Withdrawals (by year)	Groundwater	89.19	106.96	395.09	305.58	303.05
	Surface water	1,385.64	2,028.19	2,190.90	1,913.33	1,794.72
	Total	1,474.83	2,135.15	2,585.99	2,218.91	2,097.77

Source: Marella et al. 1993

Surface water withdrawals increased 805 mgd (58 percent) between 1970 and 1980, primarily because of increased public supply demands in the northern part of the basin and the operation of several new thermoelectric power plants. However, surface water withdrawals decreased 396 mgd (18 percent) between 1980 and 1990, primarily because of more efficient uses of water for industrial and thermoelectric power generation purposes. Surface water withdrawals for thermoelectric power generation decreased from 1,581 mgd in 1980 to 1,075 mgd in 1990. Use of more water-efficient machinery, reuse or recirculation of water, and use of cooling ponds were some of the reasons for the decreases in water withdrawals for these categories. More information on closed-cycle recirculation cooling at thermoelectric power plants in the ACF Basin is provided section 2.1.1.2.6. Despite the year-by-year ups and downs in surface water withdrawals, there was an overall increase of about 29 percent for the 20-year period from 1970 to 1990.

Georgia. The Chattahoochee and Flint rivers and their tributaries have served as the primary source of water for many public supply systems, industries, and power plants in Georgia, whereas groundwater has been the primary source of water for irrigation purposes.

From 1970 to 1990, total water withdrawn in the ACF Basin in Georgia increased nearly 38 percent from 1,262 mgd to 1,727 mgd. Total withdrawals for public supply continually increased during that period. Surface water withdrawals for public supply, in particular, increased nearly 350 percent (321 mgd) between 1970 and 1990, and groundwater withdrawals for public supply increased nearly 32 percent (11 mgd). The largest decrease in water withdrawals between 1970 and 1990 were for self-supplied commercial-industrial and thermoelectric power generation uses. Use of more water-efficient commercial-industrial processes, recirculation of water, and use of cooling ponds are some of the reasons for decreases in water withdrawals for these categories. While overall water withdrawals increased overall from 1970 to 1990, total withdrawals actually increased dramatically in the 1970s, peaked, and decreased in the 1980s. Total withdrawals in 1980 had reached 2,253 mgd and had declined to the 1,727 mgd level by 1990.

Total agricultural water withdrawals in the ACF Basin in Georgia increased 1,320 percent between 1970 and 1990. Groundwater withdrawals for agricultural use increased more than 3,070 percent (138 mgd) during this period. Most of the increase occurred during the 1970s and peaked around 1980. The introduction of the center pivot and other self-propelled irrigation equipment led to the rapid expansion of irrigated acreage and water use between 1970 and 1980. The need for water for irrigation purposes was greater than normal in 1980 (1980 was considered a dry year). Irrigation system efficiencies increased considerably after 1980, and harvested cropland declined throughout Georgia between 1980 and 1990 (including a reduction in irrigated acreage). Those factors resulted in a decrease in irrigation water use during the period.

Alabama. Total water use in the ACF Basin in Alabama increased nearly 230 percent from 55 mgd (1970) to 183 mgd (1990). Nearly 78 percent of this increase was related to the opening of the Farley Nuclear Power Plant during the late 1970s. Discounting withdrawals by the Farley Plant, surface water withdrawals increased 23 percent. Groundwater withdrawals between 1970 and 1990 increased nearly 244 percent, due mostly to increased crop irrigation and public-supply use.

Florida. Total water use in the ACF Basin in Florida increased 19 percent from 157 mgd (1970) to 188 mgd (1990). The dominant use of water in the ACF Basin in Florida was cooling water for thermoelectric power generation at the Sholtz Power Plant. Water withdrawals for this plant actually declined gradually from about 145 mgd (1970) to 108 mgd (1990). Despite a 20-percent increase in the power generated, surface water withdrawals decreased as a result of the more efficient use of water for thermoelectric power generation. The overall increase in total water withdrawals between 1970 and 1990, for the most part, was attributed to the withdrawal and interbasin transfer of water from the Chipola River to the St. Joe Paper Company in Port St. Joe, Florida (the paper company closed in 1999). All categories of water use, except thermoelectric power generation, increased moderately in the basin in Florida between 1970 and 1990.

Groundwater withdrawals in the Apalachicola River Basin in Florida increased between 1970 and 1990. That was consistent with the statewide trend of increasing reliance on groundwater and the decreasing use of surface water.

2.1.1.2.5.1.3 Recent Water Use Trends from 1990 to 2010

Between 1990 and 2010, the region continued to experience rapid population growth, particularly in the metropolitan Atlanta area and in other urban areas within the ACF Basin, although the rate of growth leveled off somewhat beginning in 2008 due to poor economic conditions in the region. Additionally, acreage of irrigated agriculture has increased in southwestern Georgia. Both factors tend to indicate a continued upward trend in both surface water and groundwater withdrawal and use. However, a number of technological and economic factors have, in large part, offset increased water demands in the ACF Basin. Some of those factors include the following:

- Increased agricultural irrigation efficiencies.
- Improved cooling water technologies for thermoelectric power plants.
- Reduced water demands in the commercial-industrial water use category due to the changing economy of the region. The industrial sector of the economy in the region (which frequently requires significant quantities of water to support manufacturing processes) has significantly declined as business has shifted more to a service-based economy.
- Numerous water conservation/water efficiency technologies and programs instituted by the states and public water supply providers.
- Concerted regional water planning initiatives.

Georgia. Fanning and Trent (2009) evaluated water use trends in Georgia from 1980 through 2005. Statewide, total water use in 2005 (about 5,353 mgd) was about the same as in 1990 (5,471 mgd). Statewide public-supply water use steadily increased from 1980 to 2000, corresponding to an increase in population (from 4,189,000 to 8,186,450) during the same period; however, water use leveled off and slightly decreased from 2000 to 2005. Commercial, domestic, and livestock uses remained about the same for the period from 1980 to 2005. Industrial water use fluctuated during the period from 1980 to 2005, mostly because of improved water efficiency, water recycling, and conservation measures at industrial plants and changes in the number and type of industrial facilities. The statewide statistics are considered to be generally indicative of water use trends in the ACF Basin in Georgia.

Irrigation water use declined from 1980 to 1990, increased from 1995 to 2000, and decreased markedly from 2000 to 2005. Estimated irrigation withdrawal was 30 percent lower in 2005 than in 2000 because of decreased irrigation demands resulting from the greater amount of rainfall in 2005, which relieved the prolonged drought that began in 1998 and continued through 2002. The total number of acres irrigated in the state increased by nearly 32 percent between 1995 and 2005.

Water for thermoelectric power generation has continued to be the largest of any off-stream use category in Georgia. Thermoelectric power withdrawal peaked in 1980, dropped sharply in 1985, and declined again in 1990 before increasing in 1995 and 2000. The rising trend was reversed in 2005, after thermoelectric power decreased by 24 percent from 2000 because of the decommissioning of three power plants and retrofitting cooling towers at several other plants, including some in the ACF Basin.

Specifically, for the ACF Basin in Georgia, surface water withdrawals between 1990 and 2005 compare as follows (Fanning and Trent 2009; Marella et al. 1993):

- Total withdrawals—decreased by 10.8 percent (1,327 mgd as of 2005)
- Public water supply withdrawals—increased by 27.4 percent (526 mgd as of 2005)
- Self-supplied domestic-commercial-industrial withdrawals—decreased by 9.2 percent (129 mgd as of 2005)
- Irrigation withdrawals—increased by 46.0 percent (92 mgd as of 2005)
- Thermoelectric power generation withdrawals—decreased by 33.2 percent (580 mgd as of 2005)

Alabama. Hutson et al. (2009) evaluated recent water use trends in Alabama as of 2005. On a statewide basis, total water use in 2005 in Alabama varied little from total use in 2000. Total water withdrawals decreased less than 1 percent in 2005 compared to 2000. Surface water withdrawals in 2005 decreased less than 5 percent from 2000 levels. In contrast, groundwater withdrawals in 2005 increased about 12 percent over 2000 levels.

Total public-supply water withdrawals decreased 4 percent from 834 mgd in 2000 to 802 mgd in 2005. Water withdrawals for irrigation statewide increased about 274 percent from 2000 (43.1 mgd) to 2005 (161.2 mgd). Groundwater withdrawals for irrigation increased at a faster rate than surface water withdrawals. Part of this increase in irrigation numbers was due to a more complete inventory of golf courses, nurseries, and sod farms. Primarily as a result of this inclusion, total irrigated acreage from 2000 to 2005 increased about 94 percent from 70,010 ac to 135,800 ac. In 2000, 57 self-supplied industries reported withdrawals compared with 66 industries in 2005. Although the number of reporting industries increased in 2005, water withdrawals decreased 34 percent from 2000 (833 mgd) to 2005 (550 mgd). Groundwater withdrawals were 51 percent less in 2005 than in 2000. Surface water withdrawals were 33 percent

less in 2005 than in 2000. Reasons for reduced water withdrawals include reduced production, increased water conservation, or improved metering and reporting. Water withdrawals to support thermoelectric power generation (almost exclusively from surface water sources) have remained level in recent years.

For the portion of the ACF Basin in Alabama, surface water withdrawals between 1990 and 2005 compare as follows (Marella et al. 1993; Hutson et al. 2009):

- Total withdrawals—increased by 4.4 percent (166 mgd as of 2005)
- Public water supply withdrawals—increased by 142.6 percent (19 mgd as of 2005)
- Self-supplied domestic-commercial-industrial withdrawals—decreased by 34.2 percent (30 mgd as of 2005)
- Irrigation withdrawals—increased by 76.3 percent (12 mgd as of 2005)
- Thermoelectric power generation withdrawals—decreased by 6.6 percent (105 mgd as of 2005)

Florida. Northwest Florida Water Management District (NWFWMD) (1998, 2008) provided an assessment of water use in 1995 and 2005 in the 8-county area adjacent to the Apalachicola River (Regions IV, V, and VI in the Northwest Florida Water Management District's area of operation), which generally, but not precisely, aligns with the ACF Basin. Overall, total consumptive water use in the Apalachicola River Basin in Florida decreased slightly between 1995 and 2005, despite moderate increases in various water use categories such as public supply, domestic self-supply, and agricultural irrigation. These increases have been offset by the termination of industrial surface water withdrawals from the Chipola River by the St. Joe Paper Company in Port St. Joe, Florida, which closed in 1999.

Metro Atlanta Water Use Trends. The MAAWRMS summarized 1975 water withdrawals by the City of Atlanta and several surrounding metropolitan counties from the Chattahoochee and Flint River basins (USACE, Savannah District 1978). The study also included projections of year 2000 water withdrawals from those same governmental entities. The quantities are depicted in Table 2.1-9, along with average water withdrawals by the water providers in 2006, 2007, and 2008 (USACE, Mobile District 2009a). Other metropolitan Atlanta counties, such as Forsyth County and Hall County, were not specifically included in the 1978 study and are not included in Table 2.1-9 because the intent of the table is to compare water use and water use projections over time.

For the water providers summarized in Table 2.1-9, water withdrawals between 1975 and 2006 increased by 73 percent. However, with the exception of Gwinnett County, 2006 average withdrawals for each water provider was substantially lower than year 2000 water withdrawal projections from the MAAWRMS. Their overall total was lower as well. Cumulative withdrawals in these Metro Atlanta counties peaked in 2006–2007. Thereafter, total withdrawals abruptly declined in 2008 (by about 13 percent) and have not returned to those peak levels. Year 2008 water use in north Georgia was reduced due to restrictions associated with drought conditions, including a mandate from the Governor of Georgia for public water suppliers to reduce water use by at least 10 percent during the balance of the drought period. Consequently, 2006–2007 withdrawal levels provide a reasonably conservative representation of present withdrawals in the Metro Atlanta counties included in Table 2.1-9.

Table 2.1-9.
Water Withdrawals (average) by Selected Metro Atlanta M&I Water Suppliers Compared to Projected 2000 Water Withdrawals from MAAWRMS

M&I Water Supplier	Withdrawal Source (basin)	MAAWRMS Report (Oct 1978)		2006[a] Withdrawals (mgd)	2007[a] Withdrawals (mgd)	2008[a] Withdrawals (mgd)
		1975 Withdrawals (mgd)	Projected 2000 Withdrawals (mgd)			
Atlanta	Chattahoochee	86.8	116.4	102.5	100.9	87.8
Fulton	Chattahoochee	21.1	67.3	43.8	44.1	36.1
DeKalb	Chattahoochee	59.0	110.8	82.8	78.4	72.6
Cobb	Chattahoochee	29.7	74.1	51.0	52.1	43.7
Gwinnett	Chattahoochee	14.5	50.7	92.6	88.2	73.6
Douglas	Chattahoochee	4.3	17.7	13.2	9.6	11.0
Clayton	Flint	15.6	40.6	13.9	12.3	10.6
Totals		231.0	477.6	399.8	385.6	335.4

Source: USACE, Mobile District 2009a

The 2010 Water Metrics Report (covering the years from 2000 through 2009), prepared for the MNGWPD (ARC 2011), substantiates that M&I water withdrawals from the Chattahoochee River and Flint River basins within the 15-county MNGWPD area remained relatively steady from 2000 through 2007. During this period, average annual withdrawals ranged from 395 to 447 mgd in the Chattahoochee River Basin and from 19 to 22 mgd in the Flint basin. Withdrawals declined about 15 percent in 2008 and 2009 due to conservation and water use restrictions associated with drought conditions and, subsequently, reduced economic activity in the region associated with the 2009 recession. Reduced economic activity and the associated effects on water use in the region have extended over several years but are expected to be temporary.

2.1.1.2.5.2 Current Water Use—ACF Basin in Georgia

Surface Water. According to a USGS report of water use withdrawals in Georgia in 2005 (Fanning and Trent 2009), surface water use in the ACF Basin (Georgia) totaled 1,326.51 mgd, consisting of the water use categories shown in Table 2.1-10. When the draft EIS was being prepared, the 2005 water use report was the most recent available comprehensive assessment of water use in the State of Georgia, including the Georgia portion of the ACF Basin. As stated in the previous section, additional water use data available since 2005 (particularly data relative to Metro Atlanta) indicated that overall surface water withdrawals in the basin had declined during the 2007–2008 drought period and the subsequent economic recession and had not yet returned to levels observed from 2005 through 2007. Consequently, water use values from the 2005 report were considered to reasonably represent, or slightly exceed, current water use across the Georgia portion of ACF Basin for purposes of this analysis.

Following public coordination of the draft EIS in October 2015, an updated comprehensive report on water use in Georgia as of 2010 was published by USGS (Lawrence 2016a). The 2010 withdrawal values confirm that total surface water withdrawals declined slightly across the entire State of Georgia. Table 2.1-10 has been updated from the draft EIS to include 2010 surface water withdrawal values in the Georgia portion of the ACF Basin. Specifically, in the Georgia portion of the ACF Basin, surface water withdrawals overall declined by about 33 percent between 2005 and 2010 (Table 2.1-10). Withdrawals for thermoelectric power generation were the largest single contributor to this decline. Those withdrawals in the basin decreased by 74 percent, as power generation processes evolve to those which demand less withdrawal and use of water. Water withdrawals for public water supply in the Georgia portion of the

ACF Basin also decreased by about 7.7 percent during that 5-year period. Surface water withdrawals for irrigation and livestock were the only major water uses to increase in the Georgia portion of the basin between 2005 and 2010. Combined, surface water withdrawals for irrigation and livestock increased by about 41 percent. Withdrawals for industrial and commercial use remained about the same over the 5-year period.

Table 2.1-10.
Surface Water Use: ACF (GA)

Water Use Category	Quantity (mgd) 2005 / 2010	% of Total 2005 / 2010
Total Use	*1, 326.51 / 887.78*	*100% / 100%*
Public Supply	525.75 / 485.50	39.6% / 54.7%
Domestic and Commercial	6.90 / 0.14	0.5% / 0.0%
Industrial and Mining	121.84 / 121.08	9.2% / 13.6%
Irrigation (Crop and Golf Course)	75.92 / 107.42	5.7% / 12.1%
Livestock	16.06 / 22.44	1.3% / 2.5%
Thermoelectric Power Generation	580.04 / 151.20	43.7% / 17.0%

Sources: Fanning and Trent 2009; Lawrence 2016b

The decline in water withdrawals and use in the State of Georgia overall and in the Georgia portion of the ACF basin between 2005 and 2010 can most likely be attributed to several factors working together during that period: (1) water conservation laws and policies along with advances in water conservation technology; (2) the onset of a major economic recession in 2007; and (3) below average rainfall in 2007, 2008, and the latter half of 2010. Because of these factors, water withdrawn by public suppliers in Georgia decreased by 4.8 percent (despite a nearly 11 percent increase in the population served in the state) and per capita use decreased by 19 percent between 2005 and 2010 (Lawrence 2016a). Metro Atlanta suppliers were significant contributors to these statewide trends toward decreased withdrawals and decreased per capita use during this period.

Georgia law—the Georgia Groundwater Use Act (Official Code of Georgia Annotated [O.C.G.A.] sections 12-5-90 *et seq.*) and the Georgia Water Quality Control Act (O.C.G.A. 12-5-31)—requires any surface water user who withdraws more than 100,000 gpd on a monthly average to obtain a withdrawal permit from the GAEPD. The basic provisions, requirements and procedures associated with the permit program are summarized in section 2.1.1.2.10.1.1.

Table 2.1-11 provides a summary of permitted surface water withdrawals for M&I uses in the ACF Basin in Georgia (GAEPD 2011). The information is provided beginning with the most upstream counties in the Chattahoochee River and Flint River watersheds working downstream. The numbers in the table do not necessarily reflect actual quantities of water withdrawn or whether a withdrawal could even be occurring at any time by those who hold surface water withdrawal permits from Georgia. They do reflect the allowable limits placed on each user. Actual quantities withdrawn from surface waters in Georgia are used in modeling the ACF Basin for the purpose of updating the Master Manual and project WCMs.

Table 2.1-11.
Georgia Permitted M&I Surface Water Withdrawals within the ACF Basin

River Basin	Permit Holder	Permit Number	County	Source Water	Permit Limit Max Day (mgd)	Permit Limit Monthly Average (mgd)
Upper Chattahoochee River Basin—Headwaters to Whitesburg, GA						
Chattahoochee	Baldwin, City of	068-1201-04	Habersham	Chattahoochee River	4.000	3.000
Chattahoochee	Clarkesville, City Of	068-1201-03	Habersham	Soque River	1.500	1.000
Chattahoochee	Cornelia, City Of	068-1201-01	Habersham	Hazel Creek, Camp Creek Reservoir, Emergency Camp Cr.	4.000	4.000
Chattahoochee	HaBest, Inc.[a]	068-1201-06	Habersham	Soque River	223.000	128.000
Chattahoochee	White County Water & Sewer Authority	154-1202-02	White	Turner Creek	2.000	1.800
Chattahoochee	Birchriver Chestatee Company, LLC	093-1202-03	Lumpkin	Chestatee River	0.430	0.430
Chattahoochee	Dahlonega, City of	093-1204-03	Lumpkin	Yahoola Creek Reservoir	9.100	6.800
Chattahoochee	Dahlonega, City Of New Plant	093-1204-01	Lumpkin	Yahoola Creek	1.500	1.250
Chattahoochee	McRae and Stolz, Inc.	042-1202-01	Dawson	Lake Lanier	0.780	0.500
Chattahoochee	Buford, City Of	069-1290-04	Hall	Lake Lanier	2.500	2.000
Chattahoochee	Gainesville, City Of	069-1290-05	Hall	Lake Lanier	35.000	30.000
Chattahoochee	LLI Management Company, LLC	069-1205-01	Hall	Lake Lanier	0.600	0.600
Chattahoochee	LLI Management Company, LLC (Pineisle)	069-1205-02	Hall	Lake Lanier	0.600	0.600
Chattahoochee	Gwinnett County Water & Sewerage Auth	069-1290-06	Hall	Lake Lanier		150.000
Chattahoochee	Cumming, City Of	058-1290-07	Forsyth	Lake Lanier	21.000	18.000
Chattahoochee	Forsyth County Board Of Commissioners	058-1207-06	Forsyth	Lake Lanier	16.000	14.000
Chattahoochee	Lanier Golf Club	058-1207-05	Forsyth	Golf Course Pond #1	0.290	0.210
Chattahoochee	Sequoia Golf Olde Atlanta LLC	058-1207-03	Forsyth	ManMade Lakes	0.340	0.200
Chattahoochee	Sequoia Golf Windermere, LLC	058-1207-09	Forsyth	James Creek	0.400	0.400
Chattahoochee	Southeast Investments, L.L.C.	058-1207-08	Forsyth	Dick Creek	0.200	0.080
Chattahoochee	Dekalb Co Public Works Water & Sewer	044-1290-03	Dekalb	Chattahoochee River	140.000	140.000
Chattahoochee	Atlanta Athletic Club	060-1209-02	Fulton	Chattahoochee River	0.860	0.430
Chattahoochee	Atlanta, City of	060-1291-01	Fulton	Chattahoochee River	180.000	180.000
Chattahoochee	Atlanta-Fulton Co. Water Res Commission	060-1207-02	Fulton	Chattahoochee River	90.000	90.000
Chattahoochee	Cherokee Town & Country Club	060-1290-09	Fulton	Bull Sluice Lake	0.720	0.430
Chattahoochee	GCG Members' Purchasing Committee, Inc.	060-1209-04	Fulton	Big Creek	2.000	1.000

River Basin	Permit Holder	Permit Number	County	Source Water	Permit Limit Max Day (mgd)	Permit Limit Monthly Average (mgd)
Chattahoochee	Palmetto, City Of	060-1218-01	Fulton	Cedar Creek	0.600	0.450
Chattahoochee	Riverfarm Enterprises, Inc.(RiverPines Golf)	060-1207-04	Fulton	Johns Creek	1.150	0.500
Chattahoochee	Roswell, City Of Big Creek	060-1209-01	Fulton	Big Creek	1.200	1.200
Chattahoochee	Standard Golf Club	060-1209-03	Fulton	Unnamed tributary to Johns Creek	0.750	0.600
Chattahoochee	Perimeter Terminal LLC	060-1290-08	Fulton	Chattahoochee River	0.250	0.250
Chattahoochee	Caraustar Mill Group, Inc. - Mill 2	033-1214-02	Cobb	Sweetwater Creek	0.864	0.864
Chattahoochee	Caraustar Mill Group, Inc. - Sweetwater	033-1214-01	Cobb	Sweetwater Creek	0.560	0.490
Chattahoochee	Cobb Co Marietta Water Authority	033-1290-01	Cobb	Chattahoochee River	87.000	87.000
Chattahoochee	GPC Plant McDonough	033-1291-03	Cobb	Chattahoochee River	394.000	394.000
Chattahoochee	Douglasville Douglas County W & S A	048-1216-03	Douglas	Bear Creek	6.400	6.000
Chattahoochee	Douglasville Douglas County W & S A	048-1217-03	Douglas	Dog River Reservoir	23.000	23.000
Chattahoochee	East Point, City Of	048-1214-03	Douglas	Sweetwater Creek	13.200	11.500
Chattahoochee	Carroll County Water Authority	022-1217-01	Carroll	HC Seaton Reservoir (Snake Cr)	8.000	8.000
Chattahoochee	Coweta County Water & Sewerage Authority	038-1218-02	Coweta	BT Brown Reservoir	10.000	6.700
Chattahoochee River—Whitesburg to Jim Woodruff Lock and Dam (Lake Seminole)						
Chattahoochee	GPC Plant Yates	038-1291-02	Coweta	Chattahoochee River	720.000	700.000
Chattahoochee	Newnan Utilities	038-1221-01	Coweta	Sandy/Browns Creek	8.000	8.000
Chattahoochee	Newnan Utilities	038-1221-02	Coweta	Raw Water Reservoirs	14.000	14.000
Chattahoochee	GPC Plant Wansley	074-1291-06	Heard	Chattahoochee River	116.000	116.000
Chattahoochee	GPC Plant Wansley	074-1291-07	Heard	Service Water Reservoir	110.000	110.000
Chattahoochee	Heard County Water Authority	074-1220-02	Heard	Centralhatchee Creek	4.000	3.100
Chattahoochee	Heard County Water Authority	074-1220-03	Heard	Hillabahatchee Creek	4.000	3.100
Chattahoochee	Heard County Water Authority	074-1291-08	Heard	Chattahoochee River	0.550	0.550
Chattahoochee	Hogansville, City Of	141-1222-01	Troup	Blue Creek Res	1.000	1.000
Chattahoochee	LaGrange, City Of	141-1292-01	Troup	West Point Lake	22.000	20.000
Chattahoochee	West Point, City Of	141-1292-02	Troup	Chattahoochee River	2.100	1.800
Chattahoochee	Chat Valley Water Supply District	072-1291-04	Harris	Chattahoochee River	8.000	5.800
Chattahoochee	Harris County Water Dept	072-1224-01	Harris	Bartletts Ferry Res	3.000	3.000
Chattahoochee	Southern Power Co Plant Franklin	106-1225-08	Muscogee	Chattahoochee River	31.500	31.500
Chattahoochee	Columbus, City Of	106-1293-05	Muscogee	Lake Oliver	90.000	90.000

River Basin	Permit Holder	Permit Number	County	Source Water	Permit Limit Max Day (mgd)	Permit Limit Monthly Average (mgd)
Chattahoochee	Continental Carbon	106-1225-07	Muscogee	Chattahoochee River	0.900	0.660
Chattahoochee	Eagle-Phenix Hydro-electric Project, Inc.[b]	106-1225-04	Muscogee	Chattahoochee River	1,694.000	1,694.000
Chattahoochee	Eagle-Phenix Mills, LLC	106-1293-07	Muscogee	Chattahoochee River	1.400	1.300
Chattahoochee	Smiths Water Authority	106-1225-05	Muscogee	Lake Oliver (Chattahoochee River)	8.000	8.000
Chattahoochee	Fort Benning	026-1225-01	Muscogee	Chattahoochee River	12.000	10.000
Chattahoochee	Unimin Georgia Company, L.P.	096-1225-09	Marion	Duck pond on tributary to Black Cr	1.152	0.768
Chattahoochee	Yellow Pine Energy Company	030-1295-04	Clay	Chattahoochee River	2.650	2.650
Chattahoochee	Georgia. Pacific Cedar Springs, LLC	049-1295-01	Early	Chattahoochee River	144.000	115.000
Chattahoochee	Homestead Energy Resources, LLC[c]	049-1295-02	Early	Chattahoochee River	16,130.000	16,130.000
Chattahoochee	Longleaf Energy Associates, LLC	049-1295-03	Early	Chattahoochee River	27.000	25.000
Flint River Basin—Headwaters to Jim Woodruff Lock and Dam (Lake Seminole)						
Flint	Clayton County Water Authority - Flint	031-1102-07	Clayton	Flint River	40.000	40.000
Flint	Clayton County Water Authority - Shoal	031-1101-01	Clayton	J.W. Smith Res./ Shoal Cr.	17.000	17.000
Flint	Stephens MDS, LP	031-1101-02	Clayton	Pond No. 1	0.250	0.250
Flint	Stephens MDS, LP	031-1101-03	Clayton	Pond No. 5	0.250	0.250
Flint	Board of Commissioners of Fayette County	056-1102-03	Fayette	Lake Peachtree	0.550	0.500
Flint	Board of Commissioners of Fayette County	056-1102-06	Fayette	Flat Creek Reservoir	4.500	4.000
Flint	Board of Commissioners of Fayette County	056-1102-09	Fayette	Line Cr (McIntosh Site)	17.000	12.500
Flint	Board of Commissioners of Fayette County	056-1102-10	Fayette	Whitewater Creek	2.000	2.000
Flint	Board of Commissioners of Fayette County	056-1102-12	Fayette	Horton Creek Reservoir	14.000	14.000
Flint	Board of Commissioners of Fayette County	056-1102-13	Fayette	Flint River	16.000	16.000
Flint	Fayetteville, City Of	056-1102-14	Fayette	Whitewater Creek	3.000	3.000
Flint	Newnan Utilities	038-110211	Coweta	Line Creek	12.000	12.000
Flint	Newnan Utilities	038-110302	Coweta	White Oak Creek	7.000	7.000
Flint	Senoia, City Of	038-110205	Coweta	Hutchins Lake	0.300	0.300
Flint	Griffin, City Of	126-119001	Spalding	Flint River	13.200	12.000
Flint	Griffin, City of	114-1104-03	Pike	Still Branch Reservoir	48.000	42.000
Flint	Griffin, City of	114-119102	Pike	Flint River	50.000	50.000
Flint	Zebulon, City Of	114-110401	Pike	Elkins Creek	0.400	0.300
Flint	Roosevelt Warm Springs Institute	099-110604	Meriwether	Cascade Creek	0.144	0.144

River Basin	Permit Holder	Permit Number	County	Source Water	Permit Limit Max Day (mgd)	Permit Limit Monthly Average (mgd)
Flint	Woodbury, City Of	099-110602	Meriwether	Cain Cr Res On Pond Cr	0.750	0.500
Flint	Southern Mills, Inc.	145-110402	Upson	Upper Boy Scout's Lake discharge or Boy Scout's lower	0.650	0.500
Flint	Thomaston, City Of	145-110501	Upson	Potato Creek	4.400	3.400
Flint	Thomaston, City Of	145-110502	Upson	Potato Creek	1.440	0.400
Flint	Thomaston, City Of	145-110503	Upson	Raw Water Cr Res	4.300	4.300
Flint	Manchester, City of	130-110605	Talbot	Rush Creek Reservoir	2.000	1.440
Flint	Manchester, City of	130-110606	Talbot	Lazer Creek	4.300	3.700
Flint	Unimin Georgia Company, L.P.	133-110901	Taylor	Remote Pond on Black Creek	2.592	1.728
Flint	Unimin Georgia Company, L.P.	133-110902	Taylor	Black Creek (Remote Jr.)	0.576	0.384
Flint	Weyerhaeuser Company	094-119101	Macon	Flint River	13.500	11.500
Flint	Crisp County Power Comm Hydro[d]	159-1112-02	Worth	Lake Blackshear	4,847.300	4,847.300
Flint	Crisp County Power Comm Steam	159-1112-01	Worth	Lake Blackshear	15.000	15.000
Flint	GPC Plant Mitchell	047-1192-01	Dougherty	Flint River	232.000	232.000

Notes:
[a.] Georgia withdrawal permit issued in 2007 for proposed flow through nonfederal hydroelectric power generation project at existing dam in Habersham County.
[b.] Georgia withdrawal permit (active as of 2009) for proposed nonfederal hydroelectric power generation at Eagle-Phenix Dam. Request submitted to FERC on 10/21/2010 to surrender license (75 FR 209, October 29, 2010).
[c.] Georgia withdrawal permit (active as of 2009) for proposed nonfederal hydroelectric power generation at George W. Andrews Lock and Dam. FERC terminated the license for project on 11/15/2007.
[d.] Georgia withdrawal permit (active as of 2009) for flow through nonfederal hydroelectric power generation at Lake Blackshear.

On the basis of studies conducted by Dr. James E. Hook et al. (2009) for use in conjunction with development of the Georgia statewide water plan, estimates for surface water pumping rates (projections for year 2011) in the Chattahoochee and Flint River basins for agricultural irrigation are presented in Table 2.1-12 and Table 2.1-13 In the tables, the *wet year* equals the wettest 25th percentile (1 in 4 years) and *dry year* equals the driest 25th percentile (1 in 4 years). The results of the studies are being used to characterize and quantify surface water withdrawals for agricultural irrigation to support the statewide water planning process. Surface water withdrawal for agricultural irrigation across the entire ACF Basin is relatively minor compared to other uses.

Table 2.1-12.
Chattahoochee River Basin: Agricultural Irrigation (Surface Water)
Annualized Pumping Rates (in mgd) Projected for Year 2011

Basin/Subbasin	Wet Year	Median Year	Dry Year
Basin Total	*4.06*	*6.23*	*8.35*
Upper Chattahoochee	0.15	0.27	0.46
Middle Chattahoochee – Lake Harding	0.02	0.02	0.03
Middle Chattahoochee – W.F. George Res.	1.41	2.09	2.82
Lower Chattahoochee	2.48	3.85	5.04

Table 2.1-13.
Flint River Basin: Agricultural Irrigation (Surface Water)
Annualized Pumping Rates (in mgd) Projected for Year 2011

Basin/Subbasin	Wet Year	Median Year	Dry Year
Basin Total	*64.07*	*95.09*	*126.52*
Upper Flint	2.75	3.90	5.31
Spring Creek	4.27	6.46	8.41
Middle Flint	16.20	24.80	33.40
Lower Flint	6.75	9.53	12.60
Kinchafoonee-Muckalee Creeks	13.00	19.40	25.90
Ichawaynochaway Creek	21.10	31.00	40.90

Groundwater. The GAEPD requires permits for all wells withdrawing greater than 100,000 gpd. Numerous private wells throughout the state withdraw less than 100,000 gpd, but location, density, and withdrawal rates can only be estimated. The basic provisions, requirements, and procedures associated with the GAEPD permit program are summarized in section 2.1.1.2.10.1.1.

In the Chattahoochee River Basin, 26 M&I water users are permitted to withdraw 14.89 mgd (on a monthly average). In the Flint River Basin in Georgia, 72 M&I water users are permitted by the state to withdraw 121.95 mgd (on a monthly average). Use of groundwater for M&I water needs is much more prevalent in the Flint River Basin, and over 40 percent of the permitted use (about 50 mgd) occurs in Dougherty County, principally by the City of Albany, Merck & Company, Proctor and Gamble, and Miller-Coors (GAEPD 2009b).

In the Southeastern Plains, stream and groundwater flow are highly connected and agricultural irrigation impacts streamflow during drought conditions. Low flows in streams were greater and occurred sooner in the recent droughts compared to previous droughts. Groundwater withdrawals are highest in the lower Chattahoochee River and middle and lower Flint River basins. The heaviest usage of groundwater occurs below the Fall Line in the high-yield aquifers of the Floridan, Clayton, Claiborne, and Providence aquifers, with the highest density occurring near Spring Creek (Hook et al. 2005).

A 5-year study (2000–2004) by the University of Georgia examined agricultural groundwater use throughout the state. Data collected in the study are used for modeling by the state and municipalities to determine groundwater withdrawal use and its impacts on aquifers. Data from the study revealed that most agricultural irrigation occurs during the growing season, April to September, and peaks in June, July, and August when evapotranspiration is typically highest and stream and groundwater levels are approaching their seasonal low levels. Irrigation was nearly twice as high during the drought years of 2000 and 2001 as it was in normal and wet years. The timing and volume of irrigation is also dependent

on seasonal rainfall distribution, crop type and planting date, soil conditions, and growers experience and preferences (Hook et al. 2005).

Estimates of pumping rates (projected for year 2011) contained in the Georgia statewide water plan for the Chattahoochee and Flint River basins for agricultural irrigation are presented in Table 2.1-14 and Table 2.1-15. In the tables, the *wet year* equals the wettest 25th percentile (1 in 4 yr) and *dry year* equals the driest 25th percentile (1 in 4 yr). The results of the studies are being used to characterize and quantify groundwater withdrawals for agricultural irrigation associated with development of the Georgia statewide water plan.

Table 2.1-14.
Chattahoochee River Basin: Agricultural Irrigation (Groundwater)
Annualized Pumping Rates (in mgd) Projected for Year 2011

Basin/Subbasin	Wet Year	Median Year	Dry Year
Basin Total	*11.4*	*16.9*	*21.7*
Upper Chattahoochee	0	0	0
Middle Chattahoochee – Lake Harding	0	0	0
Middle Chattahoochee – W.F. George Res.	0.4	0.50	0.7
Lower Chattahoochee	11.00	16.40	21.0

Table 2.1-15.
Flint River Basin: Agricultural Irrigation (Groundwater)
Annualized Pumping Rates (in mgd) Projected for Year 2011

Basin/Subbasin	Wet Year	Median Year	Dry Year
Basin Total	*223.3*	*328.8*	*435.8*
Upper Flint	4.0	5.7	7.6
Spring Creek	53.3	79.8	106.0
Middle Flint	37.4	56.6	76.4
Lower Flint	82.7	119.0	157.0
Kinchafoonee-Muckalee Creeks	19.6	29.3	38.4
Ichawaynochaway Creek	26.3	38.4	50.4

2.1.1.2.5.3 Current Water Use—ACF Basin in Alabama

Surface Water. Surface water withdrawals for all use categories, including agricultural irrigation and livestock, from the ACF Basin in Alabama in 2005 are summarized in Table 2.1-16. At that time, only about 7 percent of surface water use in the Alabama portion of the Chattahoochee River Basin was for agricultural irrigation and livestock (Hutson et al. 2009). When the draft EIS was being prepared, the 2005 water use report was the most recent available comprehensive assessment of water use in the State of Alabama, including the Alabama portion of the ACF Basin. As stated in the previous section, limited additional water use data available for the basin since 2005 indicated that overall surface water withdrawals in the basin had declined during the 2007–2008 drought period and the subsequent economic recession and had not completely returned to levels observed in 2005–2007. Consequently, water use values from the 2005 report was considered to reasonably represent, or slightly exceed, current water use across the ACF Basin for purposes of this analysis.

Table 2.1-17 provides a summary of the important M&I surface water withdrawals in Alabama from the Chattahoochee River (between West Point Dam and Jim Woodruff Lock and Dam) in 2005. At that time, over 80 percent of the Chattahoochee River withdrawals from within Alabama came from two sources: Mead Westvaco (changed to WestRock in 2015) and Southern Nuclear Company (Farley Nuclear Plant) (Hutson et al. 2009).

During preparation of the draft EIS for public coordination, an updated comprehensive report on water use in Alabama as of 2010 was published by the Alabama Department of Economic and Community Affairs, Office of Water Resources (ADECA 2015). The results of this report were not available in time to be incorporated into the draft EIS. Table 2.1-16 and Table 2.1-17 have been updated to reflect 2010 surface water withdrawal values in the Alabama portion of the ACF Basin. The 2010 withdrawal values confirm that total surface water withdrawals declined slightly across the entire State of Alabama. Specifically, in the Alabama portion of the ACF Basin, surface water withdrawals declined by about 10 percent between 2005 and 2010. Slight increases in surface water withdrawals for public supply and irrigation were more than offset by decreases in withdrawals for thermoelectric power generation and industrial uses.

Table 2.1-16.
Alabama Surface Water Use: ACF Basin

Water Use Category	Quantity (mgd) 2005 / 2010	% of total 2005 / 2010
Total Use	*165.95 / 138.8*	*100% / 100%*
Public Supply	18.92 / 19.71	11.4% / 13.2%
Industrial and Mining	29.76 / 27.63	17.9% / 18.6%
Thermoelectric Power Generation	105.36 / 89.30	63.5% / 60.0%
Irrigation	11.33 / 11.77	6.8% / 7.9%
Livestock	0.58 / 0.52	0.4% / 0.3%

Sources: Hutson et al. 2009; ADECA 2015

Table 2.1-17.
Alabama M&I Surface Water Withdrawals in the ACF Basin

Withdrawal by	County	Withdrawal (mgd) 2005 / 2010
WestPoint Home Inc. - Fairfax Finishing Plant (Westpoint Stevens Inc.)	Chambers	2.16 / 0.00
Chattahoochee Valley Water Supply District	Chambers	4.72 / 3.78
Smiths Water and Sewer Authority (Smiths Station Water System)	Lee	2.29 / 2,35
Opelika Water Works Board	Lee	7.48 / 6.26
Phenix City Utilities	Russell	7.04 / 7.32
Mead Westvaco Corporation (changed to WestRock in 2015)	Russell	27.60 / 27.63
Southern Nuclear Company - Farley Nuclear Plant	Houston	105.36 / 89.30

Sources: Hutson et al. 2009; ADECA 2015

Groundwater. Table 2.1-18 provides a summary of the groundwater withdrawals in Alabama in 2005 lying within the extent of the Chattahoochee River Basin (between West Point Dam and Jim Woodruff Lock and Dam). The most significant uses of groundwater in this area are public water supply and agricultural irrigation, which constitute about 90 percent of the total groundwater use (Hutson et al. 2009). This table was updated after publication of the draft EIS for public review to include groundwater withdrawal information from the updated report on water use in Alabama as of 2010 (ADECA 2015). Table 2.1-18 indicates that total groundwater withdrawals decreased by about 8 percent between 2005 and 2010, with slight increases in groundwater withdrawals for public supply and industrial uses and a notable decrease in withdrawals for irrigation.

Alabama does not have a formal water withdrawal permitting program for surface water and groundwater. Water use information is acquired through a water use reporting system administered by the Alabama Office of Water Resources (OWR) (see section 2.1.1.2.10.2.3).

Table 2.1-18.
Alabama Groundwater Use: ACF Basin

Water Use Category	Quantity (mgd) 2005 / 2010	% of total 2005 / 2010
Total Use	*23.77 / 21.84*	*100% / 100%*
Public Supply	13.48 / 13.64	56.7% / 62.5%
Industrial and Mining	2.34 / 2.93	9.8% / 13.4%
Thermoelectric Power Generation	0.17 / 0.17	0.8% / 0.8%
Irrigation	7.38 / 4.77	31.0% / 21.8%
Livestock	0.40 / 0.33	1.7% / 1.5%

Source: Hutson et al. 2009

2.1.1.2.5.4 Current Water Use—ACF Basin in Florida

Table 2.1-19 presents information on M&I surface water withdrawals from the Apalachicola River Basin. By far, the most significant surface water withdrawal from the Apalachicola River over much of the period of analysis for this Master WCM update occurred at the Gulf Power Company's Scholz Electric Generating Plant in Jackson County, Florida, 3.5 mi below Jim Woodruff Lock and Dam. While the average daily withdrawal for Plant Scholz was 96.10 mgd (over 19 yr of data), a 2008 Water Supply Assessment Update prepared by the Northwest Florida Water Management District (NWFWMD 2008) indicates that the net consumptive water use at Plant Scholz in 2005 was approximately 4.1 mgd. In 2013, Gulf Power Company announced that it planned to cease operations at Plant Scholz in April 2015. In April 2015, the Company ceased water withdrawals and completed closure of Plant Scholz (Jackson County Floridan 2015).

Table 2.1-19.
Florida M&I Surface Water Withdrawals within the ACF Basin

Withdrawal by	Avg Daily Withdrawal (monthly avg mgd)	Max Daily Withdrawal (monthly avg mgd)	Min Daily Withdrawal (monthly avg mgd)	Years For Which Data Are Available
Apalachicola River – Jim Woodruff Dam (Lake Seminole) to Apalachicola Bay				
Gulf Power (Scholz Electric)	96.10	129.60	0.06	1990–2008
St. Joe Timberland (Prudential Ins.)	0.95	10.75	0.00	1999–2008
City of Port St. Joe	0.52	4.51	0.00	2002–2008

Source: Withdrawal data compiled by USACE, Mobile District, for use in modeling the ACF Basin with HEC-ResSim.

Available St. Joe Timberland (Prudential Insurance) water use statistics represent intermittent withdrawals (three to four months each year, generally between August and January) from 1999 through 2006. These withdrawals provide for the seasonal filling of waterfowl management impoundments on the property. These waters are generally returned to the river when the waterfowl management impoundments are drained in the early spring (March/April) (Chelette 2011). No withdrawals were made in 2007 or 2008 because river levels were too low to meet NWFWMD withdrawal permit conditions due to drought conditions in the basin (Chelette 2011).

Available data indicates relatively minor and highly variable surface water withdrawals for the City of Port St. Joe between 2002 and 2008 (last year of available data). The predominant source of water supply for the city has historically been groundwater. Due to depression of the Floridan aquifer in the vicinity of Port St. Joe from pumping to supply the St. Joe Paper Company, an 18.5-mi long freshwater canal was built in 1953 between the Chipola River and Port St. Joe to serve as a freshwater supply for the paper mill, with a capacity to provide about 51.5 mgd. The mill closed in 1998, and the ownership of the canal (called the Gulf County Fresh Water Supply Canal) was transferred the City of Port St. Joe in 2001 (NWFWMD 2008). A regional water supply plan developed in 2007 for Franklin and Gulf counties (NWFWMD 2007) includes provisions to develop the surface water system, using the existing canal in lieu of groundwater resources, to meet the water supply needs of Port St. Joe up to an estimated quantity of 6.0 mgd. The City of Port St. Joe completed the conversion to surface water supply in 2009 and is currently withdrawing about 2 mgd (Chellette 2011), representing a net transfer of water out of the Apalachicola River Basin.

In an 8-county area adjacent to the Apalachicola River (regions IV, V, and VI in the NWFWMD's 2008 Water Supply Assessment Update (NWFWMD 2008), about 70 mgd (including both surface water and groundwater) was withdrawn and consumptively used in 2005. Agricultural and other irrigation (about 54 percent of the total water use) are considered virtually 100 percent consumptive. Most public supply and domestic self-supply of water in the area use septic systems, which are highly consumptive. This NWFWMD assessment also considered only the net, or consumptive, use of water at Plant Scholz—the difference between that withdrawn from, and returned to, the Apalachicola River, or about 4.1 mgd (NWFWMD 2008). On the basis of those assumptions, only about 14 percent of water use in this 8-county area comes from surface waters. With the closure of Plant Scholz in April 2015, the percentage of water use from surface water has declined further from the 2005 estimate. The remaining water withdrawn and consumptively used is groundwater. Irrigation (over 60 percent of the total) and public supply/domestic self-supply are the predominant uses of this water.

The NWFWMD's 2013 Water Supply Assessment Update provided 2010 consumptive water use estimates (including both surface water and groundwater) for the same three regions adjacent to the Apalachicola River (NWFWMD 2013). Water use actually declined slightly (5.7 percent) compared to estimated 2005 water use (from approximately 70 mgd to 66 mgd). Most of the decline in consumptive use was attributable to agricultural irrigation and power generation. Projected water use estimates through the year 2035 are about 10 percent higher than the 2010 estimates.

Florida regulates water withdrawals in the Apalachicola River Basin by way of surface water and groundwater permit programs administered by the NWFWMD. Those programs are described in more detail in section 2.1.1.2.10.3.4.

2.1.1.2.5.5 Current Water Use—an ACF Basinwide Perspective

The latest available basinwide water withdrawal estimates (as of 2010) from Lawrence (2016b) are summarized in Table 2.1-20. These estimates indicate that total water withdrawals (surface water and groundwater) in the basin in 2010 had declined by about 41 percent from peak withdrawal levels around the year 2000. Most of the basinwide decrease is attributable to about an 80-percent decrease in

withdrawals for thermoelectric power generation since 2000. However, surface water withdrawals for public supply also continued to decrease (by about 14 percent from 2000 to 2010), despite substantial continued growth in population during that time (about a 0.8 annual growth rate and 1 million additional people basinwide per Table 2.6-23 and Table 2.6-24). Agricultural withdrawal levels for 2010 (surface water and groundwater combined) were about the same as those for 2000.

Table 2.1-20.
ACF Basin Water Withdrawals by Principal Water Use Categories (1990–2010) (in mgd)

		Year				
Water Use	**Source**	**1990**	**1995**	**2000**	**2005**	**2010**
Public Supply	Groundwater	64.54	73.39	71.53	64.17	**68.50**
	Surface water	421.20	445.10	580.31	544.67	**499.07**
Self-supplied Domestic	Groundwater	32.96	32.54	39.29	37.25	**32.96**
	Surface water	0.00	0.00	0.00	0.00	**0.00**
Self-supplied Commercial-industrial	Groundwater	27.93	26.75	28.07	32.10	**24.47**
	Surface water	220.50	202.47	170.69	158.50	**149.04**
Agricultural (includes golf course irrigation in 2010)	Groundwater	177.25	273.38	409.52	264.63	**449.89**
	Surface water	77.75	114.00	159.53	100.25	**139.89**
Thermoelectric Power Generation	Groundwater	0.37	0.38	0.48	0.48	**0.44**
	Surface water	1,075.27	930.68	1,340.35	787.84	**281.17**
Total Withdrawals (by year)	Groundwater	303.05	406.44	548.89	398.63	**576.26**
	Surface water	1,794.72	1,692.25	2,250.88	1,591.26	**1,069.17**
	Total	2,097.77	2098.69	2,799.77	1,989.89	**1,645.43**

Source: Lawrence 2016b

2.1.1.2.5.6 Incidental Water Withdrawals Permitted at USACE Reservoir Projects

Historically, at USACE reservoir projects with shoreline management plans that allow for permitting of docks and other facilities (including Lake Lanier, West Point Lake, Walter F. George Lake, Lake George W. Andrews, and Lake Seminole in the ACF Basin), water pumps of 2 horsepower or less have been authorized in conjunction with a permitted facility for incidental cleaning purposes or watering of lawns and gardens. On the basis of a 2008 USACE, Mobile District review of the above projects, the following numbers of permits (issued under USACE's Title 36 shoreline management authority) allow such incidental water withdrawals: Lake Lanier–1,495; West Point Lake–31; Walter F. George Lake–104; Lake George W. Andrews–0; and Lake Seminole–44. Collectively, those minor and intermittent withdrawals are considered to have a negligible effect on the projects and water availability in the system (Day 2010).

SADR 1130-15-1, *Shoreline Management at South Atlantic Division Civil Works Projects*, published on December 1, 2015, placed limits on pumping water from the reservoir under shoreline use permits and real estate licenses. The regulation required that those parties holding existing, or receiving new, shoreline use permits or real estate licenses that allow for a pump to be attached to the facility could not pump or remove water from the reservoirs for use extending beyond the permitted or licensed dock area, including for lawn and garden irrigation and other land-based uses. Separate pump houses currently allowed in an existing real estate license can continue to be used as long as water is not pumped for use beyond the floating facility/dock area. No new separate pump house facilities will be permitted under the regulation. A subsequent South Atlantic Division memorandum (February 25, 2016) temporarily suspended SADR 1130-15-1, effective January 20, 2016, pending further review and provided interim guidance regarding

minor water withdrawals from facilities covered by shoreline use permits or real estate licenses. The review of the regulation is underway.

2.1.1.2.6 Consumptive Water Use and Return Flows

Consumptive use is defined as the part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the environment. Consumptive use is also referred to as *water consumed* (Hutson et al. 2009).

General observations on how much water is consumptively used for various categories of water use in the region (consumptive-use coefficients) are summarized in Fanning and Trent (2009). Consumptive-use coefficients vary for each of the water-use categories. Because public supplies deliver water to domestic, commercial, industrial, and thermoelectric-power users, consumptive use is estimated for those use categories and not for public supply. For domestic water use, consumptive use is estimated at about 18 percent of the total use (Hutson et al. 2009). The consumptive-use coefficient for commercial use was developed by the Georgia Water Use Program and supported by calculations using withdrawal and discharge data for some commercial users, and it is estimated to be 18 percent (Hutson et al. 2009). For industrial and mining use, consumptive-use coefficients were determined by industry type and type of mining activity. For example, in 2005 the consumptive-use coefficient was estimated at 7 percent for the pulp and paper industry and 13 percent for the textile industry. Irrigation and livestock water uses are considered to be 100 percent consumed; that is, all the water withdrawn was evaporated or transpired, incorporated into crops, or consumed by livestock. Crops in the region are irrigated using sprinkler and micro-irrigation methods, which do not have the large nonconsumptive amounts of water of flood irrigation methods. Consumptive-use coefficients for thermoelectric power ranged from zero to nearly 70 percent. The percentage is determined by the type of plant cooling (once-through cooling or cooling towers or ponds). Consumptive use is negligible for in-stream hydroelectric power generation. In 2005, total consumptive use across Georgia was estimated to be about 24 percent of total withdrawals in the state (Hutson et al. 2009).

Table 2.1-21 below depicts the cooling system types and consumptive water use characteristics of the thermoelectric power plants in the ACF Basin. The information in the table was compiled from Blalock (2010, personal communication), DOE Energy Information Administration (2006), Hutson et al. (2009), and USACE, Mobile District (2009). Other than the conversion of Plant McDonough from once-through cooling system to a closed-cycle cooling system in 2008 (as noted in Table 2.1-21), the existing thermoelectric power plants in the ACF Basin have not substantially changed operations with respect to water withdrawals and returns. The water withdrawal and return data from 2009 in Table 2.1-21 (except as noted) is considered to be representative of current withdrawal/return levels (and associated consumptive use) at thermoelectric plants in the ACF Basin.

Surface water that is not *consumed* when used is discharged (returned), with appropriate treatment, to the surface water system, which is generally at or near the point of withdrawal. Return flows from permitted M&I facilities in the ACF Basin are summarized in section 2.1.2.6 (Table 2.1-21). Return flows to other watersheds as interbasin transfers are addressed in section 2.1.1.2.10.1.9.

Table 2.1-21.
Consumptive Water Use at Thermoelectric Power Plants in the ACF Basin

Plant Name	Company	Location	River	Cooling System	Water Quantity (2009) (mgd, average annual)		
					Withdrawn	Returned	Consumed
McDonough	GA Power	Fulton Co, GA	Chattahoochee	Closed cycle[a]	6.4	1.2	5.2
Yates	GA Power	Coweta Co, GA	Chattahoochee	Closed cycle	47.0	36.5	10.5
Wansley	GA Power	Heard Co, GA	Chattahoochee	Closed cycle	59.0	42.0	17.0
Franklin	Southern Power Co.	Lee Co, AL	Chattahoochee	Closed cycle	4.8	0.5	4.3
Farley	Southern Nuclear	Houston Co, AL	Chattahoochee	Closed cycle	91.5[b]	79.2[b]	12.3[b]
Mitchell	GA Power	Dougherty	Flint	Once-through	22.0	22.0	0.0
Scholz[c]	Gulf Power	Jackson Co, FL	Apalachicola	Once-through	94.9[b]	91.8[b]	3.1[b]

Notes:

[a.] Plant McDonough was converted to a closed-cycle cooling system in April 2008 (Blalock 2010, personal communication).

[b.] These figures represent average annual quantities in year 2008.

[c.] Plant Scholz ceased operations and was closed effective April 2015.

In 2010, a Water Metrics Report was developed for the MNGWPD (ARC 2011) that analyzed the net use of water within the district from 2000 through 2009, accounting for all withdrawals and returns of treated wastewater. The percent return of water withdrawals in the MNGWPD was calculated by dividing the total wastewater returns by total water withdrawals within the district and converting to a percentage. Figures for net water use for the overall MNGWPD account for all withdrawals and wastewater returns in the district, including any interbasin transfers of water that may be occurring. For the overall MNGWPD, the *total percent returned* figures provide an accurate approximation of consumptive water use that occurred in the district during those years. In year 2000, the percent of water withdrawals returned to the rivers and streams within the MNGWPD was about 60 percent. Between 2001 and 2008, the percent returned varied between 65 percent and 78 percent. By 2009, the percent of surface water withdrawn within the district for M&I water supply returned to the natural system increased to 82 percent (ARC 2011).

Over the 10-year period analyzed for the MNGWPD in the ARC report, between 75 and 80 percent of the total withdrawals within the district area occurred in the Chattahoochee and Flint River basins. Table 2.1-22 provides data on water withdrawals, wastewater returns, and percent returned for the Chattahoochee and Flint River basins within the MNGWPD area. As presented in this section, net water use does not equate to consumptive use. The net losses to these basins reflected in these percentages include both consumptive use of water in the river basins as well as gains or losses to the basins that occur by way of interbasin transfers of water. Interbasin transfers between river basins in the MNGWPD occur when water withdrawn in one basin for water supply is used, treated, and discharged into an adjacent river basin. Table 2.1-22 simply presents an overall summary of water withdrawals and treated wastewater returns for the Chattahoochee and Flint River basins that occurred in the MNGWPD over the 2000–2009 period.

Table 2.1-22.
Water Withdrawals, Wastewater Returns, and Percent Returned for Chattahoochee and Flint River Basins within the MNGWPD Area from 2000 to 2009

River Basin	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Withdrawals										
Chattahoochee	447.4	433.1	424.4	395.3	415.0	422.2	443.8	432.4	374.1	370.6
Flint	19.1	18.5	20.1	20.2	21.5	20.4	21.0	20.1	17.8	16.0
Returns										
Chattahoochee	248.4	267.8	270.8	293.9	285.4	303.5	283.7	262.2	253.9	292.2
Flint	5.4	5.6	5.7	6.8	8.8	9.27	8.2	7.4	7.1	8.0
Percent Returned										
Chattahoochee	56%	62%	64%	74%	69%	72%	64%	61%	68%	79%
Flint	28%	31%	28%	34%	41%	46%	39%	37%	40%	50%

Source: ARC 2011

In 2000, about 56 percent of all water withdrawn from the Chattahoochee River Basin within the MNGWPD area was returned as treated wastewater. Between 2001 and 2008 in the district, the percent return of water withdrawals from the Chattahoochee Basin ranged between 62 percent and 74 percent. In 2009, the percent return of withdrawals was 79 percent.

About 28 percent of the Flint River Basin withdrawals within the MNGWPD were returned in the year 2000. Between 2001 and 2008, the percent return of water withdrawals from the Flint River Basin in the in the district ranged between 28 percent and 46 percent. In 2009, the percent return of withdrawal was 50 percent.

During the 10-year period covered by in the MNGWPD Water Metrics Report (ARC 2011), water withdrawals within the district from the Chattahoochee River and Flint River basins held relatively steady (actually declined in 2008 and 2009) while the percentage of withdrawals returned to the river basins dramatically increased.

2.1.1.2.7 Interbasin Transfers

Interbasin transfers of water and wastewater occur among municipalities, counties, and basins in the MNGWPD. Transfers among basins are particularly common within counties that straddle the ridges between two or more basins. Interbasin transfers are a key and necessary element in supplying water throughout the district; there are water supply and wastewater transfers into and out of every basin. Table 2.1-23 summarizes the existing water and wastewater interbasin transfers in the MNGWPD (MNGWPD 2009). The large net transfer from the Chattahoochee River Basin to the Ocmulgee River Basin is principally because of water withdrawals and returns in Gwinnett and DeKalb counties. While Lake Lanier (Gwinnett) and the Chattahoochee River (DeKalb) serve as primary water supply sources for the counties, only about one-third of their service areas are in the Chattahoochee River Basin. Consequently, a disproportionate share of the water supply withdrawals from the Chattahoochee River Basin for those counties is discharged into the Ocmulgee River Basin as treated wastewater.

Table 2.1-23.
Summary of Existing Net Interbasin Transfers

Source Basin	Receiving Basin	Net Transfer (aad-mgd)[a] [b]
Chattahoochee	Ocmulgee	100
Chattahoochee	Oconee	7
Coosa	Chattahoochee	14
Flint	Chattahoochee	2
Flint	Ocmulgee	5

Notes:

[a.] Transfers estimated based on 2006 actual withdrawals and discharges (MNGWPD 2009).

[b.] aad-mgd = average annual day-million gallons per day.

2.1.1.2.8 Per Capita Water Use

A popular metric for comparing the average rate of water demand within a service area is per capita use in gallons per capita per day (gpcd). Commonly, per capita water use is defined as the total annual volume of water demand divided by the population served within the service area.

The per capita use metric has limitations, and caution should be used when comparing water systems with different socioeconomic characteristics and in different climates. There are a number of variables that cause legitimate differences in per capita use among communities. Even when reviewing per capita water use changes within one water system, care should be taken to understand temporary fluctuations due to weather, drought restrictions, and economic recession. Reasons for variability in per capita use include climate; commercial and industrial activity; housing type and density; water conservation and drought restrictions; age of structures and the water supply infrastructure; income level; and the cost of water and sewer services (ARC 2011).

USGS water use data for Georgia indicate public water supply per capita use averaged 185 gpd in 2000 (USGS 2004). USGS 2005 data indicate that per capita use in Georgia had declined to an average of 158 gpd (Fanning and Trent 2009). In Alabama, public water supply per capita use averaged 233 gpd in 2000 (USGS 2004) and likewise declined to 199 gpd in 2005 (Hutson et al. 2009). Per capita public water supply use is determined by dividing the total amount of water provided by public suppliers by the total population served. While those are statewide averages, per capita use in the Georgia and Alabama portions of the ACF Basin is likely to be similar. A USGS report estimated that per capita public water supply use in the adjacent ACF Basin in 1990 was about 173 gpd (Marella et al. 1993).

Maddaus and CH2M Hill (2011) summarized per capita water use based upon a national survey of 41 metropolitan water agencies in 22 different states from 2004 and 2007. This period was relatively free of external factors that could significantly affect water use, including abnormal weather, droughts, and unusual economic conditions. Agencies surveyed represented metropolitan areas geographically distributed across the United States. The surveyed communities had a total population of almost 46 million and total water use of over 7.7 billion gpd, yielding an average per capita water use of 174 gpd. Some key statistical results from the survey of the 41 water agencies include the following:

- The lowest per capita use was 104 gpd (Seattle Public Utilities, Seattle, Washington)
- Four agencies had per capita use less than 130 gpd
- Twenty of 41 agencies were in the range of 130 to 170 gpd
- Seventeen agencies had per capita water use of 170 gpd or higher
- The highest per capita water use of the agencies surveyed was 293 gpd (Savannah, Georgia)
- The median per capita water use was 162 gpd and the average was 174 gpd

The MNGWPD, or Metro Water District, was one of the 41 agencies surveyed in Maddaus and CH2M Hill (2011). Background on the MNGWPD and its mission are provided in section 2.1.1.2.10.1.10. The per capita water use for the district in the survey was 128 gpd, which was the fourth lowest number of the 41 surveyed metropolitan water agencies. Per capita water use for other agencies in the study in the Southeast region included the following figures:

- Columbus, Georgia (143 gpd)
- Greenville, South Carolina (150 gpd)
- West Point, Georgia (153 gpd)
- Mobile, Alabama (159 gpd)
- Montgomery, Alabama (162 gpd)
- Birmingham, Alabama (167 gpd)
- LaGrange, Georgia (172 gpd)
- Phenix City, Alabama (173 gpd)
- Tallahassee, Florida (176 gpd)
- Augusta-Richmond County, Georgia (212 gpd)

The ARC developed a water metrics report in 2011 focusing on water use within the MNGWPD (15 counties and 91 municipalities in Metro Atlanta) between 2000 and 2009. The MNGWPD overlaps portions of the Chattahoochee, Flint, Coosa, Tallapoosa, Ocmulgee, and Oconee river basins, but a majority of the district lies in the Chattahoochee and Flint river basins. In 2000 (the year before the MNGWPD was created by the Georgia legislature), the average per capita use across the 15-county area was 147 gpd. By 2003, average per capita use with the MNGWPD had declined to 127 gpd, and it remained relatively steady at that level through 2007. Average per capita use for the MNGWPD for 2008 and 2009 dropped to 104 gpd and 102 gpd, respectively (ARC 2011). Increased water use restrictions and conservation measures associated with the 2007-2008 drought as well as the effect of the economic recession (beginning in 2008) on water use are likely to be primarily responsible for the decline in the 2008 and 2009 numbers, although it is not possible to determine the degree to which each factor might have contributed to the decline.

Single-family residential customers represent a relatively uniform group of water users. A single-family account typically includes one dwelling connected to city water supply through a single water meter. The MNGWPD evaluated available single-family residential water use data between 2007 and 2009. Per capita use for single-family residential customers across the MNGWPD counties generally ranged from about 55–85 gpd in 2007 to a range of about 53–70 gpd in 2009. The less densely populated outlying counties in the MNGWPD tended to have higher per capita use (ARC 2011).

2.1.1.2.9 Critical Yield for Federal Projects in the ACF Basin

Critical yield is defined as the maximum flow rate that can be continuously removed from a reservoir through releases from the dam and/or withdrawals from the reservoir, even during the most severe drought in the period of record, while completely depleting the reservoir conservation storage. *Conservation storage* is the amount of water available in a reservoir to meet project purposes other than flood risk management.

In early 2010, USACE, Mobile District developed updated critical yields for the federal projects in the ACF Basin in response to congressional direction in reports accompanying the Energy and Water Development and Related Agencies Appropriations Act, 2010 H.R. 3183; Public Law 111-85), which includes the following language (USACE Mobile District 2010c):

> Alabama-Coosa-Tallapoosa [ACT], Apalachicola-Chattahoochee-Flint [ACF] Rivers, Alabama, Florida, and Georgia.—The Secretary of the Army, acting through the Chief of Engineers, is directed to provide an updated calculation of the critical yield of all federal projects in the ACF River Basin and an updated calculation of the critical yield of all federal projects in the ACT River Basin within 120 days of enactment of this Act.

In July 2014, USACE, Mobile District updated the ACF critical yield analysis for the purposes of the Master WCM update and the WSSA for Lake Lanier. The following sections provide a summary of the 2014 updated critical yield analysis (USACE, Mobile District 2014). The complete 2014 critical yield update analysis report is included as appendix F.

Federal reservoirs in the ACF Basin that are included in this analysis are Lake Lanier, West Point Lake, and Walter F. George Lake because they hold the majority of water storage on the ACF System. George W. Andrews Lock and Dam (Lake George W. Andrews) and Jim Woodruff Lock and Dam (Lake Seminole) are federal projects on the ACF system that are excluded from the critical yield analysis because these projects are run-of-river impoundments with little or no usable water storage and cannot significantly contribute to critical yield. Similarly, the GPC reservoir projects on the Chattahoochee River have no appreciable storage and, therefore, do not contribute to the yield of the system. In addition, two proposed nonfederal water storage reservoirs, Glades and Bear Creek, have been analyzed for their individual expected yield and potential impact on existing projects. Those projects are described in section 2.1.1.1.6.10.

Critical yield provides the basis from which water stored in a reservoir is allocated to various project purposes. The volume of water stored in a reservoir can be allocated to a specific project purpose (e.g., hydroelectric power generation or water supply) on the basis of a percentage of critical yield. A change in critical yield might result in modification of the allocation of storage for a project purpose.

Critical yield is typically expressed in cfs, but it can also be expressed in other flow rate units, such as mgd or ac-ft per year (ac-ft/yr). The conversions between the various rates are 1 cfs = 0.6464 mgd = 722.7 ac-ft/yr.

2.1.1.2.9.1 Unimpaired Flow Data Set

The unimpaired flow data set is historically observed flows, adjusted for some of the human influence within river basins. Man-made changes in river basins influence water flow characteristics and are reflected in measured flow records. Determining critical yield requires removing from the observed flow measurements any identifiable and quantifiable man-made changes, such as M&I water withdrawals and returns, agricultural water use, and increased evaporation and runoff due to the construction of federal surface water reservoirs.

These quantities are used to extrapolate diversions, defined as the difference between water withdrawn and water returned to the system. A *diversion* is a net volume or quantity assumed to be permanently lost from the water system. The unimpaired flow data set is not a perfectly replicated flow data set representing conditions that would exist without the influence of human activities or a precise measure of natural flow conditions. Not all human influences, such as land use changes, can be accounted for, and many flow set adjustments are estimates based on assumptions, not direct measurements of the human influences. The unimpaired flow data set for the ACF Basin in the updated 2014 analysis includes data for the period from 1939 through 2012.

2.1.1.2.9.2 Droughts

Several drought periods were identified from the historic record and from previous yield analyses. Critical drought periods analyzed for the 2014 critical yield update included 1939–1943, 1954–1958, 1984–1989, 1998–2003, and 2006–2008. The critical yield was computed for each drought period, and the lowest value was selected as the critical yield for the 2014 update report.

2.1.1.2.9.3 Diversions

For purposes of the critical yield analysis, ACF diversions include municipal, industrial, and agricultural withdrawals and returns from the Chattahoochee River and its tributaries upstream of Lake Lanier, West Point Lake, and Walter F. George Lake. Critical yield calculations were made without diversions and with diversions, so that the impact of river withdrawals on critical yield could be determined. The maximum net river withdrawals occurred in 2007, and they are reflected in the critical yield calculation for each drought period.

2.1.1.2.9.4 Models

The USACE HEC-ResSim model, run on a daily time step, was used to simulate reservoir operations. The HEC-ResSim model has a Firm Yield subroutine that calculates the largest continuous release that can be reliably supplied during the flow record. The HEC-ResSim ACF yield models include a net precipitation-evaporation rate for each reservoir. These rates are based on evaporation values developed for NOAA Technical Reports, monthly pan evaporation rates, and NWS rainfall reports. The net evaporation losses (evaporation minus precipitation) were computed in inches at the projects. The NOAA values were used because historical monthly evaporation data are not available at the projects. Historical monthly precipitation data were obtained from the NWS.

The most severe drought event at one reservoir might not be the most severe drought event at another reservoir in the same river system. These methods use the most severe drought events documented during the hydrologic period of record (1939–2012). For the purposes of computing critical yield on the ACF system, the lowest critical yield value (typically associated with the most severe drought event) at an upstream reservoir was used to calculate a downstream reservoir's critical yield. In the ACF Basin, the amount of water exiting an upstream reservoir influences the amount of water available in a downstream reservoir. This consideration applies to critical yield computations for each reservoir by both Methods A and B.

Method A (Without Diversions). Method A assumes that there are no withdrawals from or returns to the reservoir and no withdrawals from or returns to the river as it flows between projects. This condition results in the maximum yield possible from the federal projects. Critical yield from an upstream reservoir was assumed to be permanently removed from the system and does not contribute to the inflow at downstream reservoirs. Method A is depicted in Figure 2.1-41.

Method B (With Diversions). Method B assumes that net diversions (river withdrawals minus returns) are occurring. This method does not include withdrawals from the federal reservoirs. Critical yield from an upstream reservoir is assumed to be permanently diverted from the system and does not contribute to the inflow at downstream reservoirs. These conditions result in the most severe downstream impact. The results of Method B represent a conservative assessment of the critical yield available from federal projects managed by USACE. Method B used the most severe drought events documented during the period of record and the year of maximum net diversions in the ACF Basin (2007) to make the calculations. Method B is depicted in Figure 2.1-42.

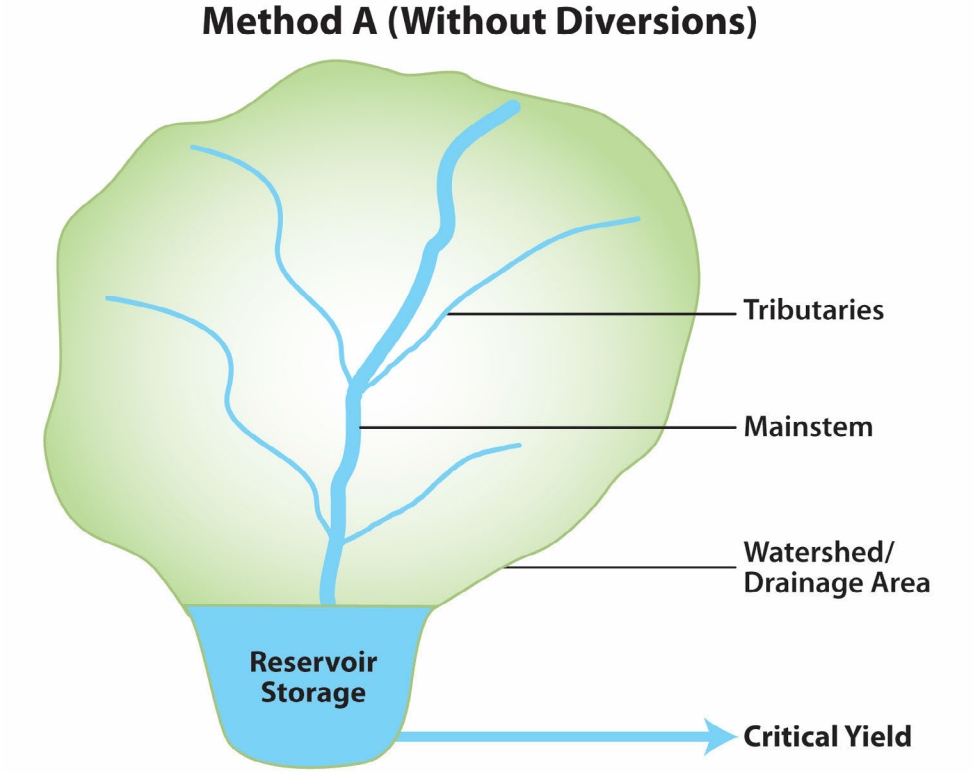


Figure 2.1-41. Critical Yield Method A.

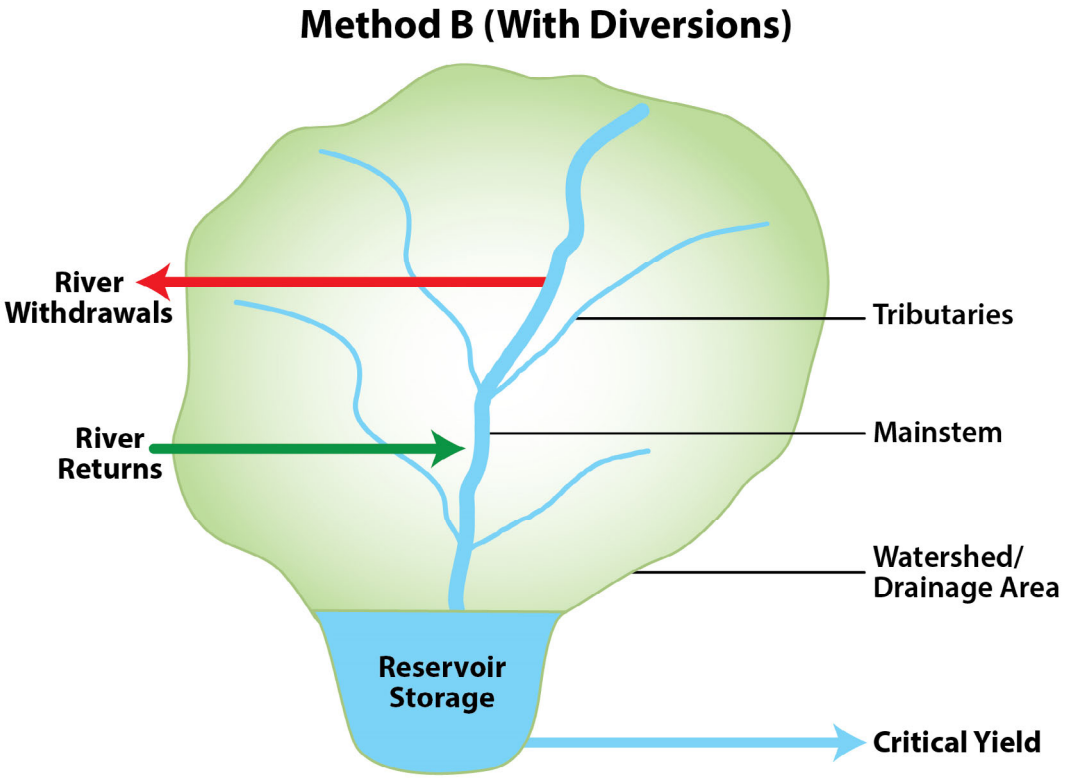


Figure 2.1-42. Critical Yield Method B.

In addition to determining the critical yield from each reservoir, a *system* yield for diversion from the most downstream storage reservoir has been determined. For purposes of the 2014 critical yield update, the analysis was called *Method C (System Critical Yield)*.

Method C (System Critical Yield). Method C assumes upstream reservoirs operate in tandem to maximize the critical yield at the most downstream reservoir. Method C computes critical yield for the ACF River System, with and without net diversions. Figure 2.1-43 depicts Method C, both with and without net river withdrawals. The *with net river diversions* results represent the yield of the system essentially as USACE operates. The *without net river diversions* results represent the system's theoretical maximum yield. Method C calculates the theoretical critical yield that might be observed if the upstream projects were operated solely to maximize yield at Walter F. George Lake. In reality, these results could not be achieved because USACE must operate in a balanced manner to achieve all authorized project purposes.

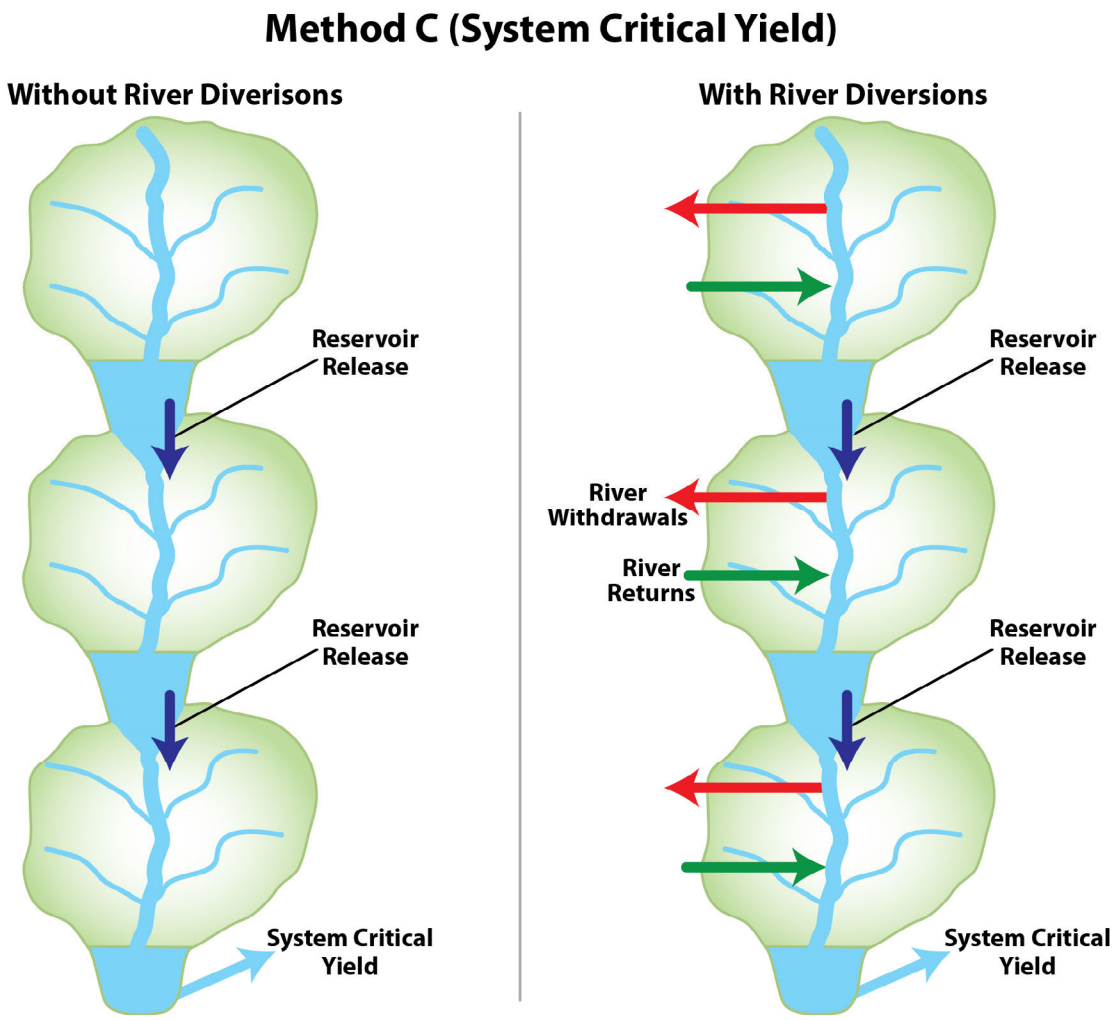


Figure 2.1-43. Critical Yield Method C.

2.1.1.2.9.5 Critical Yield Modeling Assumptions

The following assumptions were used in computing the 2010 critical yield update for the ACF Basin:

- The analysis did not consider the probability of the occurrence of drought(s) more severe than those in the period of record.
- The simulation model was operated only for critical yield. The only other operating purpose included was flood risk reduction. The critical yield represents the maximum flow that could be continuously provided to meet any, or all, demands (e.g., project purposes).
- The upstream reservoir is the primary reservoir, and its yield is met (maximized) before proceeding downstream. Upstream users can consumptively divert water, precluding the availability of water yield to a downstream user. Maximizing the yield of the upstream reservoir is consistent with current state-issued water withdrawal permits. This is a significant assumption for the ACF Basin because the federal projects are operated in tandem.
- Yield analysis is based on authorized conservation storage elevations.
- Projects are full at the beginning of the drought period simulation. The pool level at the beginning of a drought simulation is important because it is a variable that directly affects the quantity or volume of water available as critical yield.
- Under model methods A and B, none of the critical yield is returned to the system. Critical yield is permanently diverted from the system and assumed to be consumptively used. This methodology determines the conservative individual project yield. The assumption is not applicable to Method C.
- The existing area capacity curves shown in the current WCMs were used for all reservoirs in the critical yield analysis except for Lake Lanier. In 2011, a Sedimentation and Erosion Analysis for Lake Lanier was completed and a new area capacity curve was recommended (Tetra Tech 2011b). This new curve was used in the critical yield analysis model.

2.1.1.2.9.6 Critical Yield Analyses Results

Table 2.1-24 and Table 2.1-25 present the critical yield of each federal reservoir in the ACF Basin and the critical drought period used in the calculations.

Table 2.1-24.
Method A: ACF Basin Federal Project Yield (without Diversions)

Project	Critical Yield (cfs)	Critical Drought Period
Buford Dam	1,452	1984–1989
West Point Dam	809	2006–2008
Walter F. George Lock & Dam	575	2006–2008

Table 2.1-25.
Method B: ACF Basin Federal Project Yield (with Diversions)

Project	Critical Yield (cfs)	Critical Drought Period	Critical Yield Change Attributable To Diversions
Buford Dam	1,393	1984–1989	-4.5%
West Point Dam	960	2006–2008	18%
Walter F. George Lock & Dam	477	2006–2008	-17%

Table 2.1-25 also summarizes the change in the critical yield values at these projects that would be attributable to diversions. The 2007 net river diversion had a measurable impact, decreasing yield at Buford Dam and Walter F. George Lock and Dam, but increasing critical yield at West Point Dam. The yield at Buford Dam was reduced due to operations that ensure flow for downstream river withdrawals. However, a large portion of these diversions are returned to the river upstream of West Point Dam. As a result, the critical yield at West Point Dam with upstream river diversions would be 18 percent greater than the yield when there are no diversions.

The critical yields of the proposed Glades and Bear Creek reservoirs in this USACE analysis were determined to be 72 cfs (or 46.5 mgd) and 16 cfs (or 10.3 mgd), respectively. As pointed out in comments by the SFMRWSA on the draft EIS, the yield for Bear Creek reservoir in the USACE analysis is somewhat different than that presented in the SFMRWSA yield analysis and permit application documentation (16.44 mgd). Operations for Glades Reservoir would be expected to reduce the critical yield at Buford Dam by 4.6 percent. Operations for Glades and Bear Creek reservoirs would be expected to have little impact on the critical yield at West Point Dam, reducing the value by 0.34 percent.

Table 2.1-26 presents the critical yield (System Critical Yield) results based on operating the three ACF reservoirs together for a system yield at Walter F. George (Method C). When all reservoirs are operated for yield optimization at Walter F. George, the resulting yield is greater than the sum of the individual reservoir yields. Method C (River System Yield) was computed with and without river diversions. The 2007 net river diversions reduce the critical yield at Walter F. George Lock and Dam by 3.9 percent. With Glades and Bear Creek reservoirs, the critical yield reduction with 2007 river diversions at Walter F. George Lock and Dam would be 5.6 percent.

Table 2.1-26.
Method C: ACF (System Critical Yield)

Project	Critical Yield (cfs)	Critical Drought Period
ACF (without diversions)	4,110	2006–2008
ACF (with diversions)	3,948	2006–2008
ACF with Glades and Bear Creek (with diversions)	3,881	2006–2008

The critical yield calculations for Method B (with diversions) represent a realistic assessment of the critical yield from federal projects in the ACF Basin. More detail on the 2014 critical yield analysis and results is available in appendix F.

2.1.1.2.10 Summary of Water Planning, Management, and Conservation Activities Pursued by State, Regional, and Local Interests

This section provides a general overview of water resource planning, management, and conservation activities by state, regional, and local interests in Alabama, Florida, and Georgia that have noteworthy implications for water resources in the ACF Basin and the update of the Master Manual. This section is intended to identify and provide a brief summary of the general scope of each relevant program or activity. Appendix G provides a more specific overview on each of these programs or activities. The summary focuses on water quantity related programs in the states. Relevant state water quality management programs are discussed in section 2.1.2. This summary does not include water planning, management, and conservation programs and activities undertaken by individual counties and municipalities within the ACF Basin, unless those efforts are an integral part of one of the state or regional programs discussed below.

2.1.1.2.10.1 Georgia

2.1.1.2.10.1.1 Water Withdrawal Permit Program

Georgia laws—the Georgia Water Quality Control Act (O.C.G.A. 12-5-31) and the Georgia Groundwater Use Act (O.C.G.A. 12-5-90 *et seq.*)—require any water user who withdraws more than 100,000 gpd (monthly average) from surface water or groundwater in the state to obtain a withdrawal permit from the GAEPD. Permit holders generally must report their withdrawals by month. The law does not transfer to the permit recipient any property right to the water or water permit beyond the right to reasonable use of the water. The Georgia Water-Use Program collects the reported information under the withdrawal permit system and the drinking-water permit system and stores the data in the Georgia Water-Use Data System.

Before issuing a permit, GAEPD evaluates the reasonableness of the use by applying the criteria listed in the statute, including the number of persons using the water source; the nature, severity, or duration of any impairment adversely affecting availability for other users; any injury to public health, safety or welfare; the kinds of activities proposed; the importance and necessity of the uses and the extent of any injury caused to other water uses; diversion from or reduction in flows in other watercourses or aquifers; prior investment in land; and other relevant factors (O.C.G.A. 12-5-31(e)). M&I permits are issued for a term of 10 to 50 years, after which they must be renewed. Farm use permits are issued for an unlimited term, except in the Flint River Basin, in which farm use permits issued after March 2006 have a term limit of 25 yr. M&I permits are issued for a specific quantity determined by reasonable use. Farm permits issued after 1991 also have defined quantities. Farm permits issued before 1991 are based on pump capacity as of July 1, 1988. The GAEPD can revoke M&I permits for extended periods of nonuse. Farm permits cannot be revoked after an initial use unless water was never withdrawn.

2.1.1.2.10.1.2 State Drought Management Plan

The 1998–2002 drought raised awareness in Georgia regarding drought impacts and interest in drought planning and management. The first *Georgia Drought Management Plan* was adopted by the GADNR Board in March 2003 (GAEPD 2003a). The plan was developed using a collaborative approach involving stakeholders with interest and/or expertise in water-related matters. These stakeholders represented a geographical and political cross section of the state, as well as a cross section of business, industry, environmental, and water management interests. The Georgia General Assembly and the GADNR Board have assigned the director of the GAEPD principal responsibilities for implementing the drought management plan. Numerous agencies and organizations are tasked in this plan with some level of water resource or water-related management responsibilities. The GAEPD and those agencies and organizations must coordinate closely and share information about their drought or water conservation concerns and solutions. The plan contains an array of predrought strategies, primarily oriented around water

conservation as well as coordinated drought response protocols as drought conditions are encountered and persist.

In 2014, the Georgia EPD Watershed Protection Branch began a process that included stakeholder meetings to discuss the possible future rule changes. The purpose of the process is to consider possible development of a drought management rule that would replace the current Rules for Outdoor Water Use (391-3-30) and the 2003 *Georgia Drought Management Plan* (GAEPD 2016).

2.1.1.2.10.1.3 Flint River Basin Regional Water Development and Conservation Plan

The GAEPD initiated the *Flint River Regional Water Development and Conservation Plan* in October 1999 in response to growing concern over agricultural irrigation in southwest Georgia. Computer models of stream-aquifer relationships and surface water flows indicated that, under conditions of extreme drought and greatly increased irrigation, the Flint River and some of its tributaries could virtually stop flowing. The plan included a moratorium on the issuance of new farm use permits for the Floridan aquifer in southwest Georgia; however, it also called for extensive scientific study of stream-aquifer relations and agricultural water use, and the creation of an advisory committee to assist the GAEPD in crafting the plan (McDowell 2005).

The planning process was completed in 2006. The goals of the plan, as defined by statute, are to promote conservation and reuse of water, guard against a shortage of water, promote the efficient use of water resources, and manage the water resources of the Flint River Basin so they are sustainable and consistent with the public welfare. The moratorium on new farm-use permits was lifted, but applications are closely evaluated to meet the requirements of the plan. Permitting decisions are based on the requested amount of water, the connections between groundwater and surface water as determined by computer models, the impact of water withdrawals on streamflows, and the presence of endangered or threatened species (GAEPD 2006).

2.1.1.2.10.1.4 Georgia Environmental Finance Authority Reservoir Study

In response to one of its mandates under the Georgia WSA of 2008 (O.C.G.A. 12-5-470), the GEFA conducted an inventory and survey of feasible sites for multijurisdictional drinking water supply reservoirs in Georgia. The effort also considered reservoirs under development or specifically proposed, existing reservoirs with potential expansion volumes, and possible reservoir locations extracted from prior studies. The report was intended to provide information and preliminary analysis to support decisions by local governments and regional planning councils on how best to augment local water supply. The report is summarized in the following paragraphs (GEFA 2008). The study should complement the analyses conducted under the Statewide Water Management Plan (SWP).

The analysis focused on the 78-county area in Georgia above the Fall Line because the need for drinking water supply reservoirs in Georgia is sharply divided by geology at the Fall Line. Below the Fall Line (81 counties), groundwater aquifers are the principal source of public water supply and large underground aquifers function as their own natural water supply storage reservoirs. Above the Fall Line, surface water is the principal source of public water supply and man-made reservoirs are essential for water supply storage.

The study acknowledged that reservoirs are only one tool that can be used to increase water supply. Of all options, reservoirs are the most costly, environmentally sensitive, and time-consuming. The study recommended that first consideration should be given to water conservation and efficiency measures and communities should also examine interconnectivity to other systems, as well as the potential for drilling wells.

2.1.1.2.10.1.5 Georgia Statewide Water Management Plan

The 2004 Comprehensive Statewide Water Management Planning Act authorized the development of the SWP. The act established the following goal: "Georgia manages water resources in a sustainable manner to support the state's economy, to protect public health and natural systems, and to enhance the quality of life for all citizens." The GAEPD was charged with developing a draft of the plan, with oversight by the Water Council. Created by the act, the Water Council is a coordinating committee composed of the heads of eight state agencies with water-related responsibilities, four legislators, and two citizen members (GAEPD 2008a). Between January 2006 and July 2007, GAEPD used an intensive public involvement process to develop the draft plan. As required by the act, the draft plan was submitted to the Water Council by July 1, 2008. Drawing on additional public review and comment, the Water Council revised the plan and submitted it to the Georgia General Assembly in January 2009. By the end of February 2009, the plan had been adopted by the General Assembly and signed by the Governor (Cowie and Davis 2009).

The SWP has three major components designed to address the goal for water management in Georgia: 1) resource assessments and forecasting of needs, 2) toolbox of water management practices, and 3) framework for regional water planning.

The SWP makes provisions to conduct resource assessments and generate long-range forecasts. The resource assessments focus on water quantity and water quality. The water quantity resource assessment addresses the amount of water that is available to withdraw for beneficial use, while still supporting the ability of downstream users or users from the same aquifer to benefit from that water resource. The water quality resource assessment addresses, from a watershed perspective, the wastewater treatment levels that are required to protect water quality. In addition, statewide and regional population and economic forecasts are translated in a consistent manner into water and wastewater demand forecasts over a 50-yr planning horizon (Cowie and Davis 2009).

The SWP explicitly recognizes that regional variation means that different sets of water management practices will be better suited to different parts of the state. The *toolbox* of water management practices includes demand management practices; water return practices such as onsite sewage management (septic systems) and centralized wastewater treatment; and water supply management practices such as surface water storage, interbasin and intrabasin transfers, and aquifer storage and recovery. Water conservation is highlighted as a priority practice for use across the state by all water use sectors. Water quality management practices, including stormwater and nonpoint source pollution management, are also part of the toolbox (Cowie and Davis 2009).

The SWP provides a framework for regional water planning. Through regional water planning, water management practices will be selected and defined for implementation. Ten regional water planning councils have been formed to prepare recommended water development and conservation plans (WDCPs). Each council consists of 25 members that represent the water users and the water-related interests in each region, and members are appointed by the Governor, Lieutenant Governor, and Speaker of the House. WDCPs characterize the water needs for each region as those needs relate to the needs of adjacent regions and the preferred water management practices to use in each region to close any gaps between water capacities and water needs. The councils use the resource assessments and forecasts to develop the recommended WDCPs. Recommended plans were submitted to the GAEPD for review, revision if needed, and ultimately adoption by the GAEPD director. Under the 2004 act, water withdrawal permits and state loans for infrastructure projects must be consistent with the regional plans (Cowie and Davis 2009).

Resource assessments and the forecasts of water and wastewater needs were developed in 2010. Preparation of the WDCPs was fully underway in 2010. The first set of WDCPs was adopted in 2011. The 2004 act calls for review of the SWP every 3 yr to determine whether revisions are necessary. The

regional WDCPs are to be reviewed and revised, as necessary, on a 3- to 5-yr cycle (Cowie and Davis 2009).

2.1.1.2.10.1.6 Georgia Water Conservation Implementation Plan

In March 2010, the GAEPD published a comprehensive *Water Conservation Implementation Plan* (WCIP) designed to create a culture of conservation in the state and to guide Georgians toward more efficient use of the state's finite water resources (GADNR 2010). The WCIP is a product of the ongoing Georgia SWP process. The plan provides a multipronged strategy to achieve more efficient and sustainable water use through conservation (defined as beneficial reduction in water use, water waste, and water loss) and measures to promote more efficient use of water (maximizing benefit from each gallon used). The plan was developed in conjunction with representatives of state agencies, local governments, and a wide range of stakeholder interests.

The WCIP provides specific goals and benchmarks for Georgia's seven major water use sectors: agricultural irrigation, power generation, golf courses, industrial and commercial, landscapes, domestic and nonindustrial public uses, and state agencies. For each sector, the WCIP details water conservation goals, benchmarks, best practices, and implementation actions designed to reduce water waste, water loss, and, where necessary, water use.

The WCIP is used to guide decisions related to water use and water management by:

- Educating water users about water conservation practices and the goals they can accomplish
- Informing regional water plan preparation, which will be overseen by regional water planning councils
- Helping water use sectors collectively improve water use efficiency
- Informing GADNR rule-making regarding water conservation requirements in permitting

Conserve Water Georgia is a water conservation clearinghouse of the GAEPD (GADNR 2009). The focus of the clearinghouse is public information, education, and awareness. The site provides tips and tools on conservation and water efficiency strategies for individuals, teachers and students, business and industry, and communities and local governments.

2.1.1.2.10.1.7 Governor's Water Contingency Planning Task Force (2009)

In response to the July 17, 2009, Federal District Court ruling that water supply was not an authorized purpose of Buford Dam/Lake Lanier, the ability to continue water supply withdrawals from the reservoir or conduct dam operations to meet downstream needs for Metro Atlanta was severely limited. The Governor of Georgia outlined a 4-part strategy. The strategy consisted of 1) appealing the ruling in court, 2) negotiating a mutually agreeable water allocation formula with Alabama and Florida, 3) pursuing congressional reauthorization of Lake Lanier for water supply, and 4) developing a contingency plan to be implemented if the District Court ruling were to take effect. The Water Contingency Planning Task Force was created to evaluate the various options for a contingency plan and make recommendations to the Governor. The task force included several dozen leaders from business, government, and environmental organizations (GWCTF 2009).

The Task Force had two key objectives: 1) to develop a fact base to educate business and community leaders on Georgia's water situation and the implications of the District Court ruling and 2) to define a time-driven action plan that prioritized specific options and recommendations for conservation, supply enhancement, and water policy to address the potential shortfall.

Upon completing its evaluation, the task force concluded that Lake Lanier would be the best and most cost-effective water supply source for Metro Atlanta. It further concluded that the recommended contingency options, if required, would impose significant incremental economic costs and environmental impact on the region.

The task force was not optimistic about the ability of the region to meet the potential water shortfall in 2012, when the District Court ruling would take effect, even with extremely aggressive mandated conservation. Within this time frame, no new supply options could offer significant yield. By 2015, there was a potential contingency solution, consisting primarily of an indirect potable reuse project, along with a set of conservation measures and isolated groundwater options. The 2015 solution would, however, require significant up-front capital. By 2020, a broader set of more cost-effective options would exist because reservoirs and transfers could be implemented. In that regard, the task force recommended a 2020 contingency solution that would consider cost efficiency, environmental impact, and implementation feasibility criteria.

Although the supply options for 2015 and 2020 were identified as contingencies, the task force recommended that enhanced conservation, implemented through incentive-based programs, should be pursued regardless of the outcome of Lake Lanier reauthorization. This program of enhanced conservation was the basis for a set of task force recommendations on options to implement immediately, along with a supporting set of policy considerations, which are detailed in the task force report. There were three broad areas of additional conservation improvements that built on Metro Atlanta's ongoing conservation progress, as reflected in the following recommended policies:

- Institute mandatory data collection and reporting of key metrics to inform future planning efforts. For instance, utilities would have to conduct standardized water loss audits.
- Adopt higher water efficiency standards and incentive measures to increase conservation effectiveness (e.g., increasing incentives for fixture and soil meter retrofits).
- Link progress on conservation efforts to funding eligibility, low-interest loan qualifications, and permitting applications to ensure implementation of measures.

In June 2011, the 11th Circuit Court of Appeals overturned the 2009 District Court ruling and confirmed that water supply was an authorized project purpose of Lake Lanier. Thus, the recommendations by the Governor's task force did not have to be implemented as an accelerated contingency plan to address severe short-term water supply deficits. Nonetheless, much of the information developed by the task force has been utilized by state and local interests in subsequent water supply planning and management activities.

2.1.1.2.10.1.8 Georgia Water Stewardship Act of 2010 (HB-370)

In light of recent severe water resource management challenges in Georgia (e.g., frequent droughts, rapid growth, and an unfavorable court ruling that could bar most water withdrawals from Lake Lanier), the General Assembly enacted the Georgia Water Stewardship Act in the 2010 legislative session. On the basis of recommendations from the 2009 Governor's Water Contingency Task Force, the legislation initiated a process for developing alternative supply sources while also reaffirming "the imminent need to create a culture of water conservation in Georgia."

Key provisions of the Water Stewardship Act include the following:

- Requirements for state agencies with water-related programs and responsibilities to review policies and programs encouraging water conservation and enhance water supply
- Mandates for public water systems serving over 3,300 individuals to implement best practices for water efficiency and conservation and to account for and mitigate water loss leaks

- Revisions to state minimum construction standards for new buildings, including use of high-efficiency plumbing fixtures and sub-metering of multi-unit buildings for water use
- Modification of state and local authority to impose outdoor watering restrictions
- Amendments to the permitting system for agricultural water withdrawals
- Creation of a joint legislative committee on water supply to examine opportunities for enhancing the state's water supply

Implementation of these provisions will require significant action by state agencies, local governments, and public water supply utilities over the next several years (UGA 2010).

2.1.1.2.10.1.9 Governor's Water Supply Program

In January 2011, Governor Nathan Deal directed GEFA to develop and launch the GWSP and committed $300 million to the program over 4 years. The purpose of the GWSP is to align and mobilize the resources of the State of Georgia to assist local governments with developing new sources of water supply adequate to meet future water demand forecasts. The financial assistance is available in the form of low interest loans through GEFA and state direct investment through the Georgia Department of Community Affairs (DCA).

Applications for assistance under the GWSP are solicited annually. Through 2013, about $165 million was committed to water supply projects, either in low interest loans or state direct investment. State financial assistance under the GWSP can be used for detailed planning and engineering, land acquisition, construction, and related activities associated with water supply projects.

2.1.1.2.10.1.10 Metropolitan North Georgia Water Planning District

The MNGWPD was created by the Georgia General Assembly in 2001 (O.C.G.A. 12-5-572) to serve as the water planning organization for Metro Atlanta. The district's purpose is to establish policy, create plans, and promote intergovernmental coordination of water issues in the district from a regional perspective.

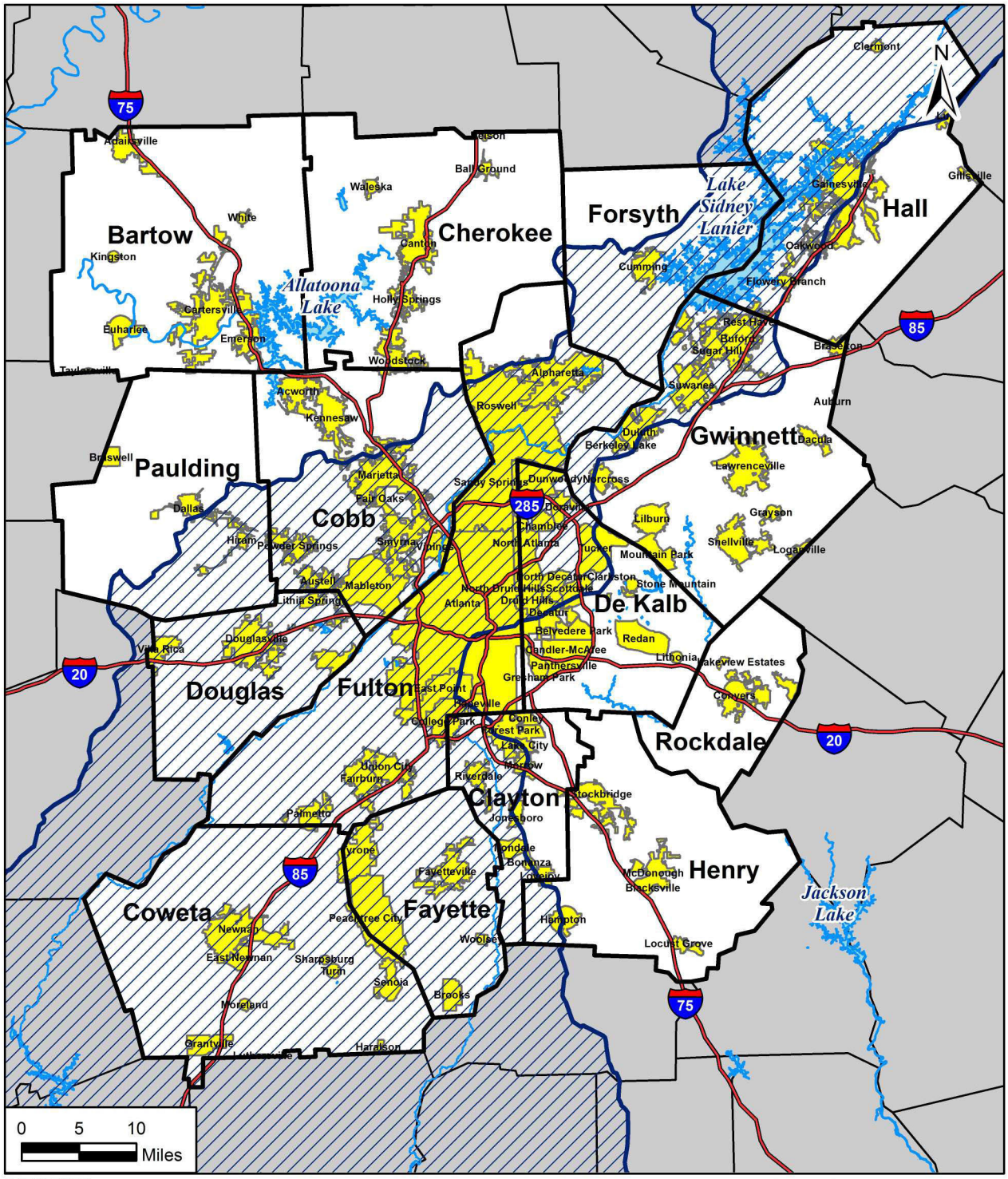
The MNGWPD includes 15 counties (Bartow, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Fulton, Forsyth, Gwinnett, Hall, Henry, Paulding, and Rockdale counties) as well as 92 municipalities partially or fully within these counties (Figure 2.1-44). The district also has seven authorities that provide water, sewer, and/or stormwater services. The district's plans and policies work to protect water resources in the Chattahoochee, Coosa, Flint, Ocmulgee, Oconee, and Tallapoosa river basins. The area represented by the MNGWPD includes much of the Upper Chattahoochee River watershed. It covers a total area of 4,800 sq mi, with approximately 4.8 million residents (MNGWPD 2008).

With the adoption of the SWP by the Georgia General Assembly in 2008, the MNGWPD became one of 10 regional water planning councils in the state. Accordingly, the work of the district will continue within the integrated framework of statewide water resources planning.

The district's enabling legislation mandated the development of three long-term regional plans to address the water resources challenges:

- Water Supply and Water Conservation Management Plan
- Wastewater Management Plan
- Watershed Management Plan

These three plans were developed concurrently, and they represent an integrated and holistic approach to water resources planning and management in MNGWPD (MNGWPD 2008).



LEGEND

- ACF Basin
- Surface Water
- Interstate Highway
- Metro Water District County
- Metro Water District Municipality

Metro North Georgia Water Planning District

Figure 2.1-44

The first plans were completed and adopted in 2003 and have been actively implemented by local jurisdictions. Updates to these plans were completed and published in May 2009 (MNGWPD 2009). The following paragraphs summarize the detailed strategies and recommendations for both effective water supply and water conservation as defined in the 2009 update to the *Water Supply and Water Conservation Management Plan*. The plan includes specific tasks and milestones for implementing these recommendations for local governments as well as regional and state agencies. The plan addresses pertinent water supply and conservation issues, including existing water supplies, water supply interconnections among water providers, interbasin transfers, water conservation programs, future water supply demands and sources, and water reuse. The water resources plans are the result of a collaborative effort between the district's local jurisdictions, the GAEPD, and numerous stakeholders.

Since the publication of the 2009 plan, several conservation-related amendments have been made to the plan in response to state legislation. The plan is currently being updated.

2.1.1.2.10.2 Alabama

2.1.1.2.10.2.1 Alabama Office of Water Resources/Alabama Water Resource Commission

The Alabama Water Resources Act (Act Number 93-44, codified as Code of Alabama 1975, Article 9-10B-1, *et seq*.) legislatively established the OWR, a division of the Alabama Department of Economic and Community Affairs.

The Alabama OWR plans, coordinates, develops, and manages Alabama's water resources (both groundwater and surface water) in a manner that is in the best interest of Alabama. This includes recommending policies and legislation, conducting technical studies, implementing and participating in programs and projects, and actively representing Alabama's intrastate and interstate water resource interests (ALOWR 2010).

The Alabama Water Resources Commission provides oversight to the Alabama OWR and serves in an advisory capacity to the Governor and presiding officers of the Alabama House of Representatives and Senate. The commission consists of 19 voting members selected by the Governor, the Lieutenant Governor, and the Speaker of the House. Members serve 6-yr, staggered terms. The Alabama Water Resources Act requires that commission membership include representatives from each congressional district and each major surface water region of Alabama. In addition to the geographic representation requirements, the membership must also represent a cross section of water user groups, including rural and urban public water systems, nonpublic (e.g., industrial, manufacturing) commercial navigation, conservation, and the environment or water-based recreation interests within Alabama (ALOWR 2010).

2.1.1.2.10.2.2 Alabama Drought Management Plan

Alabama has developed a *Drought Management Plan (Final)* dated May 22, 2013 (ALOWR 2013). The plan is administered and coordinated by the Alabama OWR, working closely with numerous local, state, and federal agencies and other water resources professionals to pursue a statewide approach to drought planning and management. The purpose of the plan is to minimize the impact of drought, to develop action plans to be used during a drought, and to reduce the risk of drought disasters. The plan outlines both long- and short-term measures to be used to mitigate the effects of drought and to respond to drought conditions. To accomplish these goals, the plan 1) defines a process to address drought and drought-related activities, such as monitoring, vulnerability assessment, mitigation, impact assessment, and response; 2) identifies long- and short-term activities that can be implemented to reduce and prevent drought impacts; 3) identifies local, state, federal, and private-sector entities that are involved with state drought management and defines their responsibilities; and 4) acts as a catalyst for the creation and implementation of local drought response efforts.

The plan creates a statewide regional structure to identify the different areas affected by drought conditions; risks associated with drought conditions; ways to possibly avoid droughts; and, when drought emergencies cannot be avoided, ways to mitigate the impacts of droughts. These objectives are accomplished by developing drought triggers and indicators and by providing guidance on responses to drought conditions for the various sectors affected by droughts.

In the plan, the Alabama Drought Assessment and Planning Team (ADAPT) has been established to serve in an advisory capacity to Alabama OWR and the Governor's Office, as needed, and to coordinate intergovernmental drought response and management in the implementation of all drought-related activities. ADAPT is composed of members from several Alabama agencies, the U.S. Department of Agriculture (USDA), the chairman of the Monitoring Advisory Committee, and the chairman of the Drought Impact Group (DIG). The Monitoring Advisory Committee provides technical support to ADAPT and is composed of representatives from federal, state, and local agencies and other water resources professionals. The DIG provides drought impact and mitigation support to ADAPT, is responsible for identifying drought impacts on water users, and is representative of the following five drought impact sectors: domestic, agricultural, environmental, industrial, and recreational.

The state is divided into nine specific regions, and drought indicators have been determined for each region. When the drought indicators begin to show the potential onset of drought conditions, the Alabama OWR, in coordination with ADAPT and the Monitoring Advisory Committee, declares appropriate drought stage determinations with increasing levels of severity (i.e., advisory, watch, warning, and emergency) as the drought deepens. Upon the inception of a new or increased drought alert phase, the ADAPT is responsible for disseminating public information concerning all aspects of the drought. The initial action in responding to drought must be public education—providing information as to existing and potential conditions and water conservation measures necessary to meet the demand presented at each drought watch phase.

Drought triggers do not automatically invoke a required response from the various categories of water users. The triggers do prompt additional monitoring and notices to the water systems and public regarding the ongoing drought conditions. The Alabama OWR, in coordination with ADAPT, notifies the local governments and water utilities regarding the severity of the drought, makes recommendations, and provides guidance on the appropriate actions to be taken during the four stages of drought.

2.1.1.2.10.2.3 Alabama Water Use Reporting Program

The Alabama OWR is mandated to administer Alabama's Water Use Reporting Program. This program requires that major nonpublic and irrigation water users that have the capacity to withdraw at least 100,000 gpd of surface water and/or groundwater, as well as all public water systems, register their use with the Alabama OWR and obtain a certificate of use. Users are not required to obtain water withdrawal permits (ALOWR 2010).

2.1.1.2.10.2.4 Water Conservation Program

In addition to the *Alabama Drought Management Plan*, which specifically supports conservation efforts during periods of drought, the state actively encourages voluntary water conservation/water efficiency initiatives on the Alabama OWR website (ALOWR 2010). The website promotes and maintains conservation tips on indoor and outdoor water use. The tips include links to assist 1) residential customers to investigate water-saving opportunities in each area of the home; 2) agricultural interests to consider adapting conservation practices that are used on agricultural land across the country to conserve and improve natural resources for use on their land; and 3) municipal water planners with step-by-step approaches and conservation measures that can be used to develop and implement plans for water conservation. The website also provides a sample water conservation ordinance for use by municipal and county government officials.

2.1.1.2.10.2.5 Alabama Water Agencies Working Group

In August 2011, Governor Bentley called together four agencies of state government with water resource responsibilities to develop an overview of water issues and activities. The four agencies were Alabama DCA, Office of Water Resources (ALOWR); Alabama Department of Conservation and Natural Resources; Alabama Department of Environmental Management (ADEM); and the Geological Survey of Alabama (GSA). In April 2012, the Governor formalized the Alabama Water Agencies Working Group (AWAWG). Soon thereafter, a fifth agency, the Alabama Department of Agriculture and Industries, was added to the AWAWG.

Governor Bentley directed the AWAWG to recommend an action plan and timeline for implementing a SWP by December 1, 2013. As part of the action plan process, AWAWG was tasked to establish a comprehensive database of Alabama's water resources and conduct meetings to gather input from stakeholders interested in water resource issues. The work of the AWAWG is coordinated by a chairman appointed by the Governor. Six subcommittees were created to help carry out the group's responsibilities and provide focus on the following specific topics: legal; database; stakeholders; legislation; reporting; and public information.

AWAWG prepared and submitted an interim report to the Governor on August 1, 2012, titled *Water Management Issues in Alabama* (AWAWG 2012). The report identified and summarized a dozen key water issues for the state and associated policy options. AWAWG reaffirmed the need for a SWP so that Alabama can address these issues responsibly and effectively. The August 2012 report provided a common base of information to assist various water agencies and others interested in water resource matters to take the first steps toward resolving policy issues and creating a comprehensive water management plan for Alabama.

The December 2013 report responding to the Governor's directive summarized actions taken by AWAWG through the August 2012 *Water Management Issues in Alabama* report and subsequent steps to develop and recommend a conceptual framework for a comprehensive statewide water resource management plan. The recommendations were developed with substantial stakeholder participation. The conceptual framework included a vision statement, guiding principles, and an action plan addressing the 12 water resource issue areas identified in the August 2012 report. Recommended actions to implement a SWP included the following considerations: identification of responsible agencies; estimated costs; relative priorities; and proposed timelines for implementation (AWAWG 2013).

2.1.1.2.10.3 Florida

2.1.1.2.10.3.1 Florida Water Plan

The *Florida Water Plan* is the Florida DEP's principal planning tool for long-term protection of the state's water resources (FLDEP 2001). It was developed pursuant to section 373.036, Florida Statutes (F.S.), which requires that it specifically include:

- The programs and activities of the Department related to water supply, water quality, natural systems, flood protection, and floodplain management
- The water quality standards of the Department
- The District Water Management Plans ([DWMPs] including regional water supply plans) of the five regional water management districts
- The Water Resource Implementation Rule (Ch. 62-40, Florida Administrative Code)

Florida has a system of five regional water management districts under the general supervision of the Florida DEP. Together, Florida DEP and the water management districts share a broad range of responsibilities related to water supply, flood protection and floodplain management, water quality, and protection of natural systems. This system strikes a balance between the need for statewide consistency and the need for regional flexibility. Figure 2.1-45 is a graphic representation of this system.



Figure 2.1-45. Florida Water Management Plan.

The plan is intended to help Florida DEP, especially the Division of Water and the six Florida DEP regulatory districts, to focus on the highest water resource protection priorities, organize its own water management responsibilities, and build water management partnerships. It identifies significant water resource management priorities facing the state and sets forth strategies and actions for addressing them. Specifically, the plan:

- Identifies what the Florida DEP regards as the priority water issues
- States the Florida DEP's main strategies for addressing the priority issues
- Focuses on accountability and performance measures
- Emphasizes the use of watershed management to achieve the Florida DEP's water resource protection goals and aids in the statewide development and coordination of the watershed management approach
- Emphasizes the best use of current information technology to set priorities, assess effectiveness, and improve public access to data pertaining to protection activities identified in the plan
- Seeks to strengthen partnerships with the water management districts and other parties

Each year the Florida DEP reports on the progress of the specific action steps provided in the Florida Water Plan, as well as other performance measures found in the plan. Typically the performance measures evaluate environmental health or track the accomplishment of specific tasks.

2.1.1.2.10.3.2 Water Conservation

In 2001, during one of the worst droughts in Florida's history, the Florida DEP began an initiative to identify additional measures to increase water use efficiency. The initiative was an open process in which the Florida DEP, in close coordination with the state's five water management districts, facilitated public meetings to develop specific water conservation recommendations. The final report (April 2002) contained 51 priority recommendations for improving water use efficiency and led to a *Joint Statement of Commitment for the Development and Implementation of a Statewide Comprehensive Water Conservation Program for Public Water Supply* (JSOC). The JSOC is a written agreement by key public water supply partners in Florida to collaborate on measures to improve water use efficiency.

Subsequent to the signing of the JSOC, and based on it, the 2004 regular session of the Florida Legislature enacted House Bill 293. Among other things, the bill creates a new section 373.227, F.S., encouraging the use of efficient, effective, and affordable water conservation measures, and it states that a goal-based, accountable, tailored water conservation program should be emphasized for public water supply utilities (FLDEP 2004).

In the legislation, the Florida DEP was directed to "develop a comprehensive statewide water conservation program for public water supply." That is to be done "in cooperation with the water management districts and other stakeholders." The legislative action affirmed the collaborative approach used in the JSOC. The legislation was enacted to support and provide guidance to the general direction that the JSOC signatories had already embarked upon. In addition to paraphrasing portions of the JSOC and authorizing the Florida DEP and the water management districts to adopt rules needed to carry out the intended purpose, the legislation required that a written report be submitted to the Florida Legislature by December 1, 2005 (FLDEP 2004).

On the basis of the principles of the JSOC, the signatories developed a work plan (completed in December 2004). The work plan details the specific tasks, interim milestones, completion dates, estimated costs and potential funding sources, and assignment of responsibilities to 1) develop standardized definitions and performance measures for water conservation data collection and analysis; 2) establish a clearinghouse for water conservation programs and practices; 3) develop and implement a standardized process for public supply utilities to participate in the statewide water conservation program for public supply; 4) develop and maintain a Florida-specific water conservation guidance document to assist public water suppliers in designing and implementing a utility-specific water conservation program; and 5) implement pilot projects through cooperative agreements with volunteer utilities. These water conservation programs are principally implemented by the five water management districts.

2.1.1.2.10.3.3 Conserve Florida Water Clearinghouse

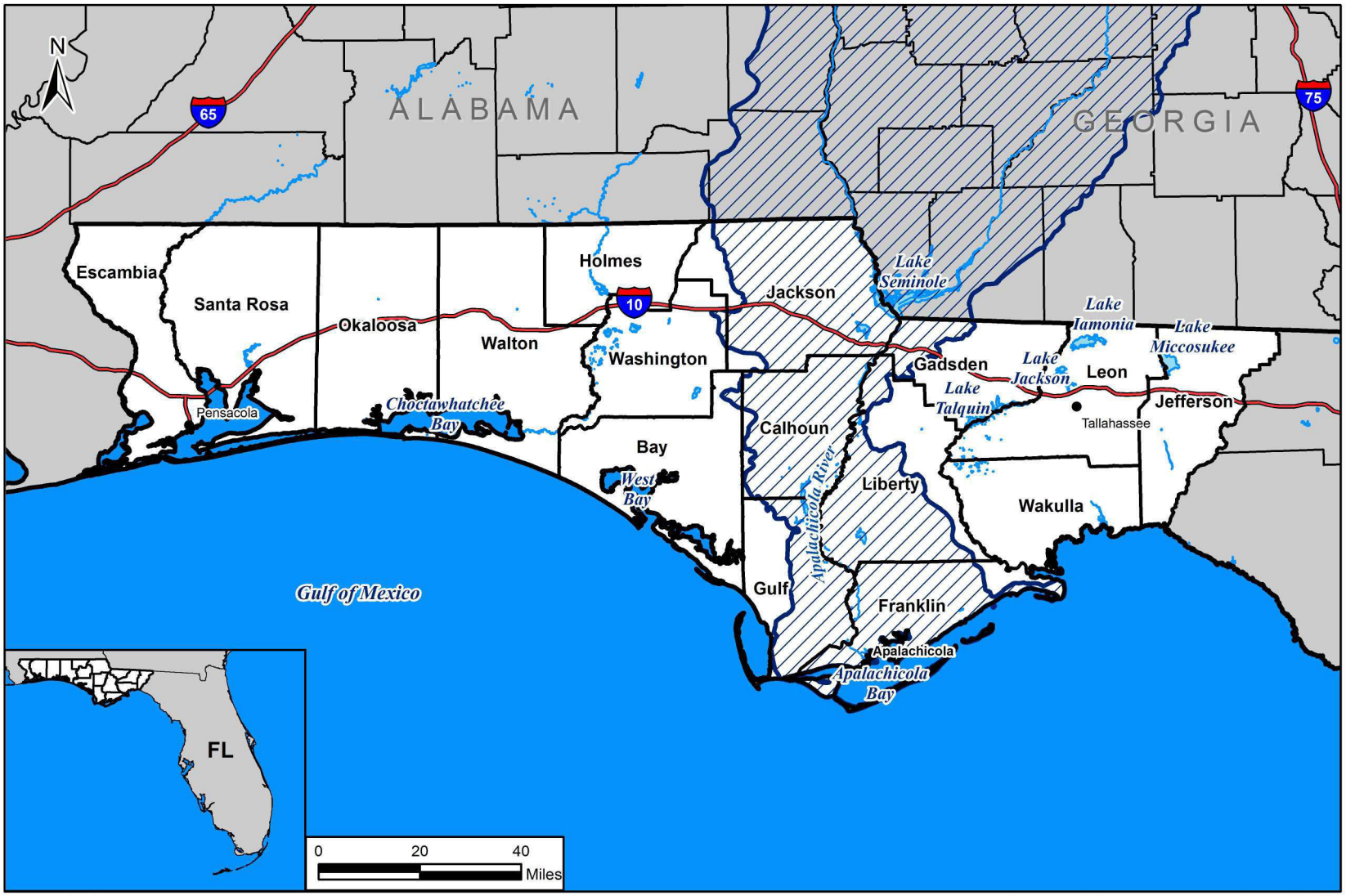
The Conserve Florida Water Clearinghouse is hosted by the University of Florida and supported by the water management districts, the Florida DEP, and several associations and public utilities in the state with an interest in water resource conservation. The mission of the clearinghouse is to develop collaborative relationships with related programs and to collect, analyze, and make available reliable information and technical assistance to public water supply utilities and water managers for use in developing effective and efficient water conservation programs (University of Florida 2010).

2.1.1.2.10.3.4 Northwest Florida Water Management District

The NWFWMD is one of five water management districts in the state created by the Water Resources Act of 1972. The water management districts are directly responsible for managing the quality and quantity of the state's waters in conjunction with the Florida DEP. The NWFWMD has worked for decades to protect and manage water resources in a sustainable manner for the continued welfare of people and natural systems across its 16-county region. The NWFWMD serves the following Florida counties: Bay, Calhoun, Escambia, Franklin, Gadsden, Gulf, Holmes, Jackson, Leon, Liberty, Okaloosa, Santa Rosa, Wakulla, Walton, Washington, and western Jefferson. The NWFWMD's area of responsibility (AOR) is depicted on Figure 2.1-46. The Apalachicola River and Bay are within the NWFWMD.

2.1.1.2.10.3.5 District Water Management Plan

Pursuant to section 373.036, F.S., the NWFWMD develops a strategic water management plan (NWFWMD SWMP) every 5 years to define the responsibilities of the district, as well as the agency's objectives, strategies, and success criteria. This plan focuses on current strategies – those activities the district plans to undertake in the near term to accomplish its mission to protect and manage the water resources of northwest Florida in a sustainable manner for the continued welfare of its residents and natural systems. The plan defines the district's current strategic priorities, implementation activities, financial resources and performance measures. The most recent published version of the NWFWMD SWMP occurred in 2015–2016.



LEGEND

- District County
- ACF Basin
- Surface Water
- Interstate Highway

Northwest Florida Water Management District

Figure 2.1-46

Source: NWFWMD 2005.

Prior to 2006, the water management districts in Florida developed DWMPs and updated them every five years. The last update to the NWFWMD DWMP was completed in 2005. The planning processes outlined below that were part of the DWMPs are now captured in the *Strategic Water Management Annual Work Plan Report*. The NWFWMD SWMP integrates major programs, including regional water supply planning, water resource development, water supply development assistance, minimum flows and levels, resource regulation, wetland mitigation, special projects, the Surface Water Improvement and Management program, technical assistance, land acquisition and management, and public outreach and education. Detailed district work plans and documents guide the implementation of these programs. Collectively, the district's programs and plans, and its budget, constitute a comprehensive approach to the interrelated issues that span the four major AORs:

- **Water Supply.** Promote the availability of sufficient water for all existing and future reasonable-beneficial uses and affected natural systems.
- **Flood Protection and Floodplain Management.** Maintain natural floodplain functions and minimize harm from flooding.
- **Water Quality.** Protect and improve the quality of the district's water resources.
- **Natural Systems.** Protect and enhance natural systems.

The NWFWMD SWMP communicates the district's most pressing water management issues and its key strategies to address them. Intergovernmental coordination is critical to the district in carrying out its responsibilities. The district forms partnerships with other levels of government that implement water management through planning, regulation, and acquisition, and service delivery programs. By maintaining close working ties with federal, state, regional, and local agencies, the district can draw upon and provide important resources, technical expertise, and knowledge to support effective water resource management and implementation of the plan.

2.1.1.2.10.3.6 Consumptive Use Permits

Through the Consumptive Use Program, the district's water supplies are allocated in a manner that is reasonable and beneficial, is in the public interest, and does not have a deleterious impact on existing legal users or the resource.

The NWFWMD operates regulatory programs that address, through rules, the consumptive use of water; the construction, repair, or abandonment of water wells and licensing of water well contractors; the safety of nonagricultural impoundments; agricultural and forestry surface water management facilities, including *farm ponds*; stormwater management systems; the artificial recharge of groundwater; and works of the district (NWFWMD 2010).

For consumptive use permitting purposes, the district is divided into three permitting areas within the NWFWMD boundary: Permit Areas A, B, and C. The six counties along the Apalachicola River corridor fall into the following permit categories: Gulf County (Area B, Area A for barrier islands); Franklin County (Area B, Area A for barrier islands); Calhoun County (Area C); Jackson County (Area C); Liberty County (Area B); and Gadsden County (Area A). Specific criteria and requirements for water use permitting are described at http://www.nwfwmd.state.fl.us/permits/water-use-permits/.

2.1.1.3 Monitoring Water Quantity for Management

Several federal government agencies monitor water quantity in the ACF Basin. The USGS has developed extensive water quantity monitoring networks as part of the Cooperative Water Program. The GAEPD provides support for continuous water quantity monitoring of surface water and groundwater as part of the Georgia Water Information Network. USACE monitors inflow and discharge at all reservoirs, along

with pool elevation. NOAA operates several gages in the ACF Basin to monitor changes in estuary, river, and ocean water levels. All federal water quantity monitoring data are available, in real time, online.

Both the GAEPD and Florida DEP operate several additional water quantity monitoring networks within the state. Water quantity data are taken yearly and continuously depending on the station.

The USGS operates several monitoring networks in the ACF Basin. The largest network, the Active Groundwater Network, contains information that the USGS or its cooperators measure at least once every year. At 12 wells, measurements are recorded at 15- to 60-minute intervals using data loggers that transmit the data to the USGS every 1 to 4 hours. Data collected within this network are used for statewide monitoring programs, drawdown monitoring, hydrologic research, and aquifer tests. The USGS Climate Response Network monitors the effects of droughts and climate variability on groundwater levels in seven wells in the ACF Basin. A portion of these wells are part of the Long-Term Groundwater Data Network, and measurements have been made at the wells at least once a year for at least the last two decades (USGS 2010a).

As part of the Cooperative Water Program in Georgia, the USGS monitors groundwater levels through the Georgia Groundwater Information and Project Support Unit in cooperation with the GAEPD, as well as several local municipalities (USGS 2010b). The wells are periodically observed and continuously monitored within the network of the state. Well inventory data are entered into the Groundwater Site Inventory database.

Although the GSA monitors groundwater levels year-round at 19 well locations, none of the wells are in the ACF Basin. The agency also samples water levels in an additional 450 wells during the month of October (GSA 2010).

Florida established its Ground Water Quality Monitoring Network (GWQMN) in 1983 to monitor the chemical and physical characteristics of aquifers. The Florida DEP coordinates the monitoring, and federal and state agencies, such as Florida's water management districts, are involved. The GWQMN is composed of two networks—the Background Network of 1,700 wells and the Very Intense Study Area (VISA) Network. Water-level data for the Background Network were collected from 1994 to 1997 in a total of 40 wells installed in the Apalachicola Basin. Water-level data are continually collected in Jackson County as part of the VISA Network. The NWFWMD also maintains a small network of five monitoring wells, one of which is in the ACF Basin (FLDEP 2010).

Limited water quantity monitoring is done within Apalachicola Bay. NOAA operates a gage at the mouth of the Apalachicola River that monitors tidal changes, and both NOAA and USGS have several gages on the Apalachicola River and nearby tributaries that monitor freshwater inflow into the estuaries. USACE operates tidal gages at the mouth of the Apalachicola River and at the bay's entrance to the Gulf of Mexico.

2.1.2 Water Quality Affected Environment

This discussion addresses the quality of water in the ACF Basin by reviewing applicable standards, regulations, data, and models. Many factors can affect water quality, including M&I discharges, land use activities, and in-stream flows. This section discusses the quality of water in the ACF Basin under existing conditions.

2.1.2.1 Historic Water Quality

Water quality in the forested headwaters of the ACF Basin was very good before the 1950s. After Buford Dam was built in the 1950s, water quality in the tailrace of the dam in the Chattahoochee River was

diminished. Water released from the reservoir was high in iron and manganese due to the reservoir stratification in the fall, causing several large fish kills at the Georgia Lake Lanier Trout Hatchery. In April 1987, USACE completed a study indicating that fish hatchery water quality concerns could be addressed if GADNR would add water-hardening chemicals to water pumped from the river during the critical periods as a least-cost alternative (appendix A, appendix B - Buford Dam and Lake Sidney Lanier).

Water quality downstream of Buford Dam, in Metro Atlanta and the 70 mi immediately downstream of Metro Atlanta, was notoriously poor from the 1940s to the 1970s. Raw sewage was often directly discharged into the Chattahoochee River, along with industrial effluent. Wastewater from the R.M. Clayton Plant, the main wastewater treatment plant for Atlanta, received only primary treatment before being discharged into the river during that time (USEPA 2000a).

Discharges to the Chattahoochee River contained elevated fecal coliform counts and high concentrations of total suspended solids, ammonia, and biochemical oxygen demand in the mainstem and its tributaries. Water quality was typically worse during the summer months. River flows generally diluted the wastewater, but low flows and warm water temperatures during summer months decreased DO. From 1968 to 1974, DO was regularly less than 1 milligram per liter (mg/L) in Metro Atlanta. Phosphorus levels were also very high in the rivers because phosphates were still being used in laundry detergent (U3SEPA 2000a).

Before the 1970s, water quality immediately downstream of wastewater plants was so inhospitable to fish that none were found in those locations during fish surveys. Fish kills were also common in Metro Atlanta because of raw sewage discharges into the river (Mauldin and McCollum 1992).

Several studies conducted in the 1960s that examined potential water quality solutions found the solution to be cost-prohibitive and no action was taken. In the 1970s, several laws and regulations were established at federal and local levels, including the Water Pollution Control Act of 1972, as amended, and the 1973 Atlanta Metropolitan River Protection Act (USEPA 2000a). The Water Pollution Control Act of 1972, as amended, required that all wastewater undergo secondary treatment, and, by 1974, Metro Atlanta facilities had been upgraded to provide secondary treatment. Improvement in technology also helped improve wastewater treatment plants.

Following improvements to wastewater treatment plants, DO concentrations increased by approximately 5–7 mg/L in the Chattahoochee River and its tributaries. There was a significant reduction in ammonia and total suspended solids being discharged, and phosphorus decreased in part because of laws passed that regulated phosphate detergent (USEPA 2000a). Biochemical oxygen demand concentrations steadily decreased after reaching a high in the late 1960s (USEPA 2000a).

Before construction of West Point Lake, there were concerns with water quality and monitoring was put in place downstream of the West Point Dam. In 1964, the U.S. Public Health Service conducted a study of water quality and water quantity that concluded a minimum of 670 cfs should be released from West Point Lake to ensure sufficient water levels for downstream intakes. Thus, the small unit was designed to provide a minimum, continuous, off-peak flow of 675 cfs. If the small unit is unavailable when the large units are not generating, the minimum flow requirement would be released over the spillway (appendix A, appendix E - West Point Dam and Lake).

Historically, low DO downstream of Walter F. George Lock and Dam had caused fish kills. A new protocol was adopted for the dam that allowed for additional water release from the reservoir during periods of fish stress and low DO. Today, special releases are made when monitoring indicates low DO or if fish below the dam appear to be in distress (appendix A, appendix C - Walter F. George Lock and Dam and Lake).

Relatively little data exists on water quality downstream of Atlanta before 1970. Wastewater from Columbus, Georgia, on the middle Chattahoochee River, and Albany, Georgia, on the lower Flint River, did contribute to poor water quality immediately downstream of their influence. Sources from those urban areas included septic tanks, industrial waste, and wastewater treatment plants. However, the size of their load and the relative magnitude of the rivers and associated flow conditions at those locations would have provided for better assimilation of pollutants, and water quality conditions were not likely to be as poor as in Metro Atlanta.

Despite the improvements to wastewater treatment plants and the passage of various water protection laws, water quality is threatened by population pressures and associated land use change. Nonpoint source pollution from the metropolitan areas, poultry farms, and agricultural farms contribute to high sediment loading and poor water quality following rain events, as described in section 2.1.2.7.

2.1.2.2 Existing Reservoir Quality

General water quality conditions that have been well documented in West Point Lake are typical of water quality conditions and trends that exist in reservoirs throughout the ACF Basin. Nutrient concentrations are highest in the upper arms of the tributaries to West Point Lake, specifically the Chattahoochee River arm, because of the nutrient-rich riverine inflows. Sediment and phosphorus concentrations are also highest in the upper arms and decrease toward the main pool as velocity is lowered and sediment is removed from suspension. DO levels were highest in the top 15 ft of the reservoir and the reservoir is anoxic or nearly anoxic near the reservoir bottom, especially in the main pool area, during periods of seasonal (summer) stratification. Currents and mixing regimes influence the concentrations of DO throughout West Point Lake.

In Lake Lanier, West Point Lake, and Walter F. George Lake, summer stratification occurs because of their depths. The surfaces of these lakes heat quickly, creating a warm, less-dense epilimnion that does not mix with the cold, dense hypolimnion. The principal cause of lower DO concentrations in the hypolymnion is oxygen-consuming decomposition of organic matter in the water column and at the sediment surface. Thermal density differences between the warmer epilimnion and hypolymnion prevent mixing between the density layers and full water column diffusion of DO. In the fall, the surface layer of the reservoir cools and becomes more dense, eventually to the point where the surface water density is higher than the hypolimnion and *turnover* (or complete mixing) of the formerly distinct layers occurs. Complete mixing in the fall reestablishes a uniform DO concentration throughout the water column. In shallow lakes, such as Lake Seminole, mixing from currents and wind prevents strong stratification and the formation of a hypolimnion layer. Additionally, chlorophyll *a* concentrations varied both seasonally and spatially and were highest from July to October during periods of low flow (Kennedy et al. 1994).

Point and nonpoint sources from metropolitan areas such as Atlanta, Columbus, and Albany increase sediment and pollutant loads in the rivers immediately downstream. The reservoirs in the ACF Basin typically act as a sink, removing pollutant loads and sediment. Although there was a decrease in nutrient loads downstream of nearly all reservoirs, significant decreases occurred only downstream of Lake Lanier, West Point Lake, and in the Flint River arm of Lake Seminole. The decreases in nutrient and sediment concentrations in the reservoirs are caused by settling of sediments and associated phosphorus and detritus, inflow from tributaries with lower nutrient concentration, and uptake of nutrients from phytoplankton in reservoirs (Frick et al. 1996).

Nutrient concentrations were lower in the Chattahoochee River during the summer because of increased nutrient uptake within the reservoirs. In the summer, the increased phytoplankton growth, along with aquatic plants, removes large amounts of nutrients. Seasonal trends in nutrient concentrations were not noticeable on the Flint or Apalachicola rivers (Frick et al. 1996).

The highest concentrations of nutrients and pollutants in the ACF Basin occur immediately downstream of Atlanta in both the Flint River and the Chattahoochee River. A large portion of the nutrient and sediment load from Atlanta in the Chattahoochee River is assimilated and deposited in West Point Lake (Frick et al. 1996). Reservoirs downstream of West Point Lake also help remove pollutants from the Chattahoochee River from Metro Atlanta point and nonpoint sources and from smaller metro areas such as Columbus. By the time the Chattahoochee River enters Lake Seminole, nutrient concentrations are similar to concentrations in Lake Seminole's tailwaters, the Apalachicola River. The Flint River, which has no reservoirs between Albany and Lake Seminole, has much higher pollutant loads upon entering Lake Seminole (Frick et al. 1996). However, poor water quality in the Flint River at Lake Seminole is not solely caused by Atlanta as water quality greatly improves between Atlanta and Albany through dilution from tributaries. The high nutrient concentrations that enter Lake Seminole from the Flint River come from point sources in Albany and nonpoint sources from the surrounding agricultural land (Frick et al. 1996).

The influence of reservoir nutrient concentrations and use of the system are often understood from evaluating the reservoirs trophic status. Ranges of trophic state index values are often grouped into trophic state classifications. The range between 40 and 50 is usually associated with mesotrophy (moderate productivity). Index values greater than 50 are associated with eutrophy (high productivity). Values less than 40 are associated with oligotrophy (low productivity). Reservoir monitoring data collected by GAEPD indicate that Lake Lanier has moderate productivity while West Point, Walter F. George, and Seminole lakes are highly productive (GAEPD 2008b). Highly productive lakes are less likely to assimilate pollutants. Changes to reservoir inflows, outflows, or water levels at highly productive lakes would be expected to have a greater influence on the system's ability to meet water quality standards.

2.1.2.2.1 Lake Lanier Water Quality

Georgia's 2014 integrated 305(b)/303(d) list of impaired waters designates four of five reaches in Lake Lanier as supporting designated uses, including the area of the dam forebay (GAEPD 2014a). Water quality monitoring in Lake Lanier by GAEPD has indicated exceedance of the water quality standard for chlorophyll *a* at times since 2001. In the state's EPA-approved 2014 assessment, one reach was identified as impaired for chlorophyll *a*: Brown's Bridge Road. Chlorophyll *a* standards for Lake Lanier are set as a growing season (April through October) average less than 5 micrograms per liter (µg/L) upstream of Buford Dam forebay, less than 5 µg/L upstream from Flowery Branch confluence, less than 5 µg/L at Browns Bridge Road, less than 10 µg/L at Bolling Bridge on the Chestatee River, and less than 10 µg/L at Lanier Bridge on the Chattahoochee River (GAEPD 2015b). Georgia's 305(b)/303(d) integrated list of waters refers to sections of the Water Pollution Control Act of 1972, as amended. Measured data at compliance points for DO, total nitrogen, and pH are in compliance with Georgia's standards. The state collects profile data at compliance points in the reservoir for DO, pH, conductivity, and water temperature during the growing season. It also collects grab samples of nitrogen, phosphorus, chlorophyll *a*, and bacteria.

In November 2015, *Georgia's List of Priority Waters* was released consistent with EPA's 2013 *A Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program*. *Georgia's List of Priority Waters* includes all five segments of Lake Lanier on the priority list for chlorophyll *a*, although only one segment, Lake Lanier—Browns Bridge Road, is on the 303(d) list. Their intent is to develop a total maximum daily load (TMDL) for the entire lake (GAEPD 2015c). For nearly a decade, Georgia has been working to identify sources contributing to high chlorophyll *a* levels in Lake Lanier through their state water planning efforts. As part of those efforts, the state has modeled the Chattahoochee River downstream of Buford Dam.

The tailrace of Buford Dam is classified as a trout stream and requires that water quality meet stringent standards, specifically DO must have a daily average of 6.0 mg/L. The water released from the dam is from the deeper levels of the lake, approximately 136 ft below the water level, where, although cool, often has DO levels less than 3 mg/L from June to December when the reservoir is stratified and has a distinct hypolmnion layer. Auto-venting turbines were installed in 2005 as part of the major rehabilitation project to improve DO in the tailrace. Vented turbines increase DO by aspirating more air into the turbine and draft tube areas before the water is discharged downstream. USACE measures basic water quality data in the tailrace. The water temperature is often 50 degrees Fahrenheit (°F), ideal to support the trout fishery, while the DO ranges from 1 mg/L to 13 mg/L. Re-aeration of the released water typically occurs within 5–6 mi of the dam because of vertical mixing in the shoals and pools within the river (appendix A, appendix B)(Greenfield 2014, personal communication).

2.1.2.2.2 West Point Lake Water Quality

Georgia's 2014 integrated 305(b)/303(d) list of impaired waters designates West Point Lake as not supporting designated uses because of polychlorinated biphenyls (PCBs) (GAEPD 2014a). A TMDL for West Point Lake was completed in 1998 for PCBs, but lists the reduction at 0 percent because PCBs are no longer being used in Georgia. The PCBs found in fish in West Point Lake are from historic contamination. A TMDL was also completed in 2000 for low DO below the West Point Dam in the Chattahoochee River (USEPA 2000b).

Georgia collects profile data at compliance points in the reservoir for nutrients and additional water quality criteria. Site-specific nutrient standards have been developed for West Point Lake; monthly average chlorophyll *a* must be less than 24 µg/L at the LaGrange water intake during the growing season (April-October), total nitrogen must be less than 4 mg/L, and phosphorus loading must be less than 2.4 pounds per acre-foot (lbs/ac-ft) of lake per volume of water a year (GAEPD 2015b). All water quality samples collected by Georgia EPD have been within those ranges. In accordance with the state water plan, GAEPD developed a 3-dimensional hydrodynamic and water quality model to examine nutrient criteria in West Point Lake.

LaGrange is also actively monitoring water quality at various locations in West Point Lake. The city's monitoring efforts are being conducted to document reservoir nutrients. The city's water supply intake is in West Point Lake. In 2008, that data effort identified several violations of the state's nitrogen standard in waters entering the reservoir. Samples collected in the reservoir pool during the same period did not experience violations. Since 2008, nitrogen concentrations entering the reservoir have not violated the state's water quality standard for nitrogen (City of LaGrange 2010).

USACE monitors water quality in the tailrace of West Point Lake. DO levels in the tailrace vary greatly, from 1 mg/L to 10 mg/L, with the lowest concentrations during late summer and early fall. Water temperature in the tailrace ranges from 50 °F to 80 °F (10 degrees Celsius [°C] to 27 °C) and can even approach 90 °F (32 °C) in July and August.

2.1.2.2.3 Walter F. George Lake Water Quality

The pool and mid-lake behind the Walter F. George Lock and Dam are both supporting their designated water uses according to Georgia's 2014 integrated 305(b)/303(d) list (GAEPD 2014a). A TMDL was completed in 1998 for PCBs, and because PCBs are no longer used in Georgia, the reduction of contaminants was listed at 0 percent. GAEPD also collects nutrient and water quality data at compliance points in the lake, and measurements have not exceeded the standards. Walter F. George Lake has site-specific nutrient criteria, and the monthly average chlorophyll *a* during the growing season must be less than 18 µg/L at mid-river at U.S. Highway 82 or 15 µg/L at mid-river in the dam forebay (GAEPD 2015b). While the growing season average has been less than 18 µg/L, chlorophyll *a* measurements have

equaled 18 µg/L. In accordance with the state water plan, GAEPD developed a 3-dimensional hydrodynamic and water quality model to further examine nutrient criteria in Walter F. George Lake.

USACE also monitors water quality in the tailrace of Walter F. George Lock and Dam. DO is often less than 3 mg/L in the tailrace during the late summer and early fall months because of stratification of the lake. In addition to the SOP to address low DO in the tailrace described in section 2.1.1.2.4.4, Appendix A, appendix C - Walter F. George Lock and Dam and Lake describes several cutoff wall projects in the 1980's and a comprehensive cutoff wall project completed in 2004 to address seepage from the dam.

USACE continues to take steps to improve DO in the tailrace of Walter F. George Lock and Dam (the headwaters of Lake George W. Andrews) following a TMDL for low DO below the dam that was finalized by the USEPA in 2000 (USEPA 2000b). Spillage siphons have been installed on the dam to improve downstream DO during minimum flow conditions and from May 1 to September 30. The spillage siphons release approximately 400 cfs of highly oxygenated water downstream. Additional releases also have been made on rare occasions when the powerhouse receives a warning of low DO from the water quality monitor downstream while the spillage siphons are in operation (appendix A, appendix C - Walter F. George Lock and Dam and Lake).

2.1.2.2.4 Lake George W. Andrews Water Quality

Lake George W. Andrews is listed as not supporting its designated water quality use for DO for fishing, according to GAEPD (GAEPD 2015b). The lake has been identified as a priority for TMDL development in 2017. Georgia has not developed site-specific water quality criteria for the reservoir. USACE monitors water quality in the headwaters of the reservoir and will use the data for future water quality planning purposes.

2.1.2.2.5 Lake Seminole Water Quality

According to Georgia's 2014 integrated 305(b)/303(d) list of impaired waters, Lake Seminole is supporting its designated recreation usage for water quality parameters other than pH. Two TMDLs were completed in 1998 for chlordane and PCBs. Reductions for both were 0 percent because neither one is used in Georgia any longer. The upper reaches of the reservoir maintain the characteristics of a river with relatively homogenous temperature and DO concentrations. The productive zone of the reservoir is not limited because of vertical stratification due to the homogenous DO concentrations and the relative shallowness of the lake. Although there is a small degree of vertical stratification, a thermocline does not exist. Interagency sampling over the 1993–1995 period does show significant areas of extremely low or zero DO in the aquatic plant beds in the lake.

Nonnative plant growth in the reservoir, specifically hydrilla (*Hydrilla verticillata*), has adversely affected water quality and aquatic life habitat (see section 2.5.3.2). USACE does operate Jim Woodruff Lock and Dam to help with aquatic plant control during periods when herbicides are applied to certain areas of the reservoir (appendix A, appendix A - Jim Woodruff Lock and Dam and Lake Seminole).

In September 1995, an interagency team directed by EPA sampled DO and temperature at 120 randomly selected locations within the lake. The results of this study show 44 percent of the stations sampled in aquatic vegetation (predominantly hydrilla) had DO levels less than 5 mg/L, compared with 8 percent of the stations in open water. On the basis of those data, a significant portion of the reservoir probably has poor water quality conditions during the hot summer and early fall months when the hydrilla has formed large surface mats. Additional field study by GADNR, Wildlife Resources Division (WRD) in 1994–1995 corroborated those findings on low DO levels below the surface in dense hydrilla beds, compared with DO levels at open water stations. During 1994 and 1995, Georgia WRD sampled three stations on the Flint River and three stations on Spring Creek from June through October monthly. At each site, water

quality parameters were recorded within topped-out hydrilla beds and in open water areas immediately adjacent to the dense hydrilla beds. Within the dense hydrilla beds, the DO levels were less than 5 mg/L at depths greater than 2 ft most of the entire June-October sampling period for both years, while stations in the open water had significantly fewer DO measurements of less than 5 mg/L. Average DO measurements on the bottom within the hydrilla beds were about 2.5 mg/L, compared with approximately 5.0 mg/L at the open water sites (Eubanks 2010, personal communication).

GAEPD regularly monitors water quality in Lake Seminole, and all water quality meets criteria. Georgia has not set site-specific nutrient criteria for Lake Seminole. USACE historically monitored water quality in the tailrace, and the data has shown that the water discharged from the dam generally has good water quality (appendix A, appendix A - Jim Woodruff Lock and Dam and Lake Seminole).

However, in the freshwater nutrient criteria drafted for Florida in January 2010, Florida's nutrient criteria will apply to Lake Seminole in the dam forebay, which is in Florida. The finalized standard of 0.006 mg/L (6 µg/L) of chlorophyll *a* is less than monitored concentrations. Monitored data collected in June, August, and November of 2007 range from 6.7 to 12 µg/L (GAEPD 2008b). The implications of new standards may require nutrient reductions throughout the ACF Basin from both point and nonpoint sources. GAEPD has developed a 3-dimensional hydrodynamic and water quality model for the reservoir that will establish nutrient criteria. This tool will help the state understand how nutrients entering the reservoir assimilate. Understanding how nutrients in the reservoir assimilate will be a factor in determining the need for upstream reductions.

2.1.2.3 Water Quality Standards

In 1972, Congress enacted the Water Pollution Control Act of 1972, which is now also known as the Clean Water Act. The object was "the protection and propagation of fish, shellfish, and wildlife and [to] provide for recreation in and on the water." The Water Pollution Control Act of 1972, as amended, established the National Pollutant Discharge Elimination System (NPDES) for the regulation of M&I water pollution control plants, the water use classification and standard process, and construction grants. In 1987, Congress made significant changes to the Water Pollution Control Act of 1972, as amended, which increased emphasis on toxic substances, nonpoint source pollution, and clean lakes, wetlands, and estuaries. The act requires that states evaluate their water quality standards and adopt numeric criteria for toxic substances to protect aquatic life and health. Each state was also required to evaluate nonpoint source pollution impacts and develop management plans to deal with documented problems.

Under the Water Pollution Control Act of 1972, as amended, 33 U.S.C. § 1313(a)(3)(A), states are required to adopt water quality standards. The standards, and any later revisions, are reviewed through public involvement and later approved by EPA. Water quality standards are based on state-assigned water use classifications, such as public water supply, recreation, and navigation. The standards consist of general narrative standards and numeric standards for water quality parameters and toxic substances.

Table 2.1-27, Table 2.1-28, and Table 2.1-29 present the water quality standards for Alabama, Florida, and Georgia, respectively, for specific stream designated uses. Figure 2.1-47 illustrates the designated uses for mainstem water bodies in the ACF Basin.

In addition to the parameters presented in the three tables, Alabama, Florida, and Georgia have water quality standards for metals and other toxic substances that are based on human use and consumption rates. More information relevant to water quality standards for metals and other toxic substances can be found in the ADEM Administrative Code, R. 335-6-10 (ADEM 2015); Florida Administrative Code 62-302: Surface Water Quality Standards (FLDEP 2016); and Administrative Rule 391-3-6-.03: Water Use Classifications and Water Quality Standards (GAEPD 2015b).

Table 2.1-27.
Alabama Water Quality Standards

Designated Use	*E. Coli* Bacteria or Enterococci Group	DO	pH	Temperature
Outstanding Alabama Water	< 126 colonies/100 milliliter (mL) as geometric mean, no more than 235 colonies/100 mL of *E. coli* for noncoastal waters < 35 colonies/100 mL as geometric mean, no more than 104 colonies/100 mL of enterococci group for coastal waters	> 5.5 mg/L at all times 4 to 5.5 mg/L if all other water quality parameters are favorable Not < 4 mg/L due to hydroelectric turbine discharges[b]	Between 6.0 and 8.5 for all Between 6.5 and 8.5 for saltwater and estuarine waters	< 90 °F
Public Water Supply	< 548 colonies/100 mL as geometric mean, no more than 2,507 colonies/100 mL of *E. coli* in any given sample for noncoastal waters No more than 275 colonies/100 mL of enterococci group for coastal waters Jun–Sep incidental water contact and recreation < 126 colonies/100 mL, no more than 487 colonies/100 mL of *E. coli* for noncoastal waters Jun–Sep incidental water contact and recreation <35 colonies/100 mL, no more than 158 colonies/ 100 mL of enterococci group for coastal waters	> 5 mg/L at all times 4 to 5 mg/L under extreme conditions due to natural causes[a] Not < 4 mg/L due to hydroelectric turbine discharges[b]	Between 6.0 and 8.5	< 90 °F
Swimming and Other Whole Body Water-Contact Sports	< 126 colonies/100 mL, no more than 235 colonies/100 mL of *E. coli* for noncoastal waters <35 colonies/100 mL, no more than 104 colonies/ 100 mL of enterococci group for coastal waters	> 5 mg/L at all times 4 to 5 mg/L under extreme conditions due to natural causes[a] Not < 4 mg/L due to hydroelectric turbine discharges[b]	Between 6.0 and 8.5 for all Between 6.5 and 8.5 for saltwater and estuarine waters	< 90 °F
Shellfish Harvesting	Incidental water contact and recreation < 126 colonies/100 mL, no more than 235 colonies/100 mL of *E. coli* for noncoastal waters Incidental water contact and recreation <35 colonies/100 mL, no more than 104 colonies/ 100 mL of enterococci group for coastal waters	> 5 mg/L at all times 4 to 5 mg/L under extreme conditions due to natural causes[a] Not < 4 mg/L due to hydroelectric turbine discharges[b]	Between 6.5 and 8.5	< 90 °F

Designated Use	*E. Coli* Bacteria or Enterococci Group	DO	pH	Temperature
Fish and Wildlife	< 548 colonies/100 mL as geometric mean, no more than 2,507 colonies/100 mL of *E. coli* in any given sample for noncoastal waters No more than 275 colonies/100 mL of enterococci group for coastal waters Jun–Sep incidental water contact and recreation < 126 colonies/100 mL, no more than 487 colonies/100 mL of *E. coli* for noncoastal waters Jun–Sep incidental water contact and recreation <35 colonies/100 mL, no more than 158 colonies/ 100 mL of enterococci group for coastal waters	> 5 mg/L at all times 4 to 5 mg/L under extreme conditions due to natural causes[a] Not < 4 mg/L due to hydroelectric turbine discharges[b]	Between 6.0 and 8.5 for all Between 6.5 and 8.5 for saltwater and estuarine waters	< 90 °F
Limited Warmwater Fishery	< 548 colonies/100 mL as geometric mean, no more than 2,507 colonies/100 mL of *E. coli* in any given sample for noncoastal waters No more than 275 colonies/100 mL of enterococci group for coastal waters	> 3 mg/L at all times	Between 6.0 and 8.5 for all Between 6.5 and 8.5 for saltwater and estuarine waters	< 90 °F
Agricultural and Industrial Water Supply	< 700 colonies/100 mL, no more than 3,200 colonies/100 mL of *E. coli* for noncoastal waters No more than 500 colonies/ 100 mL of enterococci group for coastal waters	> 3 mg/L at all times	Between 6.0 and 8.5 for all Between 6.5 and 8.5 for saltwater and estuarine waters	< 90 °F

Source: ADEM 2015

Notes:

[a.] All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5.5 mg/L DO where practicable and technologically possible.

[b.] All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, will be designed so that the discharge will contain at least 5 mg/L DO where practicable and technologically possible.

Table 2.1-28.
Florida Water Quality Standards

Designated Use	Fecal Coliform or *Escherichia coli or Enterococci* Bacteria	DO[a]	pH	Temperature
Potable Water Supply	*Escherichia coli*: 126/100 milliliter (mL) as monthly geometric mean Not to exceed 410 colonies/100 mL in 10% of samples	See Rule 62-302.53 Florida Administrative Code	Within 1 pH unit change of natural background given actual pH is between 6.0 and 8.5 If natural background pH < 6.0, pH will not be < natural background and will be < 1 pH unit > natural background If natural background pH > 8.5, pH will not be > natural background and will be < 1 pH unit < natural background	
Shellfish Propagation and Harvesting	Fecal: 14 colonies/100 milliliter (mL) as median value Not to exceed 43 colonies/100 mL in 10% of samples Not to exceed 800 colonies on any day *Enterococci*: 35/100 milliliter (mL) as monthly geometric mean Not to exceed 130 colonies/100 mL in 10% of samples	See Rule 62-302.533 Florida Administrative Code	Within 1 pH unit change of natural background given actual pH is between 6.5 and 8.5 for coastal waters, within 0.2 pH units for open waters If natural background pH < 6.5, pH will not be < natural background and will be < 1 pH unit > natural background for coastal waters, will be < 0.2 pH units for open waters If natural background pH > 8.5, pH will not be > natural background and will be < 1 pH unit < natural background for coastal waters, will be < 0.2 pH units for open waters	
Recreation and Fish & Wildlife, Fresh Waters	*Escherichia coli*: 126/100 milliliter (mL) as monthly geometric mean Not to exceed 410 colonies/100 mL in 10% of samples	See Rule 62-302.533 Florida Administrative Code	Within 1 pH unit of natural background given actual pH is between 6.0 and 8.5, within 0.2 pH units for open waters If natural background pH < 6.0, pH will not be < natural background and will be < 1 pH unit > natural background, will be < 0.2 pH units for open waters If natural background pH > 8.5, pH will not be > natural background and will be < 1 pH unit < natural background, will be < 0.2 pH units for open waters	
Recreation and Fish & Wildlife, Marine Waters	*Enterococci*: 35/100 milliliter (mL) as monthly geometric mean Not to exceed 130 colonies/100 mL in 10% of samples	See Rule 62-302.533 Florida Administrative Code	Within 1 pH unit of natural background given actual pH is between 6.5 and 8.5, within 0.2 pH units for open waters If natural background pH < 6.5, pH will not be < natural background and will be < 1 pH unit > natural background, will be < 0.2 pH units for open waters If natural background pH > 8.5, pH will not be > natural background and will be < 1 pH unit < natural background, will be < 0.2 pH units for open waters	

Designated Use	Fecal Coliform or *Escherichia coli or Enterococci* Bacteria	DO[a]	pH	Temperature
Agricultural Water Supply	No alteration of natural water quality	See Rule 62-302.533 Florida Administrative Code	Within 1 pH unit change of natural background given actual pH is between 6.0 and 8.5 If natural background pH < 6.0, pH will not be < natural background and will be < 1 pH unit > natural background If natural background pH > 8.5, pH will not be > natural background and will be < 1 pH unit < natural background	
Navigation, Utility, and Industry	No alteration of natural water quality	See Rule 62-302.533 Florida Administrative Code	Between 5.0 and 9.5 except in certain swamp water, which may be as low as 4.5	

Source: FLDEP 2016

Note:
[a.] Rule 62-302.533 Florida Administrative Code reflects revisions to the DO standard based on percent DO saturation by bioregion and site-specific conditions.

Table 2.1-29.
Georgia Water Quality Standards

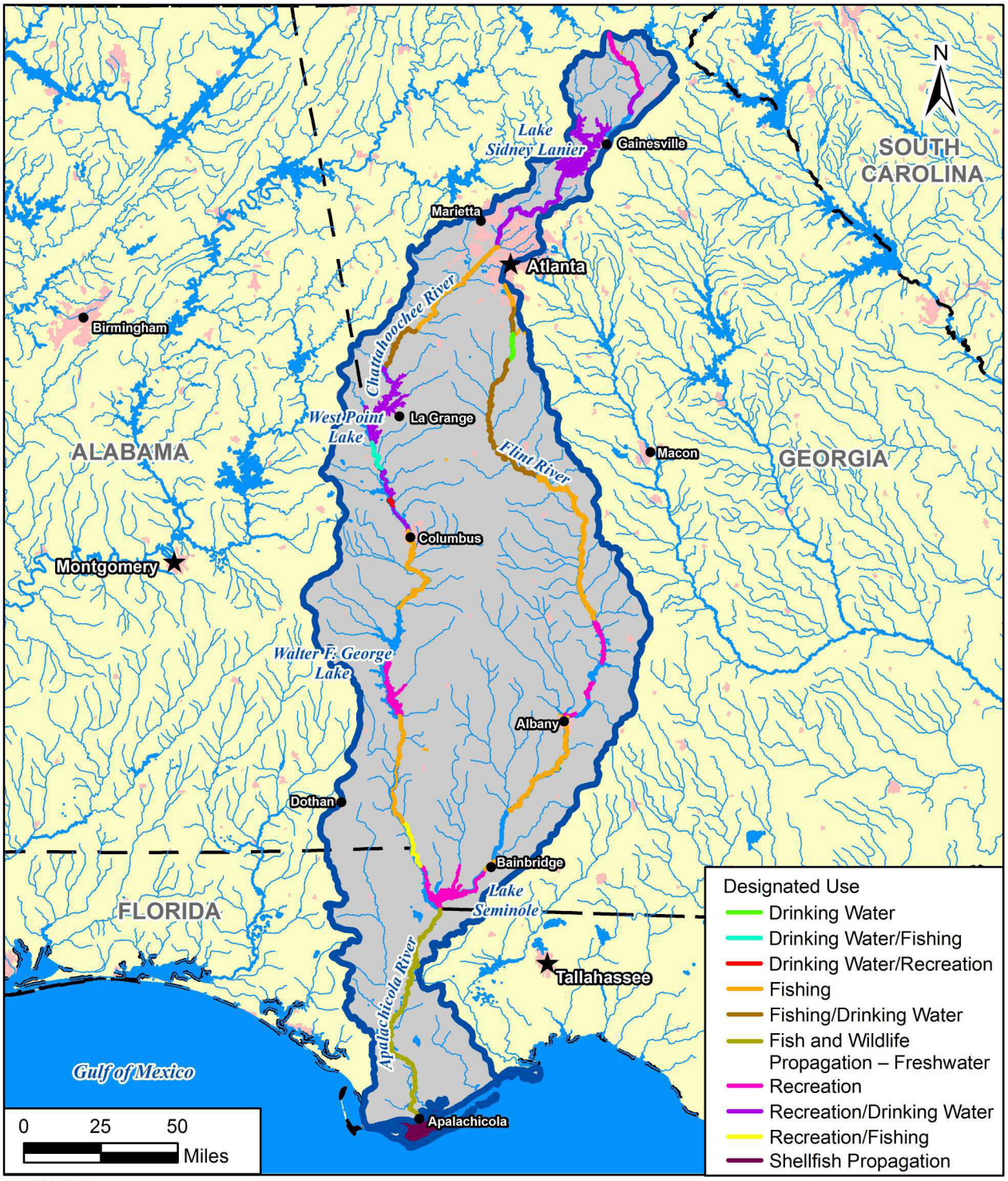
Designated Use	Fecal Coliform Bacteria	DO	pH	Temperature
Drinking Water Supply (not treated drinking water)	May–Oct < 200 colonies/100 milliliter (mL) as geometric mean During occasional exceedances, allowable geometric mean 300 colonies/100 mL in lakes and reservoirs and 500 colonies /100 mL in free flowing freshwater streams Nov–Apr < 1,000 colonies/100 mL as geometric mean, no more than 4,000 colonies/100 mL	6 mg/L daily average, no less than 5 mg/L at all times for trout streams 5 mg/L daily average, no less than 4 mg/L at all times for warm water species of fish	Between 6.0 and 8.5	< 90 °F
Recreation	Coastal waters: 100 colonies/100 mL as geometric mean Recreation: 200 colonies/100 mL as geometric mean During occasional exceedances for recreation, allowable geometric mean 300 colonies/100 mL in lakes and reservoirs and 500 colonies /100 mL in free-flowing freshwater streams	6 mg/L daily average, no less than 5 mg/L at all times for trout streams 5 mg/L daily average, no less than 4 mg/L at all times for warm water species of fish	Between 6.0 and 8.5	< 90 °F
Fishing	May–Oct < 200 colonies/100 mL as geometric mean During occasional exceedances, allowable geometric mean 300 colonies/100 mL in lakes and reservoirs and 500 colonies /100 mL in free-flowing freshwater streams Nov–Apr < 1,000 colonies/100 mL as geometric mean, no more than 4,000 colonies/100 mL	6 mg/L daily average, no less than 5 mg/L at all times for trout streams 5 mg/L daily average, no less than 4 mg/L at all times for warm water species of fish	Between 6.0 and 8.5	< 90 °F

Designated Use	Fecal Coliform Bacteria	DO	pH	Temperature
Coastal Fishing	May–Oct < 200 colonies/100 mL as geometric mean During occasional exceedances, allowable geometric mean 300 colonies/100 mL in lakes and reservoirs and 500 colonies /100 mL in free-flowing freshwater streams Nov–Apr < 1,000 colonies/100 mL as geometric mean, no more than 4,000 colonies/100 mL	Site-specific	Between 6.0 and 8.5	< 90 °F
Wild or Scenic River	No alteration of natural water quality	No alteration of natural water quality	No alteration of natural WQ	No alteration of natural water quality

Source: GAEPD 2015b

Alabama, Florida, and Georgia, have developed site-specific criteria in addition to the standard water quality guidelines. Additional requirements for lakes include chlorophyll *a*, a commonly used indicator of nutrients in water bodies, and total phosphorus and total nitrogen. In 2002, EPA recommended nutrient criteria for water bodies on the basis of their ecoregion (USEPA 2008); Alabama and Georgia have established plans to define those standards. Additional water quality standards have been set for lakes regarding hydroelectric facilities to ensure that water quality standards are met by setting tailwater DO targets of 4 mg/L during power generation. Table 2.1-30 provides the site-specific criteria for water bodies in the ACF Basin for Georgia, Alabama, and Florida. Table 2.1-31 provides EPA's numeric nutrient criteria for Florida streams and lakes in the ACF Basin.

EPA required that states develop a strategy for adopting numeric water quality nutrient criteria by 2003. Alabama and Georgia have since developed site-specific nutrient criteria for some lakes and established a plan to establish numeric nutrient standards for all water bodies. Florida did not establish statewide nutrient criteria, and, in July 2008, the Florida Wildlife Federation sued EPA for failure to comply with section 303(c)(4)(B) of the Water Pollution Control Act of 1972, as amended, which requires EPA to *promptly* propose criteria on a state's behalf if the state has failed to do so. EPA established and finalized nutrient criteria for lakes and streams by November 2010 (USEPA 2010a). However, based on a court ruling on January 2014, EPA was allowed to discontinue its work on the inland and coastal rule. The State of Florida would implement statewide and EPA approved nutrient criteria for inland and coastal waters (USEPA 2014). Florida has established site-specific nutrient criteria for Apalachicola Bay (Table 2.1-30) (Florida 2016).



Designated Uses

Figure 2.1-47

Source: GAEPD 2014b, USEPA OW 2010.

Table 2.1-30.
Site-specific Standards in Georgia, Alabama, and Florida

State	Basin	Water Body Name	Chlorophyll *a*	Other
Georgia	Chattahoochee	Lake Lanier Tributaries		Total phosphorus annual loading: Chattahoochee River at Belton Bridge Road < 178,000 lbs, Chestatee River at GA Hwy 400 < 118,000 lbs, Flat Creek at McEver Road < 14,400 lbs
Georgia	Chattahoochee	Lake Lanier	3 < 6 µg/L upstream from the Flowery Branch confluence, < 7 µg/L at Browns Bridge Rd, < 10 µg/L at Boiling Bridge on the Chestatee River, < 10 µg/L at the Chattahoochee River	pH: 6.0-9.5 Total nitrogen: < 4 mg/L Phosphorus: < 0.25 lbs/ac-ft per volume per year DO: daily average of 5 mg/L and no less than 4 mg/L at all times
Georgia	Chattahoochee	Buford Dam to I-285 West a Secondary Trout Stream		No elevation exceeding 2 °F of natural stream temperatures. A daily average DO of 6.0 mg/L and no less than 5.0 mg/L at all times.
Georgia	Chattahoochee	West Point Lake Tributaries		Total phosphorus loading: Yellow Jacket Creek at Hammet Road < 11,000 lbs, New River at Hwy 100 < 14,000 lbs, Chattahoochee River at U.S. 27 < 1.4 million lbs
Georgia / Alabama	Chattahoochee	West Point Lake	Growing season monthly average[a] (shall not exceed more than once in a five-year period) < 24 µg/L at the LaGrange Water Intake and 22 µg/L upstream from the dam in the forebay	pH: 6.0-9.5 Total nitrogen: < 4 mg/L Phosphorus: < 2.4 lbs/ac-ft per volume per year DO: daily average of 5 mg/L and no less than 4 mg/L at all times
Georgia	Chattahoochee	Walter F. George Lake Tributaries		Total phosphorus loading: Chattahoochee River at Hwy 39 < 2 million lbs
Georgia / Alabama	Chattahoochee	Walter F. George Lake	Growing season monthly average[a] < 18 µg/L at mid-river at U.S. Hwy 82 and < 15 µg/L at mid-river below dam forebay	pH: 6.0-9.5 Total nitrogen: < 3 mg/L Phosphorus: < 2.4 lbs/ac-ft per volume per year DO: daily average of 5 mg/L and no less than 4 mg/L at all times
Florida	Apalachicola Bay	Apalachicola Bay	8.4 µg/L as AGM[b]	Total nitrogen: 0.84 mg/L as AGM[b] Total phosphorus: 0.063 mg/L as AGM[b]
Florida	Apalachicola Bay	St. George Sound	6.1 µg/L as AGM[b]	Total nitrogen: 0.92 mg/L not to be exceeded more than 10% of the time Total phosphorus: 0.083 mg/L not to be exceeded more than 10% of the time

State	Basin	Water Body Name	Chlorophyll *a*	Other
Florida	Apalachicola Bay	East Bay	9.7 µg/L as AGM[b]	Total nitrogen: 1.12 mg/L not to be exceeded more than 10% of the time Total phosphorus: 0.101 mg/L not to be exceeded more than 10% of the time
Florida	Apalachicola Bay	St. Vincent Sound	17.4 µg/L not to be exceeded more than 10% of the time	Total nitrogen: 1.10 mg/L not to be exceeded more than 10% of the time Total phosphorus: 0.116 mg/L not to be exceeded more than 10% of the time
Florida	Apalachicola Bay	Apalachicola Offshore	8.2 µg/L not to be exceeded more than 10% of the time	Total nitrogen: 0.57 mg/L not to be exceeded more than 10% of the time Total phosphorus: 0.032 mg/L not to be exceeded more than 10% of the time
Florida	Apalachicola Bay	Alligator Harbor	6.0 µg/L as AGM[b]	Total nitrogen: 0.42 mg/L as AGM[b] Total phosphorus: 0.028 mg/L as AGM[b]

Source: GAEPD 2015b, ADEM 2015, FLDEP 2016
Notes:
[a.] Growing season is April–October as defined by GAEPD.
[b.] For bay segments with criteria expressed as annual geometric means (AGM), the values shall not be exceeded more than once in a 3-year period.

Table 2.1-31.
EPA's Final Numeric Nutrient Criteria for Florida Streams and Lakes in the ACF Basin

	Chlorophyll *a* (mg/L)[a b]	TN (mg/L)[c]	TP (mg/L)[c]
Panhandle West Freshwater Streams[d]	None	0.67	0.06
Clear Lakes, Low Alkalinity[e,f]	0.006	0.51 [0.51–0.93]	0.01 [0.01–0.03]

Source: USEPA 2010a
Notes:
[a.] Chlorophyll *a* is defined as corrected chlorophyll, or the concentration of chlorophyll *a* remaining after the chlorophyll degradation product, phaeophytin a, has been subtracted from the uncorrected chlorophyll *a* measurement.
[b.] For a given water body, the annual geometric mean of chlorophyll *a*, TN, or TP concentrations may not exceed the applicable criterion concentration more than once in a 3-year period.
[c.] For a given water body, the annual geometric mean of TN or TP concentrations may not exceed the applicable criterion concentration more than once in a 3-year period.
[d.] Panhandle West Region includes Perdido Bay Watershed, Pensacola Bay Watershed, Choctawhatchee Bay Watershed, St. Andrew Bay Watershed, and Apalachicola Bay Watershed. Watersheds pertaining to each Nutrient Watershed Region were based principally on the NOAA coastal, estuarine, and fluvial drainage areas with modifications to the NOAA drainage areas in the West Central and Peninsula Regions that account for unique watershed geologies. For more detailed information on regionalization and which WBIDs pertain to each Nutrient Watershed Region, see the Technical Support Document.
[e.] Platinum Cobalt Units (PCU) assessed as true color free from turbidity.
[f.] Long-term Color ≤ 40 PCU and Alkalinity ≤ 20 mg/L $CaCO_3$.

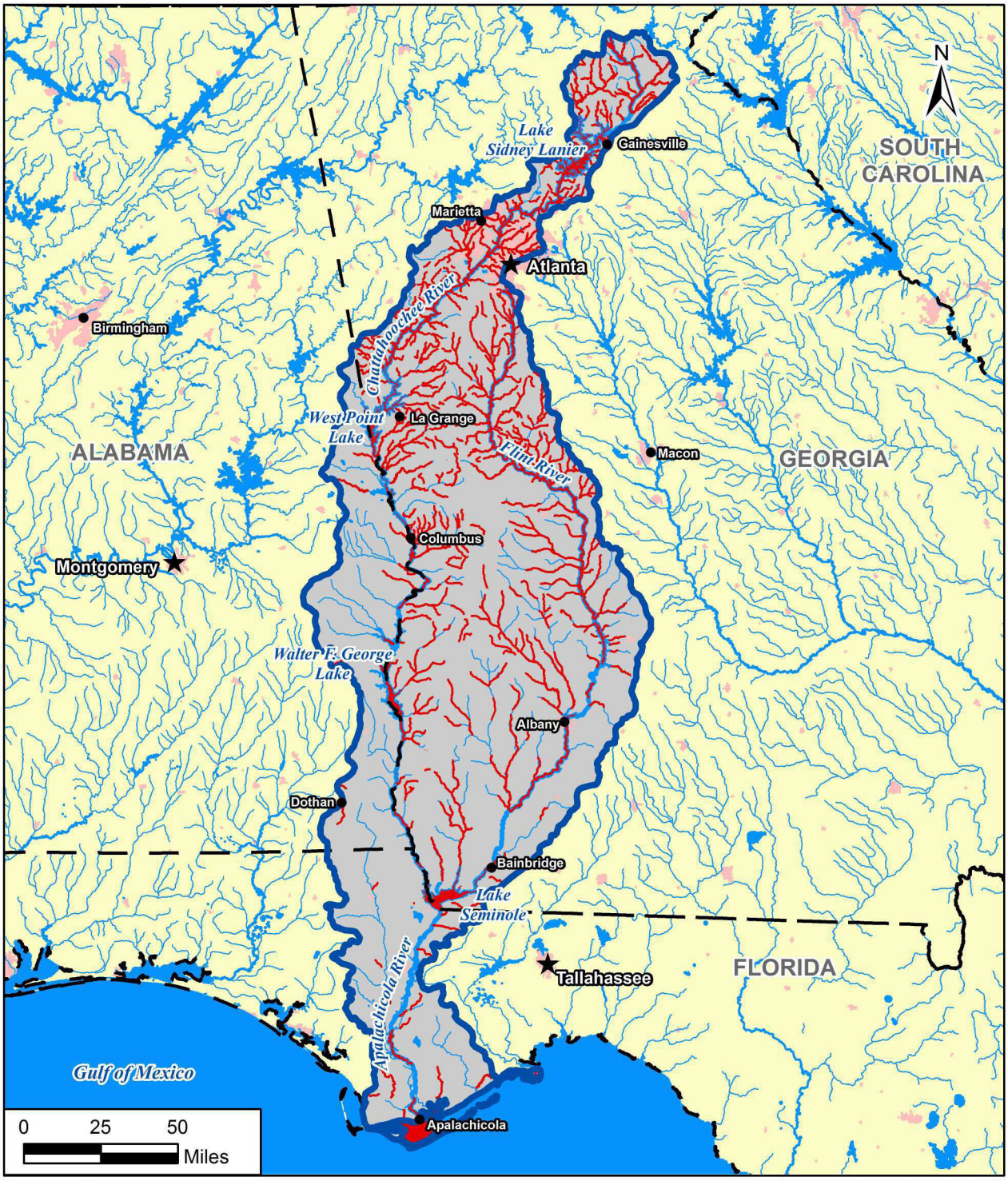
2.1.2.3.1 Impaired Waters and Total Maximum Daily Loads

Water bodies that do not meet water quality standards on the basis of their designated use(s) are identified by states as impaired under section 305(b) of the Water Pollution Control Act of 1972, as amended, and by EPA under section 303(d) of the Water Pollution Control Act of 1972, as amended. Figure 2.1-48 shows the mainstem, major tributaries, and lakes in the ACF Basin identified as impaired on the 2014 section 303(d) list. GAEPD has developed 3-dimensional hydrodynamic and water quality models for Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole. These models are being used as part of the Georgia statewide water management planning effort and the following efforts: a TMDL for Lake Lanier, comparing nutrient criteria for West Point Lake and Walter F. George Lake, and establishing nutrient criteria for Lake Seminole. Table 2.1-32 also lists the impaired water bodies. In 2010, ADEM did list Cowikee Creek from the Chattahoochee River to the end of the embayment in Walter F. George Lake as impaired for mercury in fish tissue samples from atmospheric deposition (ADEM 2010). Rivers and streams in the Chattahoochee and Flint River basins are most often impaired due to elevated fecal coliform levels, and estuaries and rivers in the Apalachicola River Basin are most often impaired due to atmospheric deposition of mercury.

TMDLs must be developed for impaired water bodies. The TMDLs identify sources of impairment, the necessary reductions to the sources, and methods to implement the reductions. Mathematical models are used to determine waste load allocation for TMDLs and recommend load reduction rates (GAEPD 2008b). Following TMDL completion, states coordinate with local governments and industries to modify NPDES permits when necessary. Historically, TMDL development in Alabama, Florida, and Georgia has been driven by lawsuits brought by environmental nonprofit organizations. Finalized TMDLs for the mainstem and major tributaries of the ACF Basin are listed in Table 2.1-33.

GAEPD and EPA have developed a number of TMDLs for legacy pollutants (PCBs) and metals (mercury), as shown in Table 2.1-33. The TMDLs were developed on the basis of human health criteria. Regulations in the 1970s stopped the use of PCBs, and current concentrations are from historical use. Sampling since the 1970s in Georgia indicates a 90 percent reduction in fish tissue concentrations of PCBs (GAEPD 2009c). The primary source of mercury in the basin is atmospheric deposition. TMDLs finalized by the GAEPD and EPA for mercury assign loads to protect public health, particularly with respect to the consumption of fish (GAEPD 2004).

When developing TMDLs for reservoirs, their tributaries, and tailwaters, the GAEPD and EPA have used dynamic mathematical models to ensure that the systems are adequately represented. The nutrient cycling in the reservoirs is dependent on point and nonpoint sources, reservoir turnover rates, and water releases from the dams. The DO levels and temperatures in the tailwaters of dams can also be influenced by upstream releases, and TMDLs have recommended releasing more highly oxygenated water (USEPA 2000b).



LEGEND

- ACF Basin Boundary
- State Boundary
- State Capital
- City
- Urban Area
- Surface Water
- 303(d) Listed Waters

Basin 303(d) Listed Waters

Figure 2.1-48

Source: ADEM 2014b, GAEPD 2014b, USEPA OW 2015.

Table 2.1-32.
Impaired Mainstems, Major Tributaries, and Lakes in the ACF Basin

Reach Name	Reach Location	Violation	Potential Causes	TMDL Status
Upper Chattahoochee River to Whitesburg, GA				
Chattahoochee River	GA Hwy 17, Helen to SR 255	Fecal coliform, affected biota (fish)	Urban runoff	Completed for fecal coliform
Chattahoochee River	SR 255 to Soquee River	Fecal coliform	Nonpoint/unknown source	Completed
Chattahoochee River	Soquee River to Mossy Creek	Fecal coliform	Nonpoint/unknown source	2007 draft
Chattahoochee Rivera	Mossy Creek to Lake Lanier	Fecal coliform	Nonpoint/unknown source	2007 draft
Chestatee River	Tate Creek to Tesnatee Creek	Fecal coliform	Nonpoint/unknown source	Completed
Chestatee River	Tesnatee Creek to Yaholla Creek	Fecal coliform	Nonpoint/unknown source	Completed
Chestatee River[a]	Yaholla Creek to Lake Lanier	Fecal coliform	Nonpoint/unknown source	Completed
Lake Lanier[a]	Browns Bridge Road	Chlorophyll a	Nonpoint/unknown source, urban runoff	
Chattahoochee River	Johns Creek to Morgan Falls Dam	Fecal coliform	Urban runoff	
Chattahoochee River	Morgan Falls Dam to Peachtree Creek	Fecal coliform, fish consumption (PCBs)	Urban runoff	Completed
Peachtree Creek	I-85 to Chattahoochee River	Fecal coliform	Urban runoff, combined sewer outflow	Completed
Chattahoochee River	Peachtree Creek to Utoy Creek	Fecal coliform, fish consumption (PCBs), lead	Combined sewer overflow, industrial facility point source, urban runoff	Completed (temperature, fecal coliform, and PCBs), lead expected 2017
Chattahoochee River	Utoy Creek to Pea Creek	Fecal coliform, fish consumption (PCBs)	Urban runoff, combined sewer overflow	Completed
Chattahoochee River	Pea Creek to Wahoo Creek	Fecal coliform, fish consumption (PCBs)	Urban runoff	Completed
Lower Chattahoochee River to Jim Woodruff Lock and Dam				
Chattahoochee River	Wahoo Creek to Franklin (West Point Lake)	Fish consumption (PCBs)	Urban runoff	Completed
West Point Lake[a]	Troup and Heard counties	Fish consumption (PCBs)	Nonpoint/unknown source, urban runoff	Completed
Harding Lake	Bartletts Ferry, Harris County	Fish consumption (PCBs)	Nonpoint/unknown source	Completed
Goat Rock Lake	Harris County	Fish consumption (PCBs)	Nonpoint/unknown source	Completed
Oliver Lake	Near Columbus	Fish consumption (PCBs)	Nonpoint/unknown source	Completed
Chattahoochee River	Oliver Dam to North Highlands Dam	Fish consumption (PCBs)	Urban runoff	Completed
Chattahoochee River	North Highlands Dam to Bull Creek	Fish consumption (PCBs)	Urban runoff	Completed

Reach Name	Reach Location	Violation	Potential Causes	TMDL Status
Chattahoochee River	Bull Creek to Upatoi Creek	Fecal coliform, fish consumption (PCBs)	Urban runoff	Completed
Chattahoochee River	Upatoi Creek to Chattahoochee/ Stewart County line	Fecal coliform	Urban runoff	Completed
Mill Creek	Chattahoochee River to its source	Organic enrichment (CBOD, NBOD)	Land development	Draft expected 2016
Uchee Creek	Chattahoochee River to County Road 39	Metals (mercury)	Atmospheric deposition	Draft expected 2020
Cowikee Creek (Walter F. George Lake)	Chattahoochee River to the end of embayment	Metals (mercury)	Atmospheric deposition	Draft expected 2020
Barbour Creek	Chattahoochee River to its source	Siltation (habitat alteration)	Agriculture	Draft expected 2016
Cedar Creek	Omusee Creek to its source	Metals (mercury)	Atmospheric deposition	Draft expected 2020
Ihagee Creek	Chattahoochee River to its source	Siltation (habitat alteration)	Land development and silviculture activities	Draft expected 2020
Moores Creek	Chattahoochee River to its source	Siltation (habitat alteration)	Land development	Draft expected 2020
Chattahoochee River	Downstream Walter F. George Dam	DO, fecal coliform	Dam release, nonpoint/unknown source	Completed
Chattahoochee River	Downstream of Fort Gaines to Lake George W. Andrews	DO	Dam	Draft expected 2017
Lake Seminole	60	Nutrients (TSI)		
Flint River to Jim Woodruff Lock and Dam				
Flint River	Hartsfield Airport to Hwy 138	Fecal coliform, affected biota (macroinvertebrates)	Urban runoff	Completed for fecal coliform
Flint River	Hwy 138 to N. Hampton Road	Fecal coliform	Urban runoff	Completed
Flint River	Road S1058/Woolsey Rd. to Horton Creek	Fecal coliform	Urban runoff, nonpoint	Completed
Flint River	Flat Shoals Rd. to Taylor County line	pH	Nonpoint	Completed for fecal coliform
Flint River	Horse Creek to Spring Creek	Fecal coliform	Nonpoint/unknown source	Completed
Apalachicola River Basin and Estuary				
Chipola River	51, 51B–-51E	Mercury (in fish tissue)		
Chipola River	51E	Fecal coliform		
Apalachicola River	375A-–375H	Mercury (in fish tissue)		
Apalachicola River	375B	Bacteria (in shellfish)		
East Bay	1274A	Mercury (in fish tissue), fecal coliform, fecal coliform (3), bacteria (in shellfish)		
East River	1275A	Bacteria (in shellfish)		

Reach Name	Reach Location	Violation	Potential Causes	TMDL Status
East Bayou	1278	Mercury (in fish tissue), bacteria (in shellfish)		
Apalachicola Bay	1274	Mercury (in fish tissue), fecal coliform, fecal coliform (3), bacteria (in shellfish)		
Apalachicola Bay	1274B	Mercury (in fish tissue), bacteria (in shellfish), nutrients (chlorophyll a)		
Indian Lagoon	1291	Mercury (in fish tissue), bacteria (in shellfish)		
Money Bayou	1288	Mercury (in fish tissue), bacteria (in shellfish)		
St. George Sound	1266	Bacteria (in shellfish)		
Gulf of Mexico (Franklin County)	8019	Mercury (in fish tissue)		
West Bayou	1279	Mercury (in fish tissue), bacteria (in shellfish		
Whiskey George Creek	1236	Bacteria (in shellfish)		

Sources: GAEPD 2014a, ADEM 2014a
Note:
[a.] Denotes segment that directly feeds into a USACE reservoir or is in a USACE reservoir.

Table 2.1-33.
Completed TMDLs for Mainstems, Major Tributaries, and Lakes in the ACF Basin

Water Body	Pollutant Of Concern	Percent Reduction	TMDL Completed
Chattahoochee River Basin, Georgia	Sediment (affecting biota)	Various (25 segments, including Lake Lanier headwater reaches), from 0 to 72%	January 2008
Chattahoochee River Basin, Georgia	Sediment (affecting biota)	Various (31 segments, including W.F. George headwater reach), from 0 to 25%	January 2003
Chattahoochee River Basin, Georgia	Copper		January 2003
Chattahoochee River Basin, Georgia	DO	0% recognizing that there were no permitted sources	January 2003
Chattahoochee River Basin, Georgia	Fecal coliform	Various (13 segments), from 22 to 99%	January 2013
Chattahoochee River Basin, Georgia	Fecal coliform	Various (79 segments, including Lake Lanier and West Point Lake headwater reaches), from 9 to 99%	November 2008
Chattahoochee River Basin, Georgia	PCBs in fish tissue	99.2%	January 2003

Water Body	Pollutant Of Concern	Percent Reduction	TMDL Completed
Upper Chattahoochee River to Whitesburg, Georgia			
Chattahoochee River at Atlanta, Georgia	Temperature	0% recognizing that wastewater temperatures do not equal or exceed allowable temperatures during July, August, and September but instead requiring the removal the discharge from two power plants which occurred following changes in 2008 to a closed current cooling system (Blalock 2010, personal communication; PR Newswire 2008) and the conversion of two coal units to natural gas in 2011 (Power Engineering 2012)	January 2003
Chattahoochee River Basin, Georgia	Basin sediment	Various (2 segments), 60% and 70%	February 2003
Chattahoochee River, Georgia	Mercury	Loading must be less than 2.3 kg/yr (Lake Lanier headwater)	February 2003
Chestatee River, Georgia	Fecal coliform	30% for urban areas, 99% for agricultural areas, 0% for forested areas	February 1998
Big Creek, Georgia	Fecal coliform	70% for agricultural areas, 0% for barren, urban, and forested areas	February 1998
Lower Chattahoochee River to Jim Woodruff Lock and Dam			
Flat Shoal Creek, Georgia	Fecal coliform	40% for agricultural areas, 20% for urban areas, 0% for barren and forested areas	February 1998
Hannahachee Creek, Georgia	Fecal coliform	0%	February 1998
Walter F. George Lake, Georgia	PCBs	0%, no PCBs currently used in Georgia	February 1998
West Point Lake, Georgia	PCBs	0%, no PCBs currently used in Georgia	February 1998
West Point Dam, W.F. Georgia Dam	DO below dams	NA, federal agencies release higher oxygenated water from dams	November 2000
Flint River to Jim Woodruff Lock and Dam			
Flint River Basin, Georgia	Sediment (biota impairment)	0%	January 2008
Flint River Basin, Georgia	Sediment (biota impairment)	Various (28 segments), 0% to 41%	January 2003
Flint River Basin, Georgia	Copper		January 2003
Flint River Basin, Georgia	DDE/DDD	99.6%	January 2003
Flint River Basin, Georgia	DO	Various (8 segments, including Lake Seminole headwater reaches), 0% to 67%	January 2003
Flint River Basin, Georgia	Fecal coliform	Various (12 segments), 18 to 97%	January 2013
Flint River Basin, Georgia	Fecal coliform	Various (6 segments), 13.5 to 73.5%	January 2008
Flint River Basin, Georgia	Fecal coliform	Various (28 segments), 1% to 96%	February 2003

Water Body	Pollutant Of Concern	Percent Reduction	TMDL Completed
Flint River Basin	Zinc		January 2003
White Oak Creek	Fecal coliform	0% baseflow, 99% storm flow	February 1998
Potato Creek	Fecal coliform	85%	February 1998
Kinchafoonee Creek	Fecal coliform	60% for agricultural areas, 0% for urban and forested areas	February 1998
Kinchafoonee Creek	Mercury	0%, from atmospheric contributions	February 2003
Chickasawakee Creek	Fecal coliform	96% baseflow, 25% agricultural areas, 50% forested, barren, and urbanized areas	February 1998
Ayocks Creek	Fecal coliform	60% for agricultural areas, 0% for barren, urban, and forested areas	February 1998
Lake Seminole	Chlordane	0%, no chlordane currently used in Georgia	February 1998
Lake Seminole	PCBs	0%, no PCBs currently used in Georgia	February 1998

2.1.2.4 Minimum Flow Requirements

As described in section 2.1.1.2.1, Buford Dam, West Point Dam, and Woodruff Lock and Dam have minimum release obligations as part of their operations. The minimum flow requirements at Buford and West Point dams are based on the original project authorization and can benefit temperature, DO, and nutrients. The minimum releases at Jim Woodruff Lock and Dam are necessary to comply with USACE's ESA requirements established during ESA section 7 consultation.

Historically, there also have been state minimum flow requirements in the ACF Basin to ensure that the designated use of the Chattahoochee River is maintained in two locations. These two locations are (1) downstream of Peachtree Creek in Atlanta, Georgia, and (2) near Phenix City, Alabama. In 2015, GAEPD removed the requirement at Peachtree Creek, indicating they would manage wastewater treatment discharges to ensure that water quality standards are met along that reach of the Chattahoochee River (GAEPD 2014c).

GAEPD requires an average flow of 750 cfs in the Chattahoochee River at its confluence with Peachtree Creek to maintain DO and temperature standards from May through October. The history of the 750 cfs minimum flow was presented in section 2.1.1.2.4.6. The normal flow target of 750 cfs is met by flows from Buford Dam as part of basin water management. Morgan Falls Dam (GPC), downstream of Buford Dam, reregulates the project inflows to ensure that the flow target at Peachtree Creek is met.

As described in section 4.1.2.4.2, in 2008 GAEPD requested reducing the 750 cfs year round minimum flow in the cooler months, from April through November, to 650 cfs. USACE performed an analysis of the effects of reduced flows following the GAEPD request. The EA indicated flows could be reduced to 650 cfs during November through April without significant adverse effects on water quality (USACE, Mobile District 2008b). In GAEPD's 2013 triennial review, they proposed that the 750 cfs be removed and indicated they would ensure that water quality standards are met at all flows (GAEPD 2014c). The standards were finalized in May 2015 (GAEPD 2015b).

Near Phenix City, Alabama, the WestRock (formerly MeadWestvaco) Mahrt Mill facility has a discharge permit that is dependent on flows. The ADEM-issued permit requires that their discharge rate is governed by a flow formula when the flow is less than 4,000 cfs from May through October. The flow formula was set to ensure that water quality standards are met in the Chattahoochee River.

2.1.2.5 Water Quality Monitoring

2.1.2.5.1 Surface Water Monitoring

Multiple federal and state laws require monitoring to ensure that water quality standards put forth by the states are being met. Most mandated water quality monitoring is conducted by local agencies and industries in accordance with NPDES permit rules and regulations. In addition to mandatory monitoring, water quality monitoring projects in the ACF Basin range in size and scope from the USGS' extensive surface water monitoring network to GAEPD's local, volunteer-staffed stream monitoring program and USACE monitoring in the tailrace of federal projects.

Several federal agencies monitor water quality within the ACF Basin. The USGS has a large network of surface water and groundwater monitoring stations through the Cooperative Water Program and coordinates its monitoring with local and state sponsors. Between 1991 and 1995, the USGS conducted intensive monitoring of groundwater chemistry and hydrology as part of the National Water Quality Assessment (NAWQA). Following completion of the intensive study, the USGS began long-term, low-intensity monitoring of the ACF NAWQA study site. USACE also monitors water quality in the tailrace of some dams (including Buford Dam, West Point Dam, and Walter F. George Dam) as a stewardship activity to monitor the fish and aquatic resource habitat downstream of reservoirs.

Georgia has several water quality sampling programs, and the data collected aids the state in making management, regulation, and water allocation decisions. Monitoring by the GAEPD includes trend monitoring, intensive surveys, reservoir and estuary monitoring, aquatic toxicity testing, and facility compliance testing (GAEPD 2008b). Georgia also requires municipalities to conduct watershed assessments when applying for NPDES permits for wastewater treatment upgrades or for construction of new wastewater treatment facilities. The watershed assessments require intense monitoring of water quality within the watershed for 1 yr to develop a watershed protection plan. Continuous, less-intense monitoring occurs in the watersheds as part of watershed protection plans.

Monitoring by other states is less extensive because the basin area within these states is 14.5 percent in Alabama and 11.5 percent in Florida. Alabama has a number of different water quality sampling programs, which focus on reservoir monitoring and trend monitoring, as well as specialty studies that address needs identified by ADEM to ensure water quality standards are met and develop wasteload allocations. The Florida DEP monitors surface water, groundwater, and trend networks on a rotating timeline. Monitoring is done to collect important information on chemical and biological parameters of the state waters and to respond to citizen concerns. More intense monitoring is conducted for regulatory issues, including the establishment of TMDLs; when developing site-specific quality criteria; and in association with regulatory permits (FLDEP 2005).

Throughout the ACF Basin, nonprofit organizations, local agencies, and industrial operations collect water quality samples to aid in management decisions and to ensure that point discharges are complying with NPDES permits. Given the size of the basin and the amount and scope of the data collected by these entities, their monitoring efforts are not detailed in this report. Information on some point sources and monitoring efforts is detailed in a number of TMDLs developed for the ACF Basin.

GAEPD monitors reservoirs in the ACF Basin to ensure compliance with water quality standards. It has developed site-specific water quality standards for chlorophyll *a*, total nitrogen, total phosphorus, and pH for Lake Lanier, West Point Lake, and Walter F. George Lake (Table 2.1-30). The lakes are sampled by the GAEPD during the growing season, April to October, when primary productivity is highest. In addition to the four above-mentioned parameters, the GAEPD collects data on DO, temperature, specific conductance, Secchi depth transparency, and turbidity. The GAEPD samples all other lakes in the ACF Basin quarterly on a 3-yr rotation basis (GAEPD 2008b).

Nonprofit organizations and universities also monitor lakes within the ACF Basin. The Upper Chattahoochee Riverkeeper works in conjunction with the GAEPD to monitor Lake Lanier and samples at 10 locations during the growing season for chlorophyll *a* and other standard water quality parameters. The Lake Blackshear Watershed Association released a report in 2002 detailing water quality and the trophic state of Lake Blackshear. Regular monitoring of temperature and DO at 21 stations has been conducted by Weyerhaeuser, a paper company, since the mid-1980s. Nutrient concentrations are also occasionally collected. Researchers at Auburn University in Auburn, Alabama, monitored fisheries, phytoplankton, and physical and chemical characteristics in a detailed study of West Point Lake from 1976 to 1985.

2.1.2.5.2 Groundwater Monitoring

In Alabama, Florida, and Georgia, groundwater quality monitoring occurs as part of required monitoring at potential contamination sites and as part of Safe Drinking Water Act requirements. Each state has a groundwater monitoring network.

Several national laws and programs require continuous groundwater quality monitoring. Such monitoring is required for NPDES permittees that have the potential to degrade groundwater, such as land application systems, underground storage tanks, and concentrated animal feeding operation lagoons. Permittees self-monitor the groundwater and report the findings to the states, and the states review the data and periodically sample the wells themselves. As part of the Safe Drinking Water Act, public drinking water wells are monitored, along with wells at permitted facilities, for pollutants such as volatile organic compounds, which come from businesses, homes, and agriculture. Public water supply systems are monitored for nitrate-nitrite, volatile organic compounds, uranium, copper and/or lead, and iron, manganese, and aluminum.

The Georgia Groundwater Monitoring Network (GGMN), managed by the GAEPD, consists of more than 130 wells, which are sampled periodically. Intensive monitoring of Georgia's groundwater occurred between 1991 and 1995, and it included sampling more than 5,000 shallow domestic wells for concentrations of nitrate-nitrite and additional standard parameters. Smaller subsets of wells within the GGMN are sampled as part of specialized projects that monitor drinking water wells for pesticides and nitrates and monitor groundwater near potential contamination sources (GAEPD 2008b).

Monitoring is focused on groundwater within the Apalachicola Basin and within the estuary. Florida established its GWQMN in 1983 to monitor the chemical and physical characteristics of aquifers. Monitoring is coordinated by the Florida DEP, and federal and state agencies, such as Florida's water management districts, are involved. The GWQMN is composed of two networks—the Background Network of 1,700 wells and the VISA Network. Data for the Background Network were collected from 1994 to 1997 and established baseline water quality data for groundwater for major ions, nutrients, and trace metals. A total of 40 wells were installed in the Apalachicola Basin (FLDEP 2010).

Along with standard chemical parameters, the VISA Network collects data on pesticides, trace metals, volatile organic compounds, and base neutral acid extractables in urban, agricultural, and forested land use areas. The resulting data are statistically compared to data from the Background Network to determine the effects of land use and site hydrogeology on the groundwater quality. On the basis of the

results of the latter analyses, predictions are made regarding the effects of comparable land uses in hydrogeologically similar areas of the state. The VISA Network study site in the Apalachicola River Basin examines the impact of cropland agriculture (FLDEP 2010).

2.1.2.5.3 Estuarine Monitoring

Water quality monitoring in Apalachicola Bay is conducted through the ANERR and Apalachicola Preserve. All levels of government are actively involved, along with private organizations and individuals. The data collected help ensure that the bay is meeting all water quality designations, including Outstanding Florida Water and Class II Shellfishing.

ANERR is one of 28 NOAA-designated research reserve sites. The 246,766 ac reserve includes estuaries, barrier islands, riverine systems, floodplains, and upland systems. In addition to routine water quality monitoring, the ANERR collects data on sediment erosion and accretion rates, and fish and macroinvertebrate populations while the Florida Department of Agriculture and Consumer Services (FDACS) collects data on fecal coliform. Research and monitoring in the ANERR are conducted by multiple organizations at the federal, state, and local level, including the USFWS, NWFWMD, and several local universities.

The ANERR water quality data are collected using data loggers at four water quality stations within Apalachicola Bay since 1993. The data loggers record temperature, depth, salinity, pH, DO, and turbidity every 30 minutes since 1993 and every 15 minutes since 2007. The data are transmitted to the NERR's Centralized Data Management Office every 2 to 3 weeks for compilation and analysis. Monthly nutrient grab samples are collected at 11 stations and analyzed for concentrations of nitrate-nitrite, ammonium, total dissolved nitrogen, orthophosphate, total dissolved phosphate, and chlorophyll *a*. In addition, nutrient samples are collected over a 25-hour period at one location monthly to determine the impacts of tidal cycles and diurnal variations on estuarine nutrient concentrations.

The Florida DEP manages the 80,000-ac Apalachicola Preserve, within the ANERR. Because most research and monitoring projects within the preserve are conducted by the ANERR, projects undertaken by the Florida DEP are focused on specific Apalachicola Bay management issues. Monitoring projects, which are conducted by both state and local entities, include periodic water sampling by the FDACS for consumption of shellfish and data collection on toxic *red tide* algae blooms by the FDACS and Florida Fish and Wildlife Conservation Commission. The Apalachicola Bay is classified as Class II Shellfish Propagation and Harvesting and as Class III Recreation, Propagation, and Maintenance of Wildlife. Most of the bay is listed as Class II water. Areas near the Gulf of Mexico do not meet the Class II water quality standards because of point and nonpoint source runoff from the City of Apalachicola, and they are closed to shellfishing (FLDEP 2013b).

2.1.2.6 Point Sources

Point source permitting has historically identified pipe discharges from M&I sources. In the late 1990s, the NPDES began to enforce its stormwater program by regulating stormwater discharges from municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. This program has changed the traditional definition of *point source*. The change allows regulators more authority over pollutants, ultimately resulting in improved water quality. Major M&I dischargers regulated under the NPDES program and discharging to the mainstem of the ACF Basin are listed in Table 2.1-34. *Major point sources* are defined as those that discharge more than 1 mgd of wastewater to surface waters.

Table 2.1-34.
2009 M&I NPDES Facilities in the ACF Basin[a]

Permit #	Facility	Receiving Waters	Design Flow (mgd)	DO (mg/L)	BOD5 (mg/L)	ON (mg/L)	NH3 (mg/L)	NO3/NO2 (mg/L)	Total P = PO4 (mg/L)
Upper Chattahoochee River to Whitesburg, GA									
GA0020168	Gainesville - Linwood WPCP	Lake Lanier	3	2	30/45	2	17.4/26.1	10	0.7
GA0021156	Gainesville - Flat Creek WPCP	Lake Lanier	12	5	9.8/14.7	2	1.5/2.3	10	0.68/1.02
GA0021504	Cornelia WPCP	So Fork-Mud Cr	3	6	25/38	2	1.5/2.3	10	0.7
GA0026077	Dahlonega WPCP	Yahoola Cr to Chestatee River	1.44	2	30/45	2	8/12	10	0.7
GA0001074	Tyson Foods Inc.	Unnamed trib/Orr's Creek	1.5	5	10	2	2	10	.75
GA0001198	USAF Lockheed (Plant No. 6)	Nickajack Cr/Rottenwood Cr/ Poorhous	2	5	10	2	2.3	10	.75
GA0001198	USAF Lockheed (Plant No. 6)	Nickajack Cr/Rottenwood Cr/ Poorhous	2	5	10	2	2.3	10	.75
GA0001198	USAF Lockheed (Plant No. 6)	Nickajack Cr/Rottenwood Cr/ Poorhous	2	5	10	2	2.3	10	.75
GA0001198	USAF Lockheed (Plant No. 6)		2	5	10	2	2.3	10	.75
GA0001198	USAF Lockheed (Plant No. 6)	Nickajack Cr/Rottenwood Cr/ Poorhous	2	5	10	2	2.3	10	.75
GA0001198	USAF Lockheed (Plant No. 6)	Nickajack Cr/Rottenwood Cr/ Poorhous	2	5	10	2	2.3	10	.75
GA0021458	Atlanta - Utoy Creek WPCP		37	5	24.8/37.2	2	16.5/24.7	10	0.7
GA0021482	Atlanta - R.M. Clayton WPCP	SE/Chattahoochee	100	5	25.2/37.8	2	16.8/25.2	10	0.7
GA0023167	Buford - Southside WPCP	Suwanne Cr	2	5	18/27	2	5/7.5	10	.75/1.1
GA0024040	Atlanta - South River WPCP	Chattahoochee	41	5	25.5/38.3	2	17/25.5	10	0.7
GA0024333	Fulton County - Big Creek WPCP	Chattahoochee	24	5	9.1/13.6	2	1.4/2.1	10	.75
GA0025381	Fulton County - Camp Creek WPCP	Chattahoochee	13	7	10/15	2	2/3	10	0.3
GA0026140	Cobb County - R.L. Sutton WPCP	Chattahoochee	40	5	10/15	2	9.1/13.7	10	.75
GA0026158	Cobb County - South WPCP	Chattahoochee	40	5	15/22.5	2	10.3/15.5	10	.75
GA0026433	Gwinnett County - Crooked Creek/North WPCP	Chattahoochee	36	5	3.4/5.1	2	1.1/1.65	10	.75
GA0030341	Douglasville - Southside WPCP	Anneewakee Cr/ Chattahoochee	3.75	2	30/45	2	6.6/9.9	10	.75
GA0030686	Fulton County - Johns Creek WRF	Chattahoochee	7	5	20/30	2	7.8/11.7	10	.75
GA0031721	Newnan - Wahoo Creek WPCP	Unnamed tributary to Wahoo Cr	3	2	30/45	2	5.6/8.4	10	0.7

Permit #	Facility	Receiving waters	Design flow (mgd)	DO (mg/L)	BOD5 (mg/L)	ON (mg/L)	NH3 (mg/L)	NO3/NO2 (mg/L)	Total P = PO4 (mg/L)
GA0038440	Fulton County - Cauley Creek WRF	Cauley Cr/ Chattahoochee	5	7	2.9/4.3	2	.5/.75	10	.13/.1
GA0038709	Douglasville Douglas County - South Central WPCP		6	5	10	2	5	10	0.7
GA0046019	Cumming - Bethelview Road WPCP	Big Cr	2	5	18/27	2	5/7.5	10	.75/1.12
GA0047201	Douglasville Douglas County - Sweetwater WPCP	Chattahoochee	3	5	20/30	2	17/25.5	10	0.75
Lower Chattahoochee River to Jim Woodruff Lock and Dam									
AL0000817[b]	MeadWestvaco (now WestRock) Coated Board	Chattahoochee (WFG Lake)	29.7[c]	5	10	2	5	10	0.7
AL0022209[b]	Phenix City WWTP	Chattahoochee	7.75[c]	6	19/28.5-Summer 25/37.5-Winter	2	4/6-Summer 20/30-Winter	10	0.7
AL0022764[b]	City of Dothan (Omussee Ck WWTP)	Omussee Creek	7.12[c]	6	3.5/5.2	4/6[d]	1/1.5	10	0.7
AL0023159[b]	City of Lanett WWTP	UT to Chattahoochee River	2.5[c]	6	25/37	2	20/30	10	0.7
AL0024619[b]	Southern Nuclear Operating Company		106.8[c]	5	30/45	2	5	10	0.7
AL0024724[b]	East Alabama WWTP (Lower Valley WTP)	Chattahoochee (Lake Harding)	4[c]	2	25/37.5	2	20/30	10	0.7
AL0059218	Opelika Eastside WWTP	Unnamed Trib to Halawaka Cr	1	6	9/13.5	2	2/3	10	0.7
AL0061671[b]	City of Eufaula WWTP	Chattahoochee	2.7[c]	5	25/37.5	2	20/30	10	0.7
AL0065641	Mount Vernon Chemical, LLC	UT Halawaka Cr	Not reported	5	10	2	5	10	0.7
AL0068837	AL-GA Wood Preserving	UT Finley Cr	Not reported	5	10	2	5	10	0.7
AL0070912	Tri-State Plant Food	Poplar Springs Branch	Not reported	5	10	2	5	10	0.7
AL0071978	Tessenderlo Kerley, Inc.	Barbour Creek	Not reported	5	10	2	10	10	0.7
AL0073555	Southern Power Company	Chattahoochee	1.68	5	10	2	5	10	0.7
AL0077259	Prince Manufacturing	UT Busseys Lake	Not reported	5	10	2	5	10	0.7
GA0000973	Columbus - Fort Benning (WPCP 1)	Chattahoochee	4.6	2	30/45	2	17.4/26.1	10	0.7
GA0000973	Columbus - Fort Benning (WPCP 2)	Chattahoochee	4.6	2	30/45	2	17.4/26.1	10	0.7
GA0020052	West Point WPCP	Chattahoochee	1	2	30/45	2	17.4/26.1	10	0.7
GA0020516	Columbus - South WPCP	Chattahoochee	42	2	10	2	5	10	0.7
GA0025585	Blakely WPCP		1.315	5	20/30	2	1.3/1.95	10	0.7
GA0036951	LaGrange - Long Cane Creek WPCP	Chattahoochee	12.5	6	10/15	2	2/3	10	1/1.5
GA0001201	Georgia Pacific - Great Southern Paper	Chattahoochee	Not reported	5	10	2	5	10	0.7

Permit #	Facility	Receiving waters	Design flow (mgd)	DO (mg/L)	BOD5 (mg/L)	ON (mg/L)	NH3 (mg/L)	NO3/NO2 (mg/L)	Total P = PO4 (mg/L)
Flint River to Jim Woodruff Lock and Dam									
GA0020079	Thomaston - Bell Creek WPCP	Bell Cr	2	2	30/45	2	5.4/8.1	10	0.7
GA0020486	Montezuma WPCP #2	Spring Cr/ Downstream of Drayton Rd.	1.95	5	20/30	2	4/6	10	0.7
GA0024503	Cordele WPCP	Cum Cr Trib to Flint River	5	6	11/16.5	2	2/3	10	0.7
GA0030121	Thomaston - Town Branch WPCP	Potato Cr Trib to Flint River	2	2	26/39	2	17.4/26.1	10	0.7
GA0030791	Griffin - Potato Creek WPCP	Potato Cr/Flint River	2	2	30/45	2	17.4/26.1	10	0.7
GA0035777	Peachtree City - Line Creek WPCP	Line Cr Trib/Flint River	2	6	8/12	2	2/3	10	0.7
GA0035807	Fayetteville - Whitewater Creek WPCP	Whitewater Cr/Line Cr	3.75	6	10/15	2	2/3	10	0.7
GA0038369	Clayton County - Shoal Creek WPCP	002-Unnamed Trib to Flint	4.4	5	10/15	2	4/6	10	2/3
GA0046655	Peachtree City - Rockaway WPCP	Line Cr Trib to/Flint River	4	6	8/12	2	2/3	10	0.7
GA0049336	Weyerhauser Company - Flint River Operations	Flint River	10	5	10	2	5	10	0.7
GA0000817	Tyson Foods Inc.	Muckalee Cr	1.15	5	10	2	5	10	0.7
GA0001619	Merck Manufacturing Division - Flint River Plant	Flint River	1.7	5	10	2	5	10	0.7
GA0001619	Merck Manufacturing Division - Flint River Plant	Flint River	1.7	5	10	2	5	10	0.7
GA0021326	Dawson WPCP	Brantley Cr	2.5	5	15/23	2	2/3	10	0.7
GA0024678	Bainbridge WPCP	Flint River	2.5	2	30/45	2	17.4/26.1	10	0.7
GA0025399	Crisp County Power Commission[e]	Lake Blackshear	4.8	5	10	2	5	10	0.7
GA0033511	Decatur County Industrial Airpark WPCP	Flint River	1.5	2	25/38	2	10/15	10	0.7
GA0037222	Albany - Joshua Street WPCP	Flint River	32	5	30/45	2	17.4/26.1	10	0.7
GA0047767	Americus - Mill Creek WPCP	Muckalee Cr Trib/Flint River	4.4	5	25/38	2	8.7/13.1	10	0.7
GA0049093	Miller Breweries East Inc.	Flint River	1.7	5	10	2	5	10	0.7
GA0049093	Miller Breweries East Inc.	Flint River	1.7	5	10	2	5	10	0.7
	= not permitted values but assumed for modeling purposes								

Notes:

[a.] Includes discharges permitted at greater than 1 mgd.

[b.] Includes design flows and permit limits based on personal communication with ADEM (Minton 2014, personal communication).

[c.] Assumes design flow for municipal WWTPs, long-term average for industrial and municipal WTPs.

[d.] Organic nitrogen permit limit was computed using the difference between total kjehldahl nitrogen and ammonia.

[e.] Assumes Crisp County Power Commission discharges into Flint below Lake Blackshear.

Facilities with NPDES permits are required to submit discharge monitoring reports to the ADEM, the Florida DEP, and GAEPD to ensure compliance with their NPDES permits. The limits expressed in NPDES permits are determined by states through the development of wasteload allocations. Wasteload allocations are developed to ensure facilities meet the in-stream water quality standards, as described in section 2.1.2.3, *Water Quality Standards*. Standard methods are used to develop wasteload allocations for individual dischargers when the facilities request new permits or changes to their existing permits. Table 2.1-34 identifies the 2009 permit limits for facilities that discharge to streams in the ACF Basin and 2012 permit limits for six Alabama facilities.

As previously described, regulations are changing to quantify stormwater runoff under the NPDES stormwater program for MS4s, construction activities, and industrial activities. The NPDES stormwater program was implemented in two phases on the basis of population. In 1990, cities and certain counties with over 100,000 residents were defined under the Phase I program; in 1999, Phase II established regulations for smaller cities. The details of the regulatory requirements are provided online at EPA's NPDES Stormwater Basic Information Web page (USEPA 2009a).

Regulations for construction activities require construction sites with equal to or more than 1 ac of disturbed area to obtain an NPDES permit and implement best management practices to prevent erosion of the disturbed areas. Regulations for industrial facilities require an NPDES permit for activities where pollutants might be transported to storm sewers or surface water. MS4s include municipal stormwater conveyance systems and, in some cases, roadways. Areas identified under the Phase I program are covered by individual NPDES permits (Table 2.1-35). In Alabama, Phase II communities and roadway MS4s are also covered under individual permits; in Georgia, however, Phase II communities are covered under a general permit, as shown in Table 2.1-36. In Florida in the ACF Basin, as of 2010, only the Department of Transportation (FLR04E023) and a small portion of the Bay County (FLR04E054) Phase II MS4 permitted area are permitted. All of these sources have been identified as major stressors on aquatic resources causing impairment to surface waters. The regulations are decreasing the amount of pollutants entering storm sewers and surface waters, but enforcement is limited.

Table 2.1-35.
Phase I Municipal Separate Storm Sewer Systems in the ACF Basin

Permit Number	Permittee
Upper Chattahoochee River to Whitesburg, GA	
GAS000300	Forsyth County
GAS000104	Buford
GAS000118	Gwinnett County
GAS000135	Sugar Hill
GAS000144	Suwanee
GAS000102	Alpharetta
GAS000138	Berkeley Lake
GAS000122	Lawrenceville
GAS000112	Duluth
GAS000131	Roswell
GAS000127	Norcross
GAS000111	DeKalb County
GAS000105	Chamblee
GAS000113	Doraville
GAS000117	Fulton County

Permit Number	Permittee
GAS000100	Atlanta
GAS000108	Cobb County
GAS000125	Marietta
GAS000132	Smyrna
GAS000110	Decatur
GAS000109	College Park
GAS000114	East Point
GAS000116	Forest Park
GAS000115	Fairburn
GAS000136	Union City
GAS000128	Palmetto
Lower Chattahoochee River to Jim Woodruff Lock and Dam	
GAS000202	Columbus-Muscogee County
Flint River to Jim Woodruff Lock and Dam	
GAS000117	Fulton County
GAS000100	Atlanta
GAS000116	Forest Park
GAS000119	Hapeville
GAS000107	Clayton County
GAS000141	Lake City
GAS000126	Morrow
GAS000130	Riverdale
GAS000120	Jonesboro
GAS000142	Lovejoy

Sources: GAEPD 2007a, 2007b

Table 2.1-36.
Phase II Municipal Separate Storm Sewer Systems in the ACF Basin

Permit Number	Permittee
Upper Chattahoochee River to Whitesburg, GA	
GAG6100000	Hall County
GAG6100000	Flowery Branch
GAG6100000	Gainesville
GAG6100000	Oakwood
GAG6100000	Cumming (Forsyth County)
GAG6100000	Mountain Park (Fulton County)
GAG6100000	Sandy Springs (Fulton County)
GAG6100000	Paulding County
GAG6100000	Dallas
GAG6100000	Hiram
GAG6100000	Douglas County
GAG6100000	Douglasville

Permit Number	Permittee
Lower Chattahoochee River to Jim Woodruff Lock and Dam	
ALR040002	ALDOT-Statewide
ALR040003	City of Auburn
ALR040007	City of Dothan
ALR040010	Geneva County
ALR040012	Lee County
ALR040018	City of Opelika
ALR040019	Phenix City
ALR040027	Houston County, City of Rehobeth, City of Taylor
ALR040028	Russell County
ALR040036	Smith Station
ALS000006	Alabama Department of Transportation Statewide
Flint River to Jim Woodruff Lock and Dam	
GAG6100000	Henry County
GAG6100000	Hampton
GAG6100000	McDonough
GAG6100000	Stockbridge
GAG6100000	Fayette County
GAG6100000	Fayetteville
GAG6100000	Peachtree City
GAG6100000	Tyrone
GAG6100000	Coweta County
GAG6100000	Newnan
GAG6100000	Spalding County
GAG6100000	Griffin
GAG6100000	Peach County
GAG6100000	Byron
GAG6100000	Houston County
GAG6100000	Centerville
GAG6100000	Warner Robbins
GAG6100000	Lee County
GAG6100000	Leesburg
GAG6100000	Dougherty County
GAG6100000	Albany
GAG6100000	Cordele (Crisp County)

Sources: GAEPD 2007c; Minton 2014, personal communication

2.1.2.7 Nonpoint Sources

Nonpoint sources of pollution are those generally associated with and quantified by land use activities in watersheds. Water quality concerns from nonpoint sources are usually related to fecal coliform bacteria, metals, nutrients (including biochemical oxygen demand, nitrogen, and phosphorus), pesticides, and suspended solids from overland and in-stream erosion. The sources of these pollutants are associated with runoff from areas and activities not regulated by the NPDES program. These activities are usually

associated with agricultural, forested, and urban land use activities. Table 2.4-1 and Figure 2.4-1 in section 2.4 present the land use activities in the ACF Basin.

Pollutant loads from agricultural, forested, and urban land use activities have been quantified though the development of TMDLs (section 2.1.2.3.1) and the Georgia state water plan in the ACF Basin. The extensive work done by a number of agencies can be consulted to quantify loads from land use activities in the basin. The variability in concentrations of a pollutant can be accounted for through understanding current and historical land use activities, along with the properties of soils and local geology.

Historically, agricultural lands have been a major source of sediment to water bodies. However, there has been a decrease in the amount of land farmed in the ACF Basin over the last century. In portions of the basin located in Georgia, a 57 percent reduction of farmland has occurred since 1950 (GAEPD 2009c). A decrease in soil erosion has been associated with the reduction in land farmed.

Urban activities in the ACF Basin, however, fall under both nonpoint and point sources as MS4 areas. Characterizing urban activities as point sources rather than nonpoint sources of pollution has allowed for improved regulatory authority over surface overland runoff from parking lots, as well as improved education on land use management to decrease pollutants (such as fertilizers and pesticides) entering surface water bodies. Regulation and enforcement of best management practices on construction sites have also decreased the amount of overland erosion and siltation and, thereby, the amount of solids entering surface water bodies.

2.2 Geology and Soils

2.2.1 Geology Affected Environment

The ACF Basin is divided into four level III *ecoregions*, or areas with similar physical, chemical, and biological environmental attributes that are identifiable at a local scale such that specific environmental management strategies can be formulated. All levels of government and research organizations use the ecoregions as the spatial framework for research and policy decisions, including the development of site-specific water quality standards and stream pollutant loads. A Roman numerical classification was set up to decrease confusion about the level of detail provided, where level I is the coarsest level, dividing North America into 15 ecological regions, and level IV to further define attributes that are identifiable at a local scale. The four ecoregions in the ACF Basin are the Blue Ridge, Piedmont, Southeastern Plains, and Southern Coastal Plain (Figure 2.1-8). These ecoregions reflect a geologic history of mountain-building in the Appalachian Mountains and long periods of repeated land submergence in the Coastal Plain ecoregion.

2.2.1.1 Blue Ridge and Piedmont Ecoregions

In the ACF Basin, the Blue Ridge ecoregion is limited to the northernmost portion of the basin and composes only about 1 percent of its area. The headwaters of the Chattahoochee River originate in this area, north of Lake Lanier. The ecoregion is characterized by mountain ridges that range in altitude from 3,000 ft and to 3,500 ft (Chapman and Peck 1997a; USGS 1996). Relative to other ecoregions in the ACF Basin, the soils are shallow and poorly developed. Runoff in the Blue Ridge ecoregion is rapid because the steep terrain sheds water quickly and the shallow soils do not store large quantities of water. The average runoff ranges from 15 to 40 in/yr (GAEPD 1997).

The Piedmont ecoregion, also in the northern portion of the basin, is directly south of the Blue Ridge. A sharp change in altitude, approximately 1,700 ft, defines the boundary between the Blue Ridge and Piedmont ecoregions (GAEPD 1997). The Piedmont has a lower relief than the Blue Ridge and is

dominated by highly dissected, rolling hills. The fault zones of the rocks, at the boundaries of the rock groups, run northeast to southwest and wield geologic control of the rivers and streams in the Upper Chattahoochee River basin. The Chattahoochee River runs parallel to the Brevard fault, and most streams have trellised and rectangular drainage patterns due to fault lines.

Both the Blue Ridge and Piedmont ecoregions are underlain by Precambrian and Paleozoic crystalline rocks, which include mica schist, felsic gneiss and schist, and granite and granite gneiss. Less extensive outcrops of quartzites are also present in the upper portion of the Flint River Basin, and ridges of quartzite rise 300 to 400 ft above the Piedmont relief (Chapman and Peck 1997b). The parent rock is typically covered by a layer of weathered rock and soil (regolith), which can range in thickness from a few ft to more than 150 ft. From the land surface, the regolith zone consists of a porous and permeable zone that grades downward into a clay-rich, relatively impermeable zone that overlies or grades into a porous and permeable saprolite known as a transition zone. Beneath the transition zone is impermeable unweathered bedrock, characterized by faults and fractures.

2.2.1.2 Southeastern Plain and Southern Coastal Plain Ecoregions

The northern boundary of the Southeastern Plain is marked by the Fall Line, which generally follows the contact between the crystalline rocks of the Piedmont and the unconsolidated sediments of the Southeastern Plains. The geology consists of the surficial sediments, which are predominantly sands of the Pliocene, Cretaceous, and Tertiary ages. Streams undergo abrupt changes in gradient at the Fall Line, which is marked by a series of rapids and shoals. In the Southeastern Plain, the streams typically lack the riffles and shoals common to streams in the Piedmont, and they exhibit greater floodplain development and increasing sinuosity (USGS 1996).

Within the ACF Basin, the Southeastern Plain ecoregion is divided into two main areas: a hilly region immediately below the Fall Line composed of the Fall Line Hills and Southern Red Hills ecoregions, and a region of karst topography area known as the Dougherty Plain ecoregion (Griffith et al. 2001). The Hills ecoregions are characterized by flat to moderately rolling sandy uplands dissected by deeply entrenched streams. The topographic relief ranges from 50 to 250 ft (Griffith et al. 2001). Cretaceous sediments lie in a band immediately below the Fall Line and crop out into the younger Eocene-Paleocene sediments of the low-lying Dougherty Plain ecoregion. The Dougherty Plain, directly south of the Hills, gently slopes southward; the relief rarely exceeds 20 ft. The karst topography has numerous sinkholes of varying size and is well-connected to surface water in some areas (Hicks et al. 1987).

The Southern Coastal Plains are sandy and flat, and they slope toward the sea. The area was shaped mostly by wave and current activity during the Pleistocene era (Arthur and Rupert 1989). The land surface is characterized by ancient marine bars, spits and sand-dunes, and marine terraces. Soils in the area are generally hydric and have a high capacity to hold and store water. The sediments that form the major aquifers in the lower ACF Basin occur in an overlapping sequence toward the southeast, roughly parallel to the Fall Line, and thicken toward the south and southeast. In this sequence, progressively younger sediments crop out and cover the older units.

The relationship between geology, and streams and aquifers is described in more detail in sections 2.1.1.1.3 and 2.1.1.1.7, respectively.

2.2.2 Soils Affected Environment

2.2.2.1 Soil Types

The sediments that are transported by the streams and deposited in the reservoirs of the ACF Basin originate as soils throughout the watershed. The different soils in the watershed have a variety of

compositions and differing proportions of rocks, sand, silt, and clay. Within the ACF Basin, three different soil orders make up most of the soils: ultisols, entisols, and spodosols (USGS 1996).

- *Ultisols* are characterized by sandy or loamy surface horizons overlying loamy or clayey subsurface horizons. These soils are formed in place through the deep long-term weathering of parent igneous and metamorphic bedrock. Although commonly called *red clay soil,* these soils range in color from bright orange to pale yellow-brown.
- *Entisols* are characterized as sandy, deep, infertile, well-drained, and subject to active erosion. These soils show poorly developed subhorizons and are called *young* because little change is exhibited from the parent material.
- *Spodosols* in the ACF Basin are characterized as sandy, shallow, infertile, and poorly drained due to an underlying layer cemented by mineral precipitation.

The Piedmont ecoregion is dominated by ultisols, which generally lack the original topsoil due to erosion during intensive cotton farming beginning in the 18th century (USGS 1996). The soils of the Coastal Plain ecoregion are formed from marine sediments eroded from the Appalachian range and Piedmont. These soils are primarily ultisols with the exception of entisols immediately south of the Fall Line and along the lower Flint River Basin. The soils of the ACF Basin in the Southern Coastal Plain are dominated by ultisols to the west of the Apalachicola, spodosols to the east, and entisols near the coast (Collins 2009).

2.2.2.2 Hydraulic Conductivity

The portions of precipitation that either run off the landscape or infiltrate the soil are regulated by the ability of soil layers to infiltrate water. This infiltration ability is expressed as the *hydraulic conductivity* of the least pervious soil layer in a soil profile. For use in hydrologic runoff calculations, the many different soil types in a watershed are typically classified into one of four hydrologic groups—A, B, C, or D—on the basis of hydraulic conductivity, expressed in inches per hour (Table 2.2-1). Infiltration ability can also be affected by the proximity of the water table to the ground surface. If a D group soil has a higher hydraulic conductivity when drained, it is given a dual group name (Table 2.2-1). The Disturbed Soil classification is used for soils with hydraulic conductivities that might have become altered during land development; such soils need to be directly tested to determine their hydrologic soil groups (NRCS 2009).

Table 2.2-1.
Hydraulic Conductivities of the Hydrologic Soil Groups

Hydrologic Soil Group	Hydraulic Conductivity (in/hr)	Runoff Potential When Thoroughly Wet
A	Greater than 5.67	Low
B	1.42 to 5.67	Moderately Low
C	0.14 to 1.42	Moderately High
D	Less than 0.14	High
Disturbed Soil	N/A	N/A
A/D, B/D, C/D	D group soil, but drainable to the greater conductivity	High when undrained

Source: NRCS 2009

The soil groups can also be described qualitatively:

- *Group A soils* are typically less than 10 percent clay and more than 90 percent sand or gravel, with textures described as a sand, gravel, or loam.

- *Group B soils* are typically 10 to 20 percent clay and 50 to 90 percent sand, with textures typically described as a loamy-sand.
- *Group C soils* are typically 20 to 40 percent clay and less than 50 percent sand, with textures that include loam plus sand, silt, and/or clay.
- *Group D soils* are typically greater than 40 percent clay and less than 50 percent sand and are described as having a clayey texture.

Also, a soil is classified as group D if the water table is within 2 ft of the surface. If a sandy or loamy soil overlying a high water table can be drained, the soil is given the dual classification A/D, B/D, or C/D.

Trends in the occurrence of the soil hydrologic groups are noted among the four ecoregions of the ACF Basin (Figure 2.2-1). North of the Fall Line, within the Piedmont and Blue Ridge ecoregions, the soils are over 90 percent group B. The Coastal Plain Ecoregion is composed of about 50 percent group B soils. The remainder consists of about 27 percent group A, 19 percent group C, and the rest groups D and B/D. No A/D or C/D soils were shown in the State Soil Geographic (STATSGO) soil data set for the ACF Basin (NRCS 2014). The group A soils occur primarily in a band south of the Fall Line and in the karst uplands along the lower Flint River valley. The group D soils primarily follow the valleys of the first- and second-order tributaries draining to the Flint River. The B/D soils are primarily found in Florida in the Southern Coastal Plain Ecoregion and along the valleys of first- and second-order tributaries to the Flint River between the Fall Line and Albany.

In general, regions of C and D soil groups generate the greatest amount of runoff per acre. This effect is increased in areas with steep topography, where precipitation has less time to infiltrate before running off to streams. The areas with the highest runoff potential are in the mountain areas of the Blue Ridge and northern Piedmont, the clay-rich C soils immediately south of the Fall Line, the clay-rich stream valleys in the Coastal Plain, and the areas of the Southern Coastal Plain with a high water table.

In general, regions of A and B soil groups promote the greatest amount of infiltration and groundwater recharge. This effect is increased in areas of low relief where precipitation is slow to run off and might even pond. The areas with the highest infiltration potential include the group A sandy soils south of the Fall Line and the sandy soils overlying the porous karst geology along the lower Flint River valley and lower Chattahoochee River valley.

2.2.2.3 Prime Farmland

Prime farmland is defined by the USDA as land that has:

> …the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for long periods of time, and they either do not flood frequently or are protected from flooding. (7 CFR, Part 657.5a)

Approximately 26 percent of the ACF Basin has been designated as prime farmland. Most of the prime farmland is in the southern third of the ACF Basin, particularly in areas along streams where surface and groundwater resources are more readily available for irrigation (Figure 2.2-2).

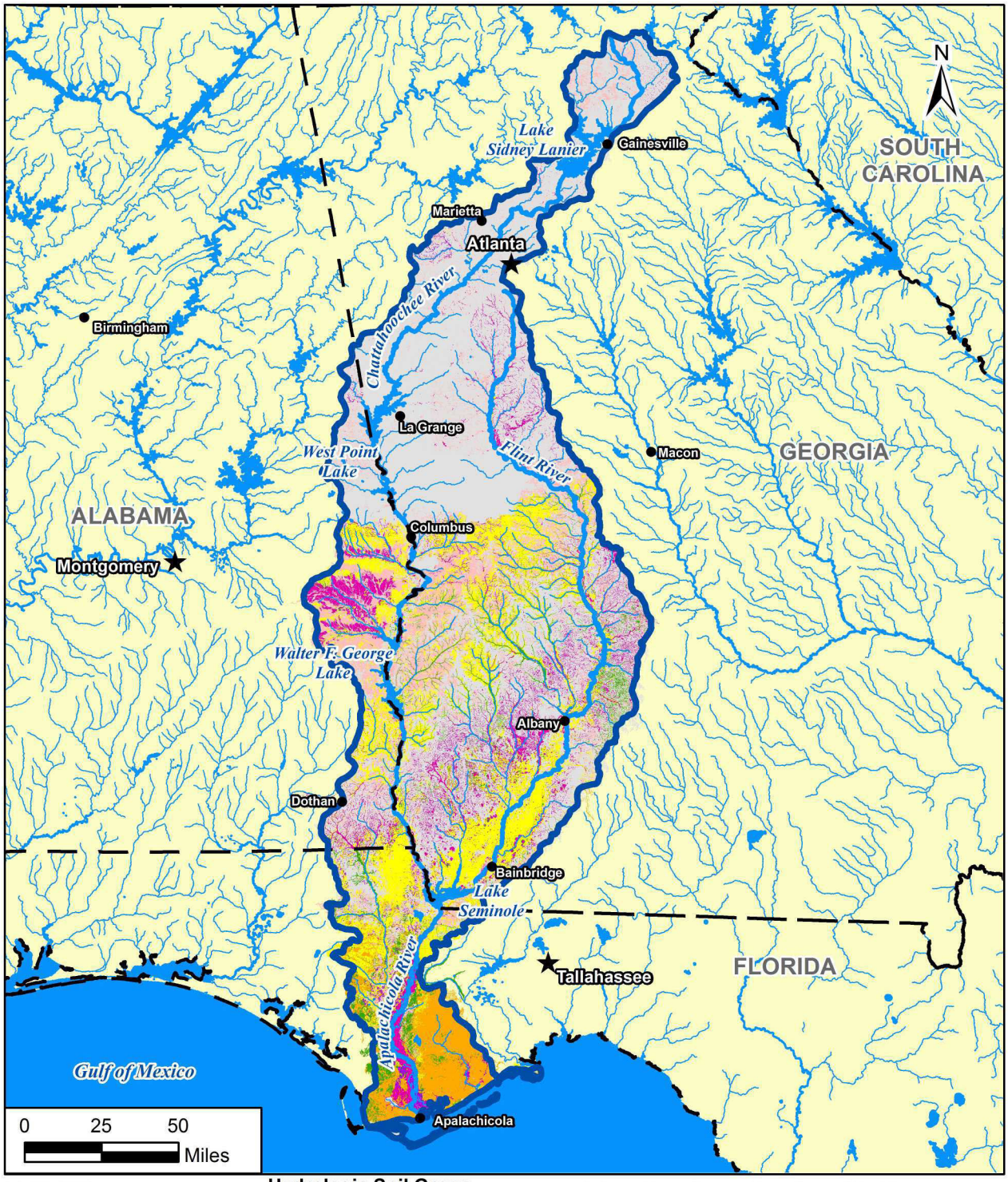


Figure 2.2-1

Source: NRCS 2014.



Figure 2.2-2

Source: NRCS 2014.

2.2.2.4 Sediment

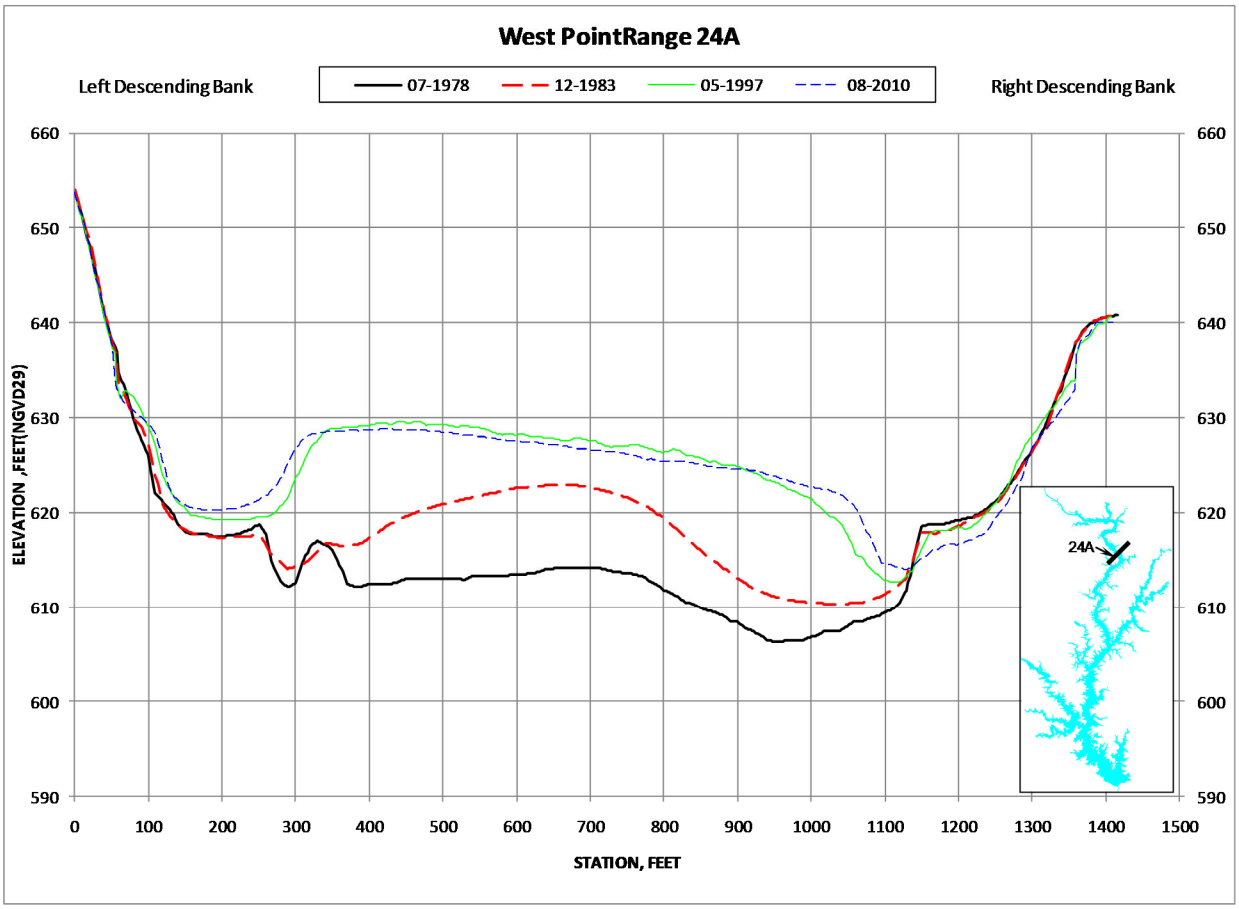
This EIS is focused on the operations of USACE reservoirs, and, therefore, it is most appropriate to focus on sediment transported by rivers rather than overland sources. In general, the quantity and size of sediment transported by rivers is related to the size and frequency of dams in the river system. Impoundments behind dams serve as sediment traps where coarse bed material particles, typically sand and larger particles, settle in the reservoir headwaters where entering flows are slowed. Fine particles, typically silts and clays, can remain in suspension and pass downstream through the reservoir. Large impoundments typically trap most of the sediment load, retaining all the sand and coarser particles plus much of the silt- and clay-sized particles. Smaller run-of-the-river impoundments tend to pass all sizes of suspended particles during low to moderate flows and coarser bed material particles during high flows. Because of this sediment trapping, impoundments can cause the stream bed to elevate in upstream channels, which reduces the channel gradient. Below dams, the river typically becomes starved for sediment. The response of a channel downstream of a dam depends on how resistant to erosion the channel bed and banks are and how quickly sediment is replenished from downstream tributaries and upland erosion sources. A typical response for channels, with bed and banks composed of easily eroded sands, silts, and/or soft clays, is for the bed to degrade to a reduced elevation; the channel might also widen through bank erosion.

The four largest projects in the system—Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole—act as sediment traps, retaining most of the sand and larger bed material. Lake George W. Andrews is a run-of-the-river project, which passes most of the sand and fine bed material. A detailed description of each of these impoundments is provided in section 2.1.1.1.6. Cross-sectional hydrographic surveys of reservoirs and tailraces were done periodically at the five USACE projects in the ACF Basin since the 1950s. Data were collected from three to five times at Lake Lanier, West Point Lake, Lake George W. Andrews, and Lake Seminole with the initial data being collected during the first year of impoundment and the most recent data collected in 2009. Following is a discussion of the five projects based on the hydrographic surveys.

2.2.2.4.1 Reservoir Sedimentation

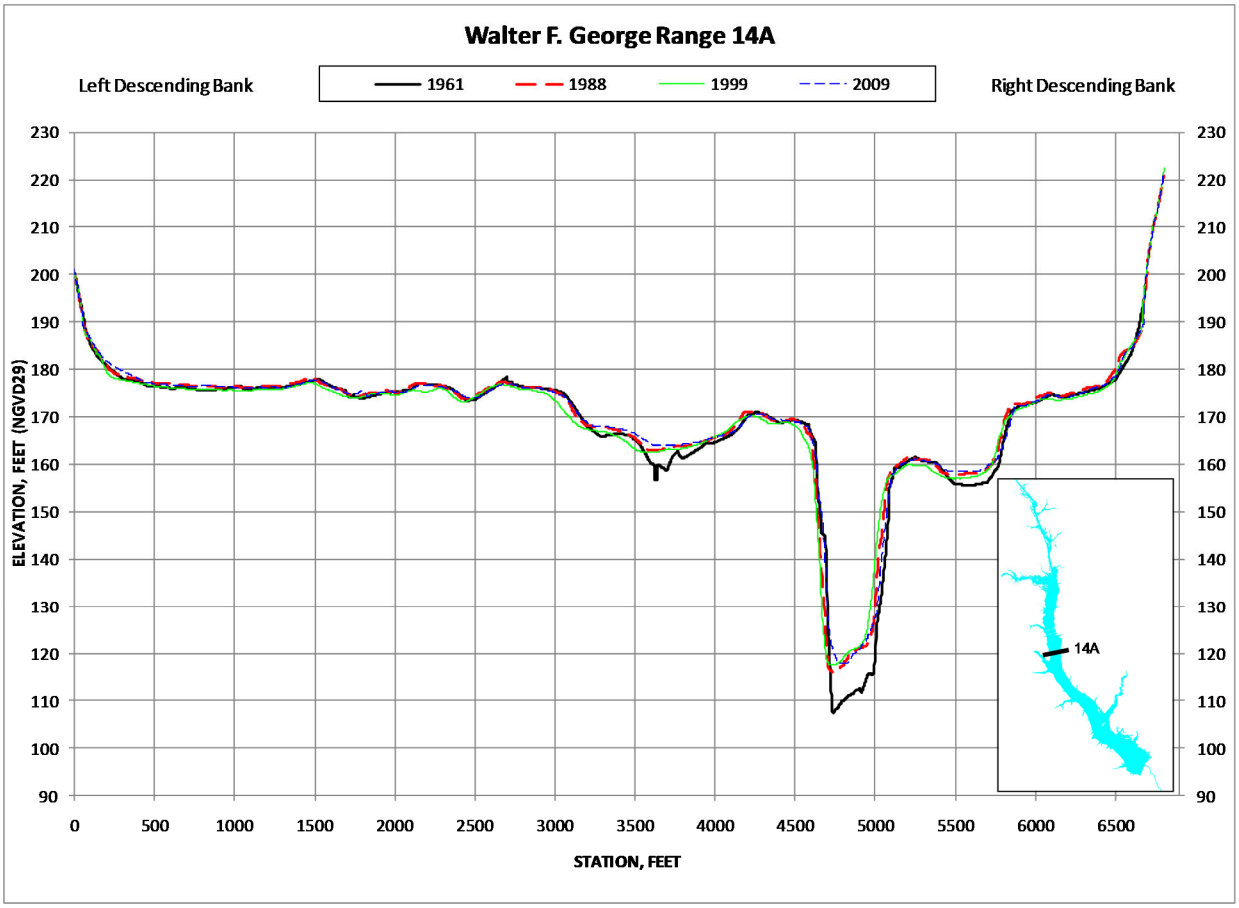
In general, four of the five projects (excluding George W. Andrews) are undergoing similar processes. Lake Lanier, West Point Lake, Walter F. George Lake, and Lake Seminole have an upper riverine region where inflows (Chestatee and Chattahoochee rivers for Lake Lanier, Chattahoochee River for West Point and Walter F. George lakes, and Chattahoochee and Flint rivers for Lake Seminole) dominate the bed and shoreline forming processes. The river beds have aggraded and widened by several ft over approximately the first 20 years since construction of the dams. Since then, the upper reaches have reached an equilibrium state where additional sediment load is transported through the reservoir without aggrading on the bed. In some upper reach locations, a portion of the sediment is being deposited overbank. Where the riverine section transitions to the main reservoir body, it is typical for sediment to be deposited in a delta. Hydrographic range surveys appear to cross delta deposits in two of the five lakes: range 24A (Figure 2.2-3) in West Point Lake, and range 4A in Lake Seminole (not depicted, see Tetra Tech 2011a). In Figure 2.2-3, the greater portion of the channel center has silted in up to the winter pool elevation of 628 ft, thus forcing flow to either channel margin. Below the deltas, the main reservoir bodies consist of a relatively flat reservoir bed several thousand ft wide (preimpoundment flood plain) cut by a 50-ft-deep by 300- to 400-ft-wide canyon (preimpoundment river channel). Sediment deposits on the flat reservoir bed are sufficiently thin to be within the depth measurement variability of the hydrographic surveys and, thus, show essentially no sedimentation through 2009. The historic river channels typically hold sediment deposits several ft thick which, in some cases, show trends of heavy deposition rates early in the life of the project, and reduced rates more recently (Figure 2.2-4). Because the historic river channels make up only a fraction of the total reservoir bed, the overall loss of storage capacity due to sedimentation for each project as of 2009 is estimated to be about 1 percent for Lanier, West Point, and Walter F. George lakes,

and 2 percent for Lake Seminole. Lake George W. Andrews is a special case in that the entire project is riverine, and the uppermost reach is within the tailwater of Walter F. George Lock and Dam. Each project is discussed in greater detail in the following sections.



Source: Tetra Tech 2011c

Figure 2.2-3. Extreme Example of Sedimentation at West Point Lake.



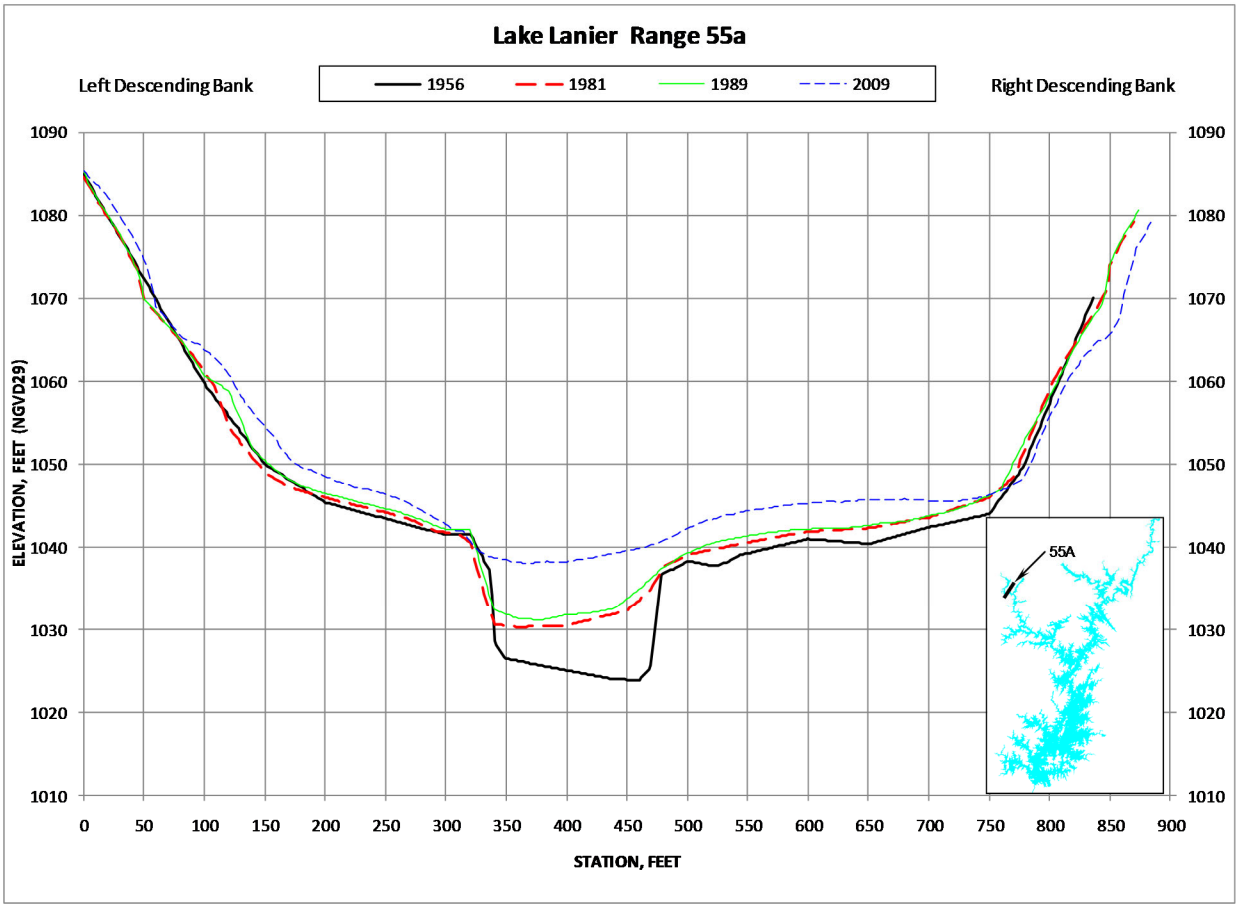
Source: Tetra Tech 2011d

Figure 2.2-4. Typical Example of Sedimentation at Walter F. George Lake.

2.2.2.4.1.1 Lake Lanier

Lake Lanier has been hydrographically surveyed four times since its impoundment: 1956, 1981/1983, 1989/1990, and 2009. The form of the reservoir is dendritic with many islands and numerous small tributaries and associated embayments joining the main reservoir body. Steeply sloping shorelines are prevalent. Two main rivers drain to the lake: the Chestatee from the northwest and the Chattahoochee from the northeast. An analysis of the survey data indicates that, in general, the main body of Lake Lanier is unaffected by sedimentation. Between 1956 and 2009, less than 1 percent of the volume of the main body of the reservoir was lost to sedimentation (Tetra Tech 2011b). Measurable sedimentation is noted in the upper reaches of the two main rivers and in several of the tributaries. The general trend indicates that, where measurable sedimentation has occurred, it has been relatively heavy and was at a constant rate from 1956 to 2009 (Figure 2.2-5). Historical aerial imagery indicates that the uppermost reaches of many of the tributaries have undergone sedimentation where they meet the lake. Because the tributary heads were not surveyed near the upper end of their embayments, the degree of sedimentation is not known.

The mainstem of the Chestatee River at the head of Lake Lanier appears to be undergoing ongoing sedimentation at about 15 ft over the past 53 years (Figure 2.2-5). Similarly, the mainstem of the Chattahoochee River at the head of Lake Lanier appears to also be undergoing continuous sedimentation. Progressing downstream toward the lake, both rivers show a much reduced sedimentation rate.



Source: Tetra Tech 2011b

Figure 2.2-5. Uniform Sedimentation on the Chestatee River at Lake Lanier.

Shoreline erosion is prevalent around the reservoir with a 2- to 5-ft-high escarpment common along most shorelines between the summer and winter pool elevations. Cross-section survey data at sedimentation ranges indicate that approximately half of the ranges had undergone most of the shoreline erosion before the 1983 survey, whereas the shorelines of the remaining ranges are still actively eroding. Locations where the erosion rate has become reduced is possibly due to the exposure of the more robust underlying bedrock (Tetra Tech 2011b).

2.2.2.4.1.2 West Point Lake

West Point Lake has been hydrographically surveyed four times since its impoundment: 1978, 1983, 1997, and 2009. An analysis of the survey data indicates that, in general, the main body of West Point Lake is unaffected by sedimentation. Between 1978 and 2009, less than 1 percent of the volume of the main body of the reservoir was lost to sedimentation (Tetra Tech 2011c). However, high rates of sedimentation have occurred in the heads of bays where major tributaries enter the reservoir and in the mainstem of the Chattahoochee River where it enters the lake. Sedimentation rates at the head of the reservoir vary between about 10 to 30 percent locally, depending on where the rates are measured. The general trend indicates that sedimentation rates were highest during the first two decades following the construction of West Point Dam, while over the most recent decade, the rate has dropped off considerably (Figure 2.2-3). The shoreline and riverbed forms of the uppermost reaches of the reservoir are dominated by riverine processes. Bed and bank forms are most strongly influenced by recurring floods, which cause channel migration through the eroding

of outside riverbends and depositing eroded sediment on inside riverbends. Erosion is pervasive along shorelines surrounding the main body and major embayments of the lake. The form of erosion is related to the topographic relief and underlying geology of the shoreline. Gently sloping shorelines in unconsolidated materials are slowly eroding in the vertical direction between the summer and winter pool elevations. Steeply sloping shorelines have eroded horizontally until an escarpment has been created. The rate of shoreline erosion appears to have been highest during the first 20 years from 1978 until 1997. From 1997 to 2009, the erosion rate appears to have been greatly reduced in most locations possibly because of the exposure of the more robust underlying stiff clays and bedrock (Tetra Tech 2011c).

2.2.2.4.1.3 Walter F. George Lake

Walter F. George Lake has been hydrographically surveyed four times since its impoundment: 1960-62, 1988, 1999, and 2009. An analysis of the survey data indicates that, in general, the main body of Walter F. George Lake is unaffected by sedimentation. Between 1960 and 2009, less than 1 percent of the volume of the main body of the reservoir was lost to sedimentation (Tetra Tech 2011d) (see also section 2.1.1.1.6.5 for further discussion on loss of total storage volume). The form of the reservoir is relatively long and narrow with only four minor tributaries and associated embayments. Where surveyed, these tributaries did not appear affected by sedimentation. However, a review of historical aerial photos indicates sedimentation has been ongoing in the uppermost portions of the embayments. The general trend indicates that most of the sedimentation appears to have occurred between 1960 and 1988, continuing to the present at a reduced rate (Figure 2.2-4).

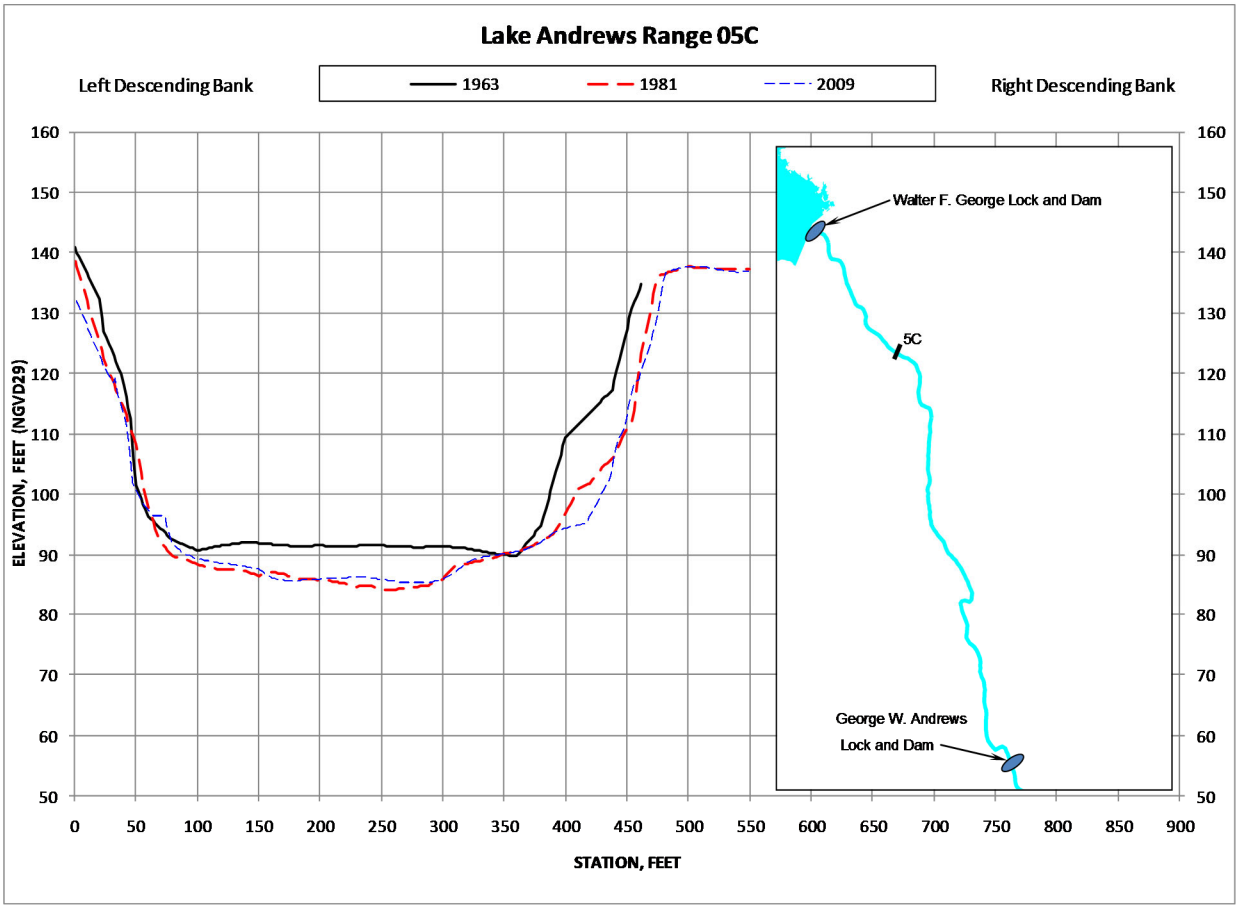
Along the uppermost portions of the lake, the impoundment is dominated by riverine channel forming process of the Chattahoochee River. Sedimentation was greatest from 1960 to 1988, with approximately 2–5 ft of deposition. Since 1988, the sedimentation rate along the riverine portion of the reservoir has been negligible.

The shoreline and riverbed forms of the uppermost reaches of the reservoir are dominated by riverine processes. Bed and bank forms are most strongly influenced by recurring floods, which cause channel migration through the eroding of outside riverbends and depositing eroded sediment on inside riverbends. Erosion is pervasive along shorelines surrounding the main body and major embayments of the lake. The form of erosion is related to the topographic relief and underlying geology of the shoreline. Gently sloping shorelines in unconsolidated materials are slowly eroding in the vertical direction between the summer and winter pool elevations. Steeply sloping shorelines have eroded horizontally until an escarpment has been created. The typical escarpment ranges from 2–5 ft high. The rate of shoreline erosion appears to have been highest during the first 20 years from 1978 until 1997. From 1997 to 2009, the erosion rate appears to have been greatly reduced in most locations, possibly because of the exposure of the more robust underlying stiff clays and bedrock (Tetra Tech 2011d).

2.2.2.4.1.4 Lake George W. Andrews

Lake George W. Andrews has been hydrographically surveyed three times since its impoundment: 1963, 1981, and 2009. The form of the reservoir is run-of-the-river joined by numerous tributaries ranging from about 1 sq mi to about 300 sq mi in drainage area. Embayments associated with the tributaries are minor in size and none contain a sedimentation range. An analysis of the sedimentation range survey data indicates that, in general, Lake George W. Andrews is unaffected by sedimentation and conversely is affected by scour. Bed erosion occurs along the entire length of the project (stream mile 46.53 to 75.17), but is most strongly exhibited along the upper half. Sedimentation range cross sections averaged an 18 percent increase in area between 1963 and 2009 (Tetra Tech 2011e). That increase was caused by both bed degradation and channel widening. The channel has widened along the entire length; however, the

right bank appears to have retreated slightly more than the left. Bank elevations undergoing erosion range from about 92 ft up to 120 ft (Figure 2.2-6).

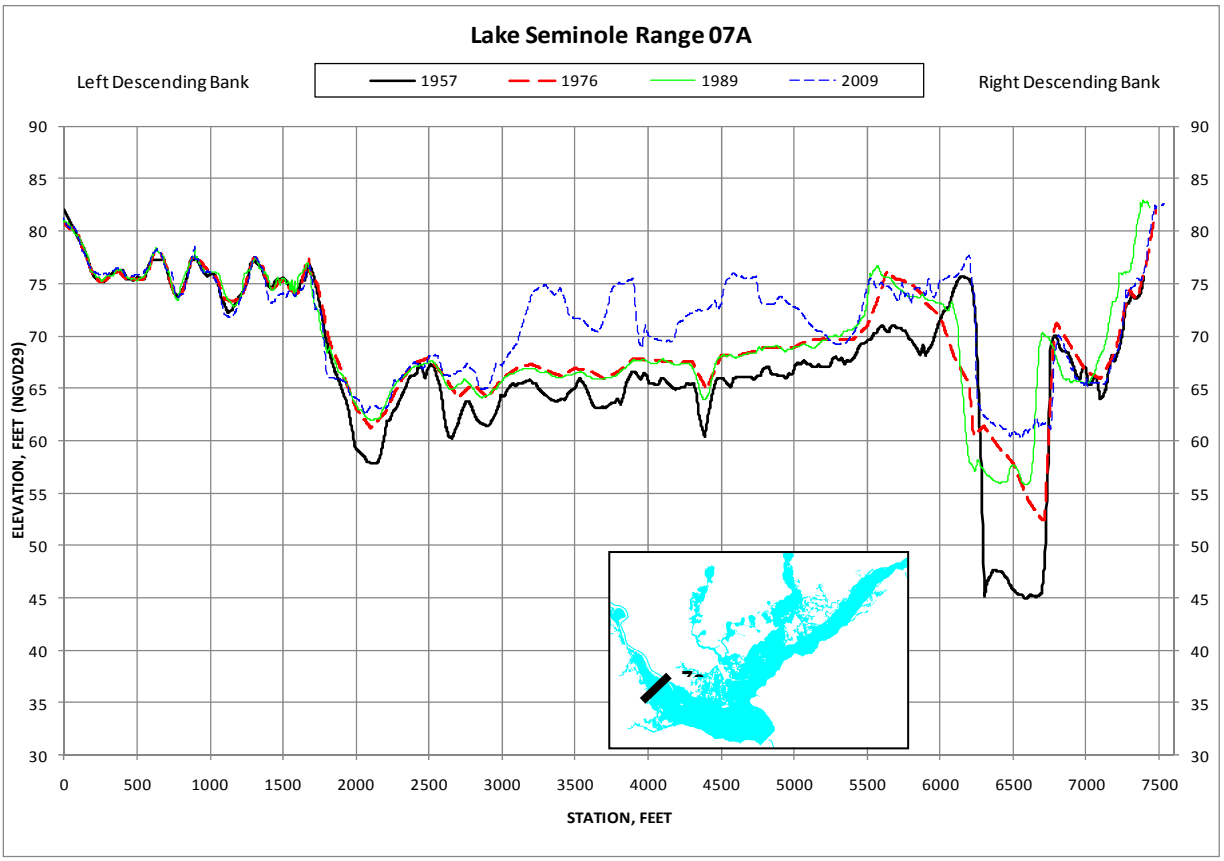


Source: Tetra Tech 2011e

Figure 2.2-6. Typical Channel Degradation and Widening at Lake George W. Andrews.

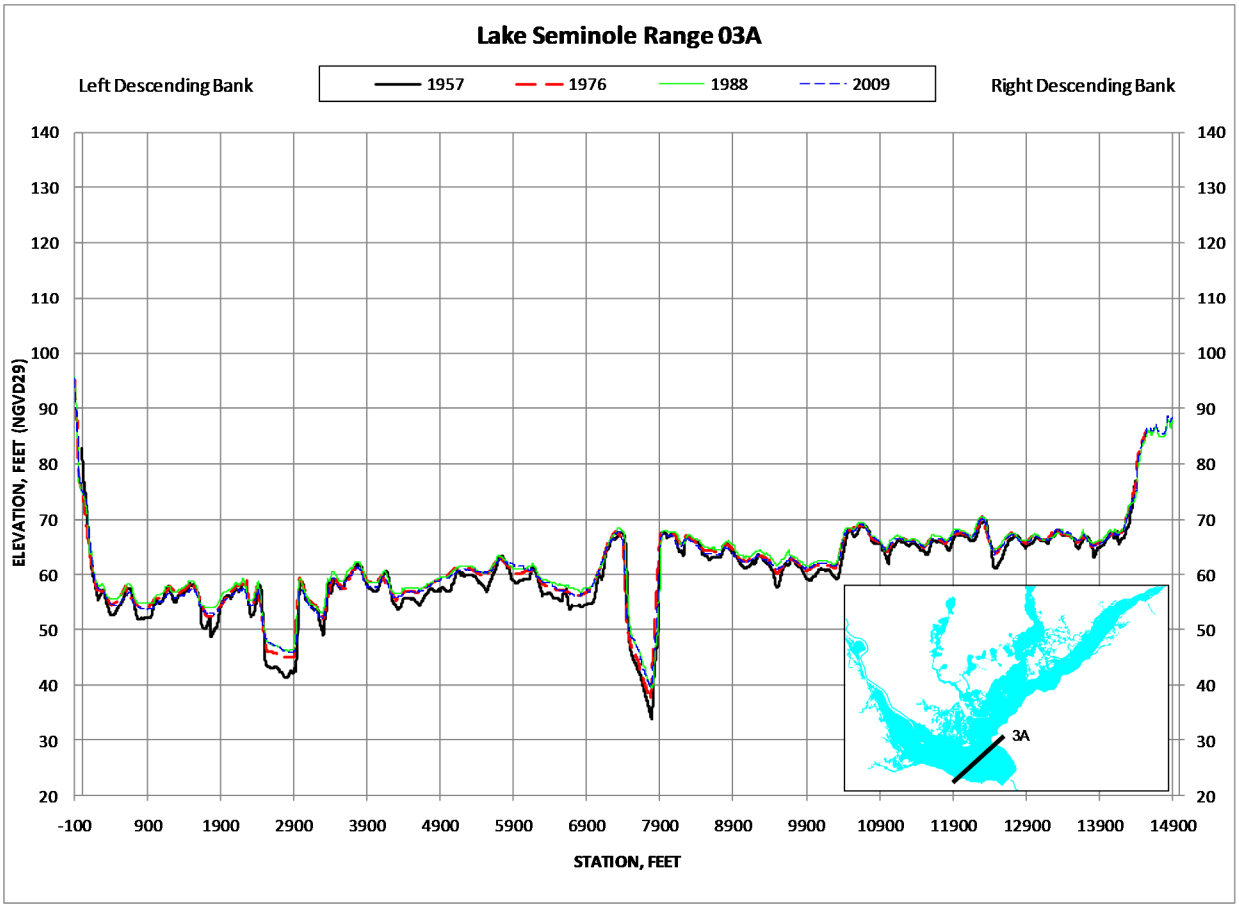
2.2.2.4.1.5 Lake Seminole

Lake Seminole has been hydrographically surveyed four times since its impoundment: 1957, 1976, 1988/1989, and 2009, plus a partial survey in 1963. The form of the reservoir is dendritic with a marshy, indefinite shoreline surrounding the main reservoir body. Two main rivers drain to the lake: the Chattahoochee River from the northwest and the Flint River from the northeast. An analysis of the survey data indicates that, in general, the main body of Lake Seminole is lightly affected by sedimentation. Between 1957 and 2009, about 2 percent of the volume of the main body of the reservoir was lost to sedimentation (Tetra Tech 2011a). However, the reach where the Chattahoochee River joins the main reservoir body is heavily affected with about 25 percent of the reservoir cross section lost to sedimentation (Figure 2.2-7). The reach where the Flint River joins the main reservoir is essentially unaffected by sedimentation. However, that lack of impact appears to be the result of channel dredging below the town of Bainbridge. The general trend indicates that, where measurable sedimentation has occurred, it was relatively heavy and at a constant rate from 1957 to 2009 (Figure 2.2-8).



Source: Tetra Tech 2011a

Figure 2.2-7. Heavy Delta Sediment Deposits at Range 7a in Lake Seminole.



Source: Tetra Tech 2011a

Figure 2.2-8. Typical Reservoir Bed Deposition at Lake Seminole.

Erosion is minor around the reservoir with some gently sloping shorelines eroding vertically downward. In general, the shorelines are well protected from wave generated erosion by their gentle slope and dense wetland and aquatic vegetation in the littoral zone. The shoreline escarpments prevalent at the northern three projects are not found at Lake Seminole. The riverine portions of the impoundment are undergoing bank erosion and channel widening, in particular on the Chattahoochee River portion (Tetra Tech 2011a).

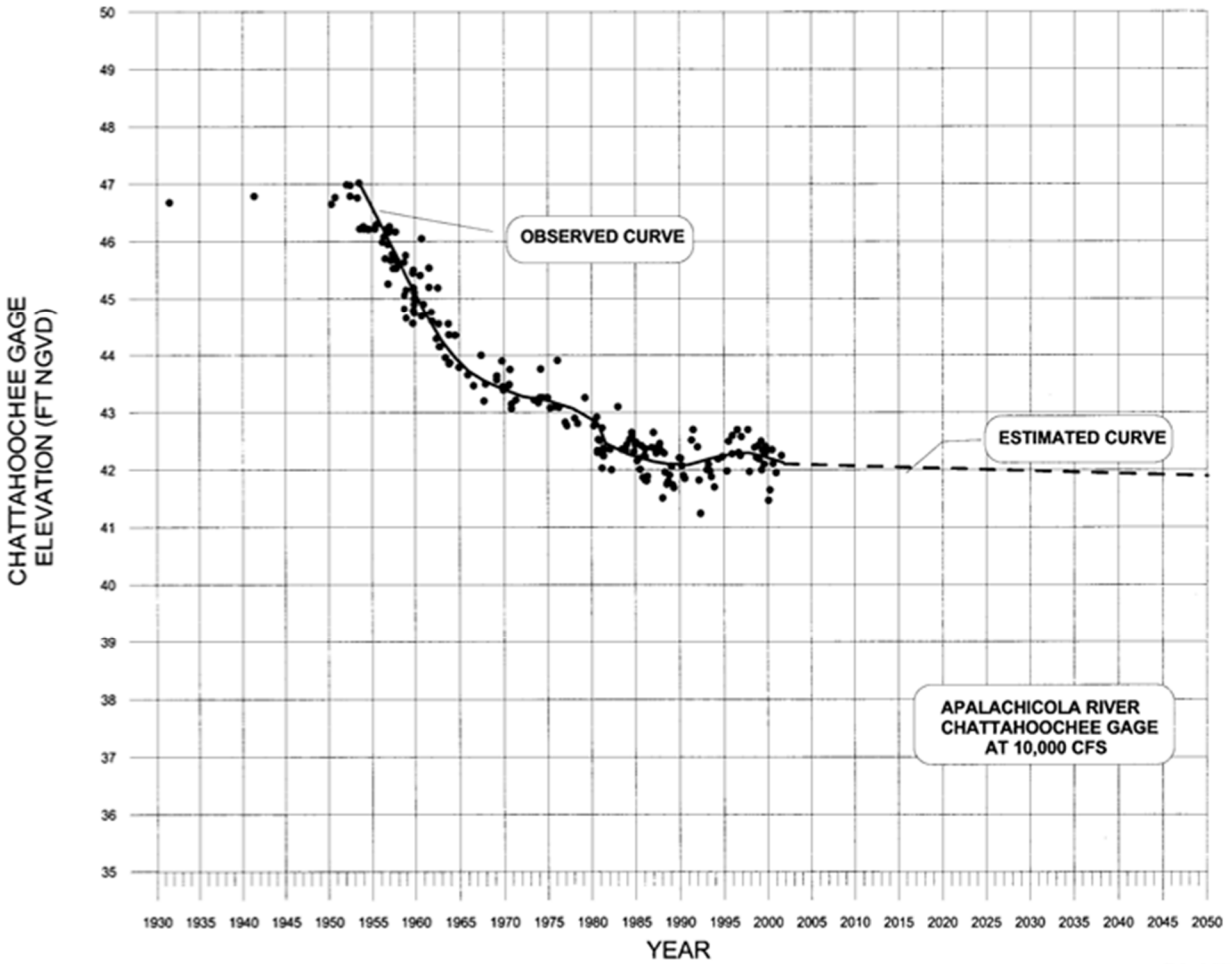
2.2.2.4.2 Tailwater Degradation: Impact of Impoundments on Channel Stability

With each major reservoir functioning as a sediment trap, the potential exists for a reduced sediment load and corresponding bed degradation along the river reaches immediately below each dam. In the middle reaches of the ACF Basin, bed degradation of the river below the Walter F. George and George W. Andrews dams is attenuated to some degree by dams downstream in the system. In the upper reaches of the ACF Basin, bed degradation below Buford and West Point dams is attenuated by natural bedrock grade controls. However, below the Jim Woodruff Lock and Dam, which is the furthest downstream, there is no controlled tailwater, and erosion has occurred. Therefore, the following discussion focuses on the portion of the river system below Jim Woodruff Lock and Dam.

Since the construction of Jim Woodruff Lock and Dam, the Apalachicola River bed has degraded by about 5 ft within 1 mi below the dam and by about 2 ft at Blountstown (Light et al. 2006; USACE, Mobile District 2002b). The rate of this degradation can be discerned through comparisons of discharge

rating curves at the four USGS gaging stations on the river at Chattahoochee (RM 105.8), Blountstown (RM 77.4), Wewahitchka (RM 41.5), and Sumatra (RM 20.6) (USACE, Mobile District 2002b).

At Chattahoochee, a tailwater degradation curve was developed to show changes in stage for a given flow over time. All flows near 10,000 cfs were used to generate the curve (Figure 2.2-9). The curve indicates that, since the construction of Jim Woodruff Lock and Dam, the channel initially eroded at a fairly constant rate until the late 1960s, when the channel appeared to stabilize and eroded at a reduced rate through the 1970s. The drop in the stage in 1981 can be attributed to rock removal at that time. The channel remained essentially stable from 1985 until the present (USACE, Mobile District 2002b). To compare tailwater degradation for flows lower and higher than 10,000 cfs, a specific gage analysis was conducted for the Chattahoochee gage (USGS02358000). The interpretation of the tailwater curve in Figure 2.2-9 is corroborated in the trend lines on Figure 2.2-10; bed degradation took place at a high rate until about 1981. Degradation has continued at a reduced rate since 1982. The slopes of the trend lines in Figure 2.2-10 equate to a degradation rate of about 0.03 ft/yr, or 1 ft over 33 years.



Source: USACE, Mobile District 2002b

Figure 2.2-9. Tailwater Degradation Curve below Jim Woodruff Lock and Dam.

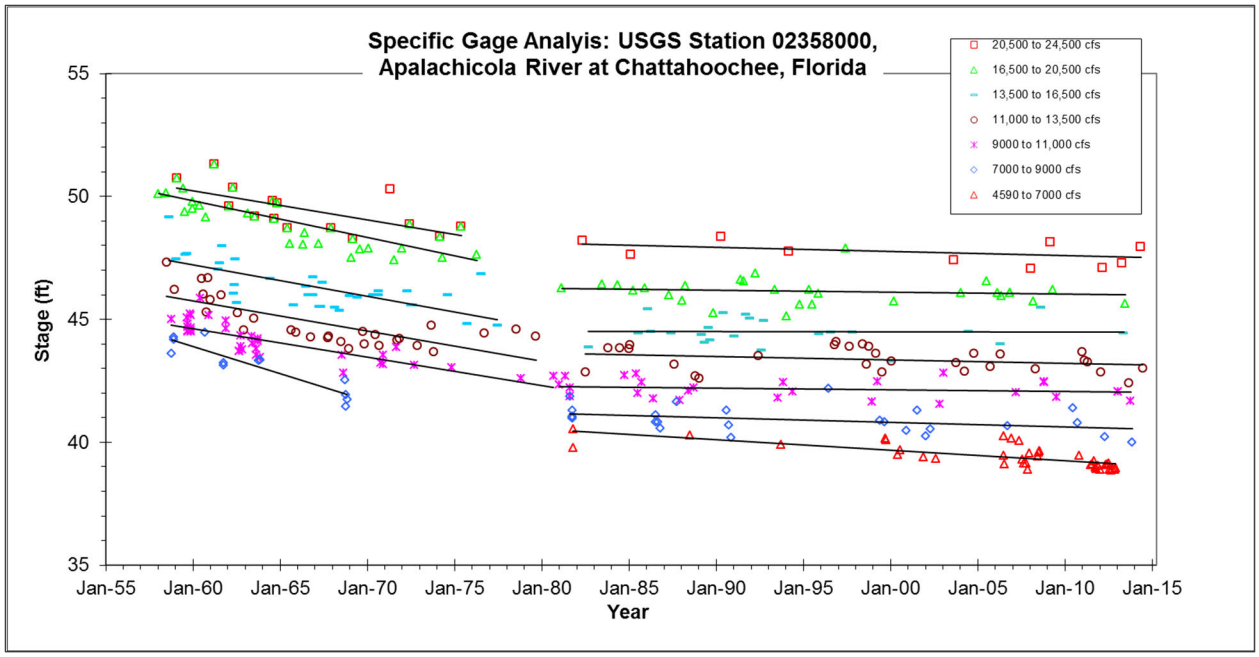


Figure 2.2-10. Streamflow Trends below Jim Woodruff Lock and Dam.

The rating curve comparison from Blountstown to Wewahitchka indicates that the channel had degraded by 1 to 2 ft between completion of the Jim Woodruff Lock and Dam and the early 1980s. Since then, the bed elevations have essentially been constant, with slight fluctuations of around 1 ft, which is not unreasonable in a sand-bedded system.

At Sumatra, the rating curve comparison spanned the period from 1977 until 1994. The lack of change between the rating curves indicates that the bed was stable, undergoing no degradation or aggradation. This is expected, given the tidal influence below the Sumatra gage.

2.2.2.4.3 Impact of Existing Operations on River Channel Stability

A specific gage analysis was conducted at several USGS stream gaging stations in the Chattahoochee and Apalachicola rivers to better understand the impact of dam operations on the stability of the two rivers.

These locations were selected on the basis of two criteria: proximity to the dam and period of record. Locations nearest the dam will be most highly affected by regulated changes in discharge and by sediment starvation due to sediment being trapped in the upstream reservoir. A long period of record contains enough data points to create accurate trend lines of past and present channel stability or instability. In addition, active gages enable recent data to be included in the analysis and afford the opportunity to duplicate that analysis in the future, provided the gage remains active.

The method for conducting a specific gage analysis entails taking all historical stage measurements and plotting them over time. Stage measurements are grouped by similar discharge values. Changes in stage, for a given discharge over time, indicate that the channel depth or width has changed. A similar process can be used for the channel width. USGS discharge measurements include width, and thus the width measurements for similar discharges can be compared, over time, for changes.

2.2.2.4.3.1 Chattahoochee River (02334430) at Buford Dam (Near Buford, Georgia)

The reach of the Chattahoochee River immediately downstream of Buford Dam is directly affected by peaking hydropower operations and the associated high daily fluctuations in flow conditions. Units of the Chattahoochee River National Recreation Area (CRNRA) lie along about 48 mi of the Chattahoochee River from Buford Dam to just above the confluence with Peachtree Creek. The specific gage analysis below Buford Dam does not show any long-term bed and/or bank erosion or sedimentation trends. The flow measurement transect is bound by bedrock and rip-rap, which has created a locally stable reach over the past 60 years. Observations of the river banks further downstream below Buford Dam, however, clearly indicate that bank erosion has been an ongoing process (Burkholder et al. 2010). It is noteworthy that Buford Dam has attenuated the downstream annual maximum flood flows from pre-dam peaks of about 20,000–40,000 cfs to post-impoundment peaks of less than 15,000 cfs. Thus, the historic channel-forming annual flood flows have been replaced by the typical cycle of 2 to 4-hour peak power plant discharge of 10,000–12,000 cfs for 5 days a week. This change in magnitude and frequency of peak flows has both positive and negative impacts. Positive impacts include protection from large floods that potentially cause severe erosion, severe deposition, and downstream flooding of developed land uses. Negative impacts include a frequent submergence of the bank faces, which prevents vegetation from becoming established and promotes erosion. Neither the present nor pre-dam erosion rate is known. Tributaries also are subject to the frequent submergence cycle for short distances upstream from their mouths. Thus, the tributary bank faces are subject to the same processes as on the main channel of the Chattahoochee River of exacerbated bank erosion and difficulty of new vegetation becoming established. However, tributaries also are subject to changes in runoff and sediment load due to land use change within their individual watersheds, indicating that the condition of their banks also is a function of the land use throughout the watershed upstream.

2.2.2.4.3.2 Chattahoochee River (02338500) above West Point Lake (Franklin, Georgia)

The specific gage analysis results for the Chattahoochee River above West Point Lake indicate that the channel has aggraded, increasing in elevation, since the construction of West Point Dam and the impoundment of West Point Lake in 1974. Although the record is missing data from the 1950s, and the late 1970s through late 1990s, the general stage trend indicates a historical dip in channel bed elevation of about 2 ft during the 1940s (Figure 2.2-11). Insufficient low-to-moderate flow data are available for the 20-yr period following the impounding of West Point Lake. Data from 1977 to 2014 indicate that the conditions of the channel have changed at this location. The stage is approximately 4 ft higher than before impounding, and additionally, for similar discharges, the range of stages varies by ±2.5 ft. The likely explanation is that this portion of the river is within the backwater effect of West Point Lake, and sediments are settling out of the water. However, the variation in stage for a given discharge is related to the lake level at the time of the measurement. Because the period of record of low to moderate flow data since 1975 is limited, it is not possible to determine whether bed aggradation is taking place or whether scour and fill cycles are occurring.

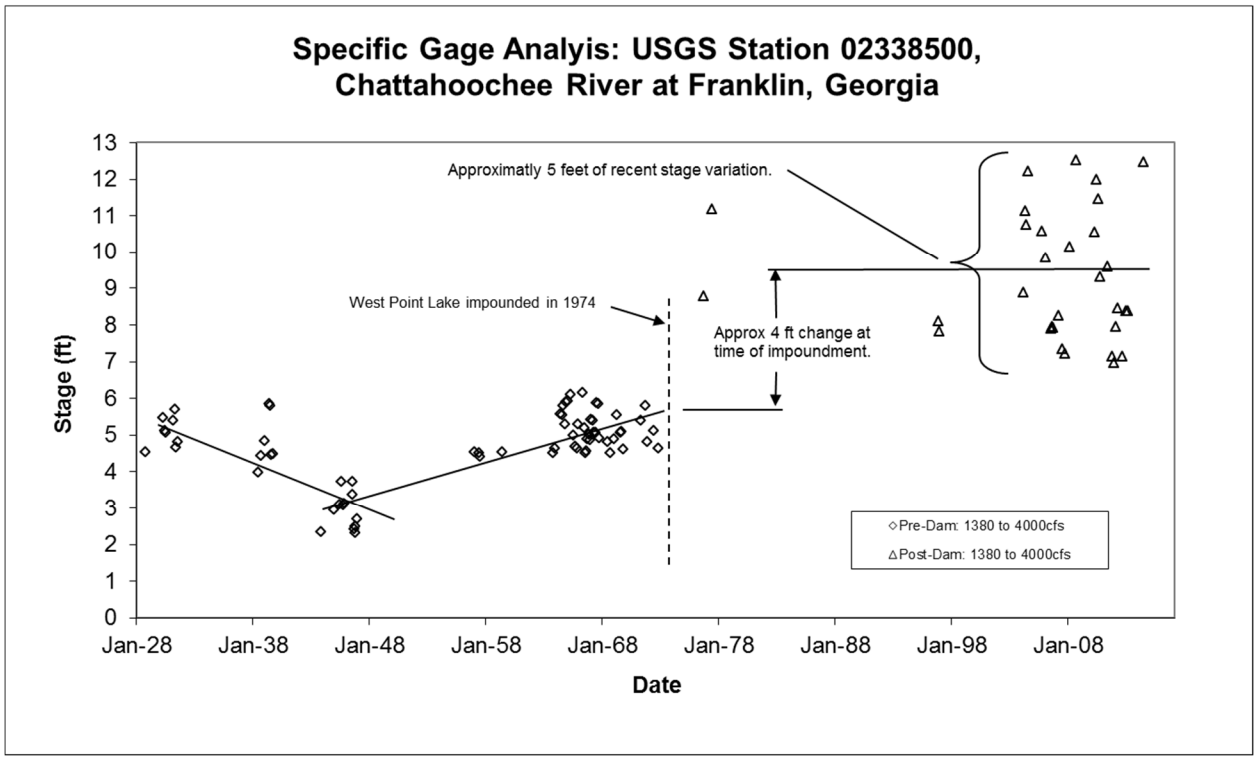


Figure 2.2-11. Specific Gage Analysis at Franklin, GA.

2.2.2.4.3.3 Below Jim Woodruff Lock and Dam (02358000)

The USGS Chattahoochee gaging station is at approximately RM 105.8 (Figure 2.2-10). The data presented in the specific gage analysis for this location may not have been collected exactly at the gage but within perhaps 200 or 300 ft upstream or downstream, depending on the flow conditions and the field personnel.

Data for low and moderate flows are represented in Figure 2.2-10. Low flows are considered to be less than 9000 cfs, and moderate flows are 9000 to 24,000 cfs. High flows (greater than 24,000 cfs) were not included in the analysis because the data were insufficient to create reliable results.

The interpretation of Figure 2.2-10 is that from the time the dam was completed in 1957 until about 1980, give or take several years, the streambed had degraded by about 4 ft, or about 0.17 ft/yr. From about 1980 to the present, the streambed has degraded by about 0.9 ft at the low flows (less than 9,000 cfs) and 0.25 ft at the moderate flows (greater than 9,000 cfs), or about 0.03 ft/yr. The trend indicates that degradation has slowed to a near standstill, if not stopped already. One explanation for the difference in rate of change between flows less than and greater than 9,000 cfs is that the deepest part of the channel, or *thalweg*, has undergone a greater rate of degradation over the past decade than have the remainder of the channel cross section (Figure 2.2-12). This change in the stage will be more strongly reflected during low flows, when a larger proportion of the flow is transported through the thalweg, as compared to moderate flows, where a large proportion of the flow is transported outside the thalweg.

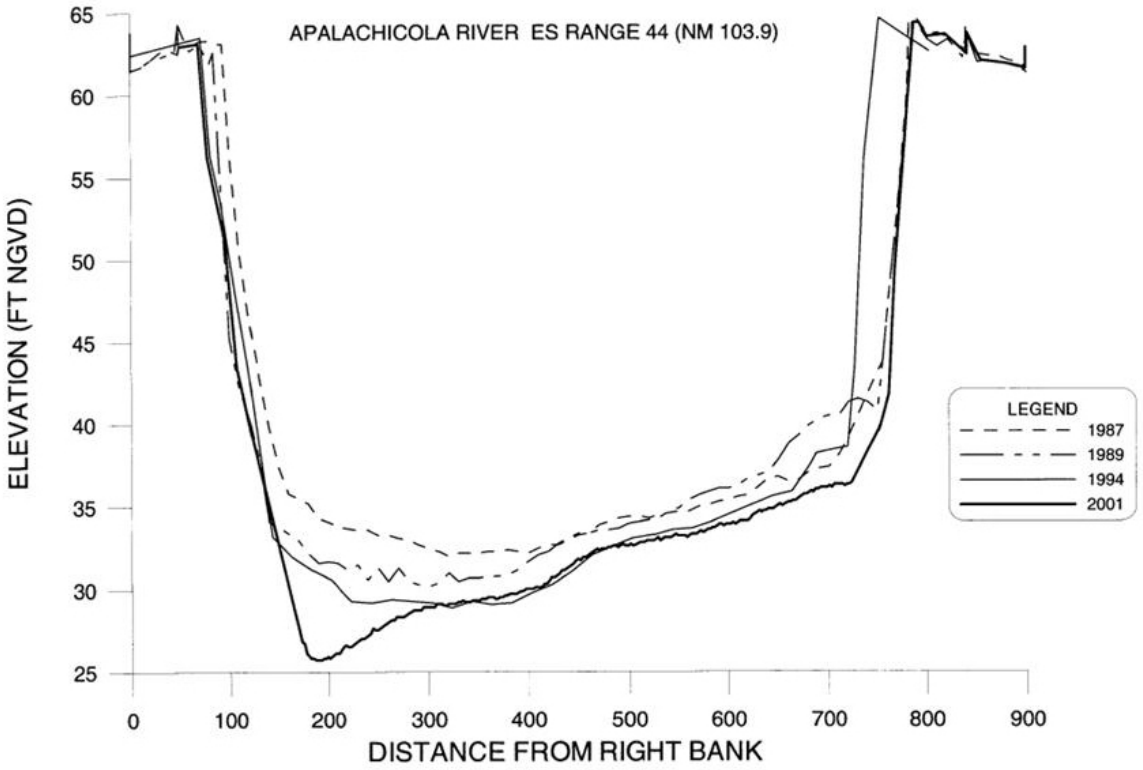
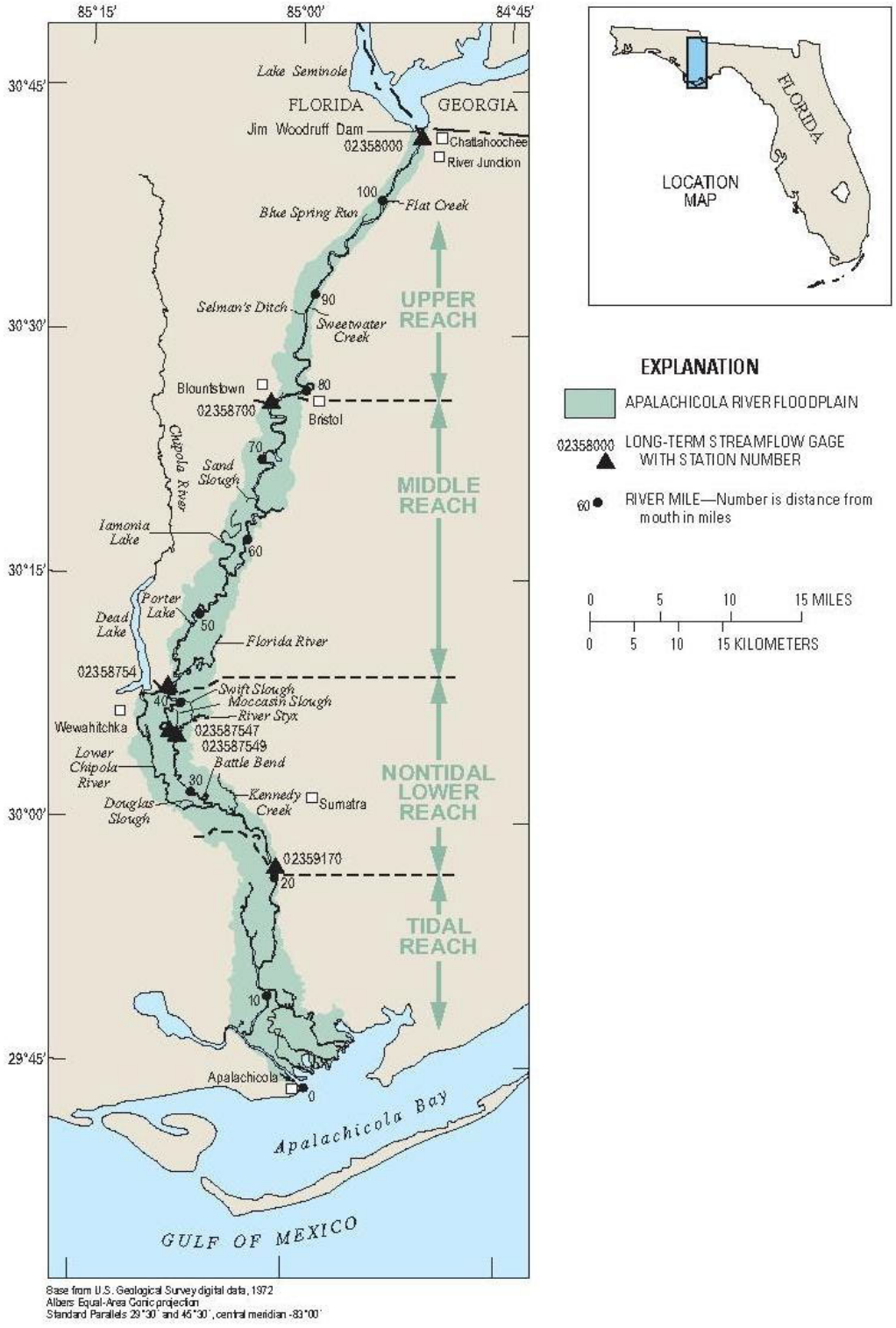


Figure 2.2-12. Cross Section below Jim Woodruff Lock and Dam.

This greater rate of degradation in the thalweg could be the result of in-channel rock removal during 1983 and 1984 (USACE, Mobile District 2002b). Between 1984 and 2007 (the latest year of data reviewed), no dredging has occurred in the reach from Jim Woodruff Lock and Dam to RM 99 whereas before 1984, minor amounts of dredging occurred upstream of RM 103.9 (154 thousand cubic yards from RM 103 to RM 106 between 1957 and 1984) and moderate amounts downstream (558 thousand cubic yards from RM 99 to RM 102 between 1957 and 1984).

The Apalachicola River below Jim Woodruff Lock and Dam can be divided into three major reaches (Figure 2.2-13): 1) the Upper Reach (Apalachicola RM 106.3 to RM 77.5) from Jim Woodruff Lock and Dam to Blountstown gage (USGS 02358700); 2) the Middle Reach (RM 77.5 to RM 41.8) from Blountstown gage to Wetwahitchka gage (USGS 02358754); and the Lower Reach (RM 41.8 to RM 20.6) from Wetwahitchka gage to Sumatra gage (USGS 02359170) (Light et al. 2006). Below the Sumatra gage, the river is considered to be influenced by tides, and, therefore, that portion of the river is not included in this discussion. Overall, the Apalachicola River has degraded and possibly widened because of the reduction in bed material from upstream following the construction of Jim Woodruff Lock and Dam. However, for the decade from 1995 to 2004, the channel has been relatively stable (Light et al 2006).



Source: Light et al. 2006

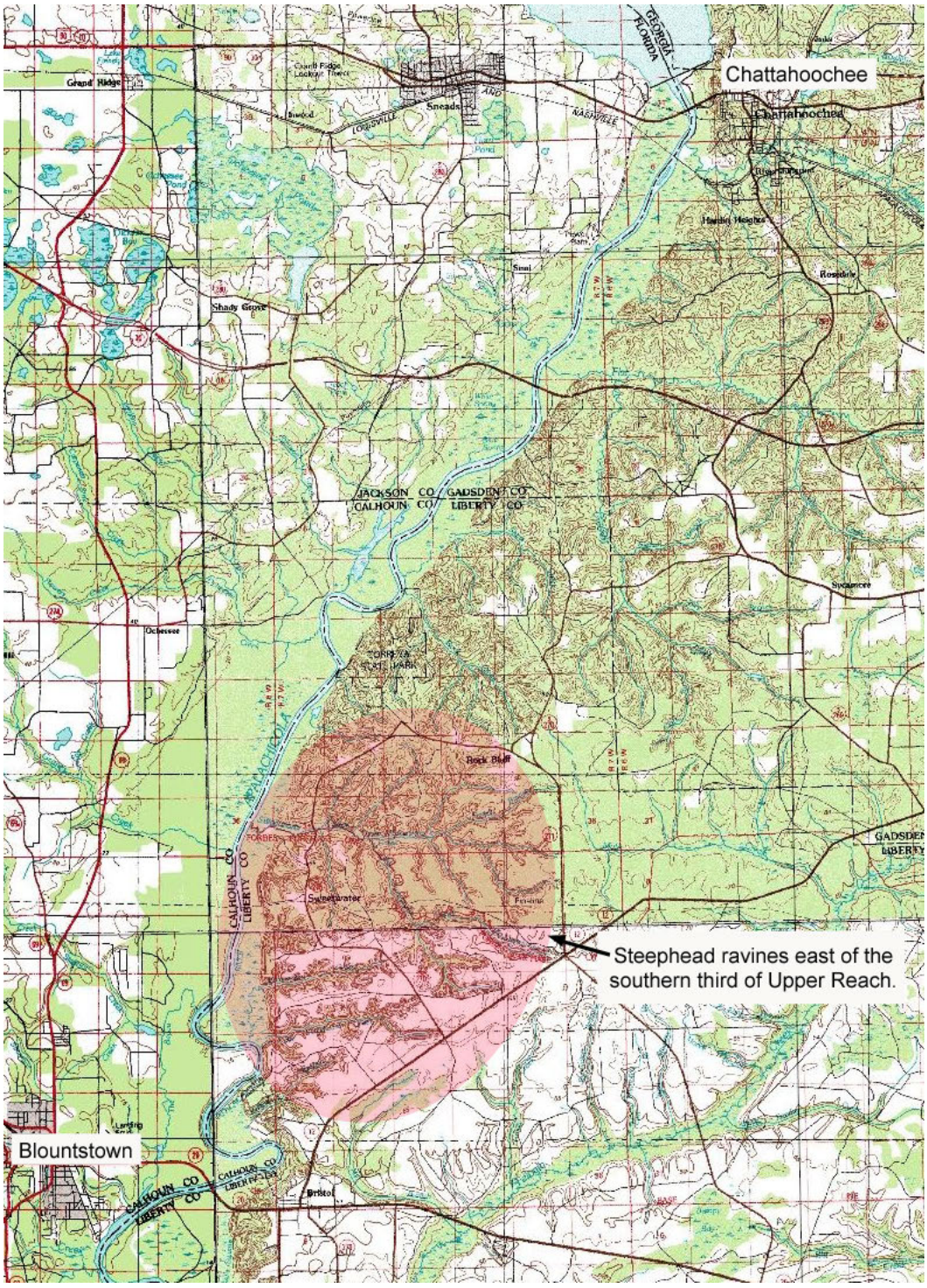
Figure 2.2-13. Major Reaches of the Apalachicola River.

The stability along the relatively straight upper reach is created by the presence of limestone outcrops, coarse sand and gravel bed materials, and local sediment sources downstream of RM 84 (Harvey 2007). The geology of the upper reach greatly differs between the east and west banks. The east bank is bordered on the east by a relatively high-relief landscape consisting of poorly consolidated silty/clayey sands and gravels of the Citronelle Formation overlying the erodible sands of the Alum Bluff Group, and limestone (Harvey 2007). The Citronelle Formation is an unconsolidated yet hard, sandy-clay that is erosion-resistant enough to have formed the high-relief topography in the area (Isphording et al. 1984). The region consists of agricultural land uses on a level plateau at an elevation of about 250 ft. The plateau is highly dissected by small streams, which have incised down to about the 50- to 60-ft elevation of the Apalachicola floodplain (Figure 2.2-14). The region potentially contributes to replenishing the sediment supply of the Apalachicola River through rainsplash, rill, and sheet wash erosion of the agricultural lands, and by streambank erosion and bed incision of the tributaries.

The topographic contours in Figure 2.2-14 clearly show extensive steephead ravine morphology across the southern third of the region. Those features, reaching depths of 100 ft, are formed when groundwater seeps from the base of the sloping surface and, undercutting the sand, creates a steep-walled amphitheater that erodes headward from the valley bottom (Enge 1998). The steephead ravines could be a significant contributor of sediment to the upper end of the middle reach. Without further investigation of the area, it is not possible to tell whether the steephead ravines are actively eroding or have stabilized. The remaining near-channel regions west of the Apalachicola and south of Blountstown on both sides of the river are exceptionally low-relief, low-elevation topography, and thus are unlikely to be significant contributors of sediment. The dominant sediment source in the middle and lower reaches is most likely to be streambank erosion.

The middle reach is very sinuous with banks composed of a mixture of cohesive and noncohesive sediments that are readily eroding on the outside of bends. The channel is actively migrating because of cutbank erosion and point bar accretion. The erosion rates are low in comparison to other large alluvial rivers and are unlikely to increase over time (Harvey 2007). Bed materials (both predam and now) are composed of uniform sands averaging less than 0.15 in in diameter (Harvey 2007).

The lower reach is very sinuous with banks composed of a mixture of cohesive and noncohesive sediments that are readily eroding on the outside of bends. As in the middle reach, bed materials (both predam and now) are composed of uniform sands averaging 0.15 in in diameter (Harvey 2007). The upper portion of the lower reach from RM 42 to RM 35 appears to be net aggradational, possibly as a result of a flow diversion into the Chipola Cutoff without a commensurate proportion of bed material load. Low radius of curvature bends in both the middle and lower reaches (at RM 38, RM 40, RM 43, RM 50, and RM 62) have the potential to become natural cutoffs, which would lead to a reduced sinuosity and increased hydraulic slope.



Source: USGS 1988

Figure 2.2-14. Highly Dissected Topography East of the Upper Reach.

2.3 Climate

Climate conditions and changes in climate conditions over time could potentially be affected by updates to reservoir project operations in the ACF Basin. In turn, scenarios for greenhouse gas (GHG) emissions and changing climate conditions in the future, regardless of the cause or sources of the changes, could directly affect the operation of the ACF Basin reservoir projects. Both of these considerations are discussed in more detail in section 6.8. The following sections describe historical and current climate-related conditions.

2.3.1 Existing Climate

The climate of Alabama, North Florida, and Georgia, including all areas associated with the ACF Basin, is classified as humid subtropical and characterized by hot, humid summers and cool winters. Significant amounts of precipitation occur in all seasons in most areas. Winter rainfall (and sometimes snowfall) is associated with large storms steering from west to east. Most summer rainfall occurs during thunderstorms or an occasional tropical storm, hurricane, or tropical cyclone (Peet et al. 2007). The paragraphs below outline the existing climate in Alabama, Florida, and Georgia. Notably, detailed information about precipitation in the ACF Basin is outlined in section 2.1.1.1.1.

Summers in Alabama are among the hottest in the United States, with high temperatures averaging above 90 °F (32 °C) in some parts of the state. The average winter minimum temperature for the entire state is 35 °F (2 °C). Alabama receives an average of 56 inches of rainfall annually and enjoys a lengthy growing season—up to 300 days—in the southern part of the state (Encyclopedia Britannica 2010).

Georgia is divided into separate climatic regions along the Chattahoochee River. The mountain region to the northwest is colder than the rest of Georgia, with average temperatures in January of 39 °F (4 °C) and 78 °F (26 °C) in July. Many summer days in Georgia exceed 90 °F (32 °C). Winter is characterized by mild temperatures and little snowfall, with cold, snow, and ice most likely across northern and central Georgia (City Data 2010).

Northern Florida, near the Gulf of Mexico, is hot during the summer, when temperatures tend to be in the 80–90 °F range (26.7–32.2 °C), and cool during winter, when temperatures tend to be in the 50–60 °F range (10–15.6 °C). The warmest month of the year is July, with an average maximum temperature of 92 °F (33 °C); the coldest month of the year is January, with an average minimum temperature of 40 °F (4 °C). The annual average precipitation in northern Florida near the Gulf of Mexico is 63 inches. Summer months tend to be wetter than winter months. The wettest month of the year is July, which has an average rainfall of 8.0 inches (Idcide 2010).

2.3.2 Greenhouse Gases and Global Warming

GHGs are components of the atmosphere that contribute to the greenhouse effect and global warming. Some GHGs occur naturally in the atmosphere, while others result from human activities such as the burning of fossil fuels. Federal agencies, states, and local communities address global warming by preparing GHG inventories and adopting policies that will result in a decrease of GHG emissions. According to the Kyoto Protocol and California Climate Action Registry, there are six GHGs: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) (UNFCCC 2007; CARB 2007).

Although the direct GHGs (i.e., CO_2, CH_4, and N_2O) occur naturally in the atmosphere, human activities have increased their atmospheric concentrations. From the preindustrial era (ending about 1750) to 2004, concentrations of CO_2 increased globally by 35 percent. Since 1900, the Earth's average surface air temperature has increased by about 1.2–1.4 ºF. The warmest global average temperatures on record have all occurred within the past 10 yr. The warmest year was 2005 (USEPA 2007b).

Within the United States, fossil fuel combustion accounted for 94 percent of all CO_2 emissions released in 2005. On a global scale, fossil fuel combustion added approximately 30 $x10^9$ tons (27 $x10^9$ metric tons) of CO_2 to the atmosphere in 2004, of which the U.S. accounted for about 22 percent (USEPA 2007a). DOE's Energy Information Administration report indicates that CO_2 emissions in the United States have grown by an average of 1.2 percent annually since 1990 and that energy-related CO_2 emissions constitute as much as 83 percent of the total annual CO_2 emissions (DOE EIA 2007).

The Council on Environmental Quality (CEQ) released final guidance to federal departments and agencies on August 1, 2016 to assist agencies in their consideration of the effects of GHG emissions and climate change when evaluating proposed federal actions in accordance with NEPA and CEQ regulations for implementing the procedural provisions of NEPA (CEQ 2016). There is evidence (Deemer, et al 2016) that collectively reservoirs created by dams may be an important source of GHG. However, current efforts to quantify, model, and manage such emissions have been limited by data availability and inconsistent methodologies. As a result of the national interest in reducing GHG, the CEQ issued a final guidance memorandum on August 1, 2016. In regards to reservoir GHG, the memorandum states "Similarly, some water management practices have GHG emission consequences (e.g., reservoir management practices can reduce methane releases, wetlands management practices can enhance carbon sequestration, and water conservation can improve energy efficiency)." There is evidence (Deemer, et al 2016) that collectively reservoirs created by dams may be an important source of GHG. However, current efforts to quantify, model, and manage such emissions have been limited by data availability and inconsistent methodologies. The potential for management decisions to affect GHG emissions at ACF reservoirs is acknowledged, as is the lack of complete data, standard methods, and adequate tools to quantify and compare the emissions impacts between the various management alternatives. Therefore, utilizing the discretion granted by the CEQ, USACE determined it would not be appropriate to include such an analysis based on the new guidance memorandum until a further methodology is devised and implemented.

2.3.3 Historical Precipitation and Droughts

Hydrological variability over time in a river basin is influenced by variations in precipitation over daily, seasonal, annual, and decadal time scales. The frequency of low or drought flows within a river basin is affected primarily by changes in the seasonal distribution of precipitation, year-to-year variability, and the occurrence of prolonged droughts. Evaporation from the land surface includes evaporation from open water, soil, shallow groundwater, and water stored on vegetation, along with transpiration through plants. The rate of evaporation from the land surface is driven essentially by meteorological controls, mediated by the characteristics of vegetation and soils, and constrained by the amount of water available. Climate change has the potential to affect all these factors—in a combined way that is not yet clearly understood—with different components of evaporation affected differently (IPCC 2001).

The recent drought in the southeastern United States began in the winter of 2005/2006. It was part of a drying out that stretched from Arizona to the Atlantic Ocean, and persisted through October 2007. According to an analysis by the National Center for Environmental Prediction, the recent drought was driven by a reduction of precipitation and not an increase in evaporation. The analysis was consistent in showing no signature of projected anthropogenic climate change in this recent drought (Seager et al. 2009). Although the exact areas of the Southeast that were affected varied, precipitation reduction has not exceeded earlier droughts, including one as recently as 1998 through 2002 (IPCC 2001).

Historically, that drought was a typical event in terms of amplitude and duration. Tree-ring records show a 21-year-long drought in the mid-16th century and a long dry period in the early- to mid-19th century, and that the Southeast was affected by medieval megadroughts centered in western North America. In general, the 20th century was moist from the perspective of the last millennium and free of long and severe droughts that were abundant in previous centuries (Seager et al. 2009).

Available precipitation is the total precipitation minus PET (potential evapotranspiration). It is a direct measure of inflows within the basin. The summer deficit is the available precipitation minus withdrawal in June, July, and August—typically the three warmest months of the year—that correspond to increased municipal, thermoelectric cooling, and irrigation demand. The summer deficit is an indicator of water shortage (in inches) on a seasonal basis that must be met through stored sources (i.e., Lake Lanier and West Point Lake) or groundwater. The historical (1934–2000) average summer deficit ranges from 5.3 inches to a surplus of 3.2 inches for any given county within the basin (Figure 2.3-1). Historically, the average summer deficit is 4.7 inches for counties within the ACF Basin (Tetra Tech 2010).

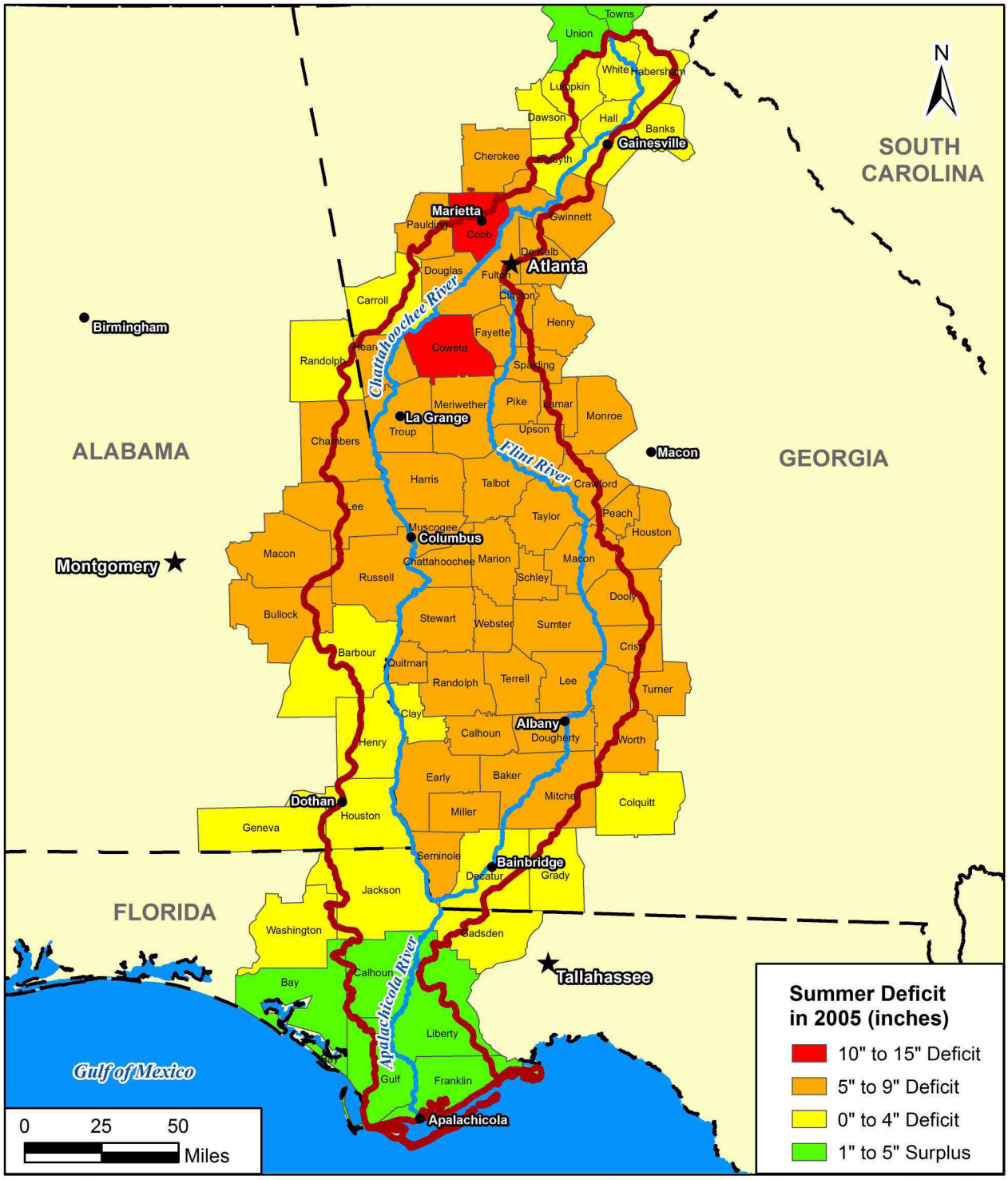
2.3.4 Historical Sea-Level Rise

Understanding trends in sea level and the relationship between global and local sea level provides critical information about the impacts of Earth's climate on our oceans. Changes in sea level are directly linked to a number of atmospheric and oceanic processes such as global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity.

Ocean levels have always fluctuated with changes in global temperatures. During the ice ages, when the Earth was 9 °F (5 °C) colder than today, much of the ocean's water was frozen in glaciers and the sea level often was more than 300 ft below the present level. Conversely, during the last interglacial period (100,000 years ago) when the average temperature was about 2 °F (1 °C) warmer than today, the sea level was approximately 20 ft higher than the current sea level (Titus 1989). Sea level has risen more than 4.7 inches since the peak of the last ice age (about 20,000 B.P.) and by 0.039 to 0.078 inches per year during the 20th century. The rate of global sea-level rise since 1963 is estimated at 0.070 inches per year. There is high confidence that the rate of observed sea-level rise was greater in the 20th century than in the 19th century.

2.3.4.1 Apalachicola Bay

A monitoring station located near Apalachicola Bay has more than 40 years of tidal data. Oceanographic and geologic conditions at the station are comparable to those of the bay. The rate of sea-level rise along the Gulf Coast near Apalachicola, Florida, was about 0.05 inch per year from 1970 to 2010 (NOAA 2010).



Summer Water Deficit in 2005 for Counties in the ACF Basin (inches)

Figure 2.3-1

2.4 Land Use

This section summarizes the land use in the ACF Basin and around each USACE project in the basin. A *project* is the dam and the associated reservoir (e.g., Buford Dam and Lake Lanier). The focus of the land use analysis is on the project land over which USACE has proprietary or managerial jurisdiction, and the immediately adjacent land. The Proposed Action to manage project pool levels and flow requirements could change lake levels, affecting the project shoreline and the adjacent land; therefore, the project land and the adjacent public or private land is the ROI for land use. This section presents a description of the ACF Basin as a whole followed by descriptions by project, running from north to south in the basin. Geographic information system data, maps, and shoreline management plans have been used to identify and define the land use in the ACF Basin and around each project.

2.4.1 Apalachicola-Chattahoochee-Flint River Basin

2.4.1.1 Current ACF Basin Land Use

ACF Basin land use has been compiled from the Georgia Land Use Trends (GLUT) 2008 data. The GLUT 2008 data set addresses the entire ACF Basin, including areas in Alabama and Florida. The major land cover uses are categorized as beaches/dunes/mud, water, developed, barren land, forested land, golf courses, pasture and row crops (i.e., agricultural), and wetlands. The overall proportions of these land cover categories in the ACF Basin are illustrated in Figure 2.4-1, and the acreages associated with these land cover categories are listed in Table 2.4-1.

Table 2.4-1.
ACF Basin Current Land Use

Land Use Classification	Acres	Percent of Total Acreage
Beaches/Dunes/Mud	30,595	0.2%
Water	372,427	3%
Developed (urban or built-up land)	1,423,097	11%
Barren	571,492	4%
Natural forested upland (forested lands)	6,229,859	48%
Golf Courses	2,067	0.02%
Pasture and Row Crop	2,753,559	21%
Wetlands	1,712,139	13%
Total Basin	13,095,236	100%

Source: GLUT 2008



Basin Land Use

Figure 2.4-1

Source: GLUT 2008.

- *Beaches, dunes, and mud* account for less than 1 percent of the ACF Basin. Roughly 30,600 ac of the basin includes open sand, sandbars, sand dunes, and mud as natural environments as well as exposed sand from dredging and other activities (GLUT 2008).
- *Water* includes lakes, rivers, ponds, ocean, industrial water, and aquaculture (GLUT 2008). As shown in Table 2.4-1, water covers 372,427 ac or almost 3 percent of the ACF Basin.
- *Developed land* is urban or built-up land, which includes residential, commercial, institutional, industrial, transportation (e.g., roads, railways, airports), and recreational land uses (GLUT 2008). Developed land accounts for more than 1.4 million ac or almost 11 percent of the ACF Basin. The largest developed areas in the basin are Metro Atlanta, Georgia, near the Chattahoochee River in the northern portion of the ACF Basin; Columbus, Georgia (the third-largest city in Georgia) along the Chattahoochee River in the central portion of the basin; and Albany, Georgia, the largest city on the Flint River in the southeastern portion of the basin.
- *Barren lands* include areas of exposed rock and soil from industrial uses, gravel pits, landfills, rock outcrops, and mountain tops (GLUT 2008). Barren lands cover approximately 571,500 ac and account for about 4 percent of land use in the ACF Basin.
- The *forested* land use category includes deciduous forest (i.e., tree species that shed foliage in response to seasonal change), evergreen forest (i.e., tree species that maintain their foliage all year), and mixed forest. Forested land is the predominant land use in the ACF Basin, accounting for more than 6.2 million ac or about 48 percent of land use.
- *Pasture and row crops*—or agricultural— is the second most predominant land use in the ACF Basin, accounting for about 2.8 million ac or 21 percent of land use. This land use category includes row crops, orchards, vineyards, groves, horticultural businesses, pasture, and nontilled grasses (GLUT 2008).
- *Wetlands* include forested, salt marsh, brackish, and freshwater marsh wetlands (GLUT 2008). Wetlands account for more than 1.7 million ac or about 13 percent of ACF Basin land use.

The ACF Basin includes nearly 1.5 million ac of national and state parks, historic parks, and national forest lands (Table 2.4-2).

Table 2.4-2.
National and State Parks in the ACF Basin

Facility Name	County, State	Area (ac)
National Park and Historic Areas		
Andersonville National Historic Site	Macon/Sumter, GA	44
Chattahoochee River National Recreation Area	Cobb/Forsyth/Fulton/Gwinnett, GA	714
Jimmy Carter National Historic Site	Sumter, GA	1
Kennesaw Mountain National Battlefield Park	Cobb, GA	267
State Parks		
Bainbridge State Park	Decatur, GA	1
Sweetwater Creek State Park	Douglas, GA	2,549
Chattahoochee State Park	Houston/Jackson/Seminole, GA/FL/AL	596
Chehaw State Park	Dougherty /Lee, GA	112
Don Carter State Park	Hall, GA	1,316
Fairchild State Park Area	Jackson/Seminole, GA/FL	168
Florence Marina State Park (Walter F. George Lake)	Stewart, GA	150
Franklin D. Roosevelt State Park	Harris/Meriweather, GA	9,049
George T. Bagby State Park & Lodge (Walter F. George Lake)	Clay, GA	700
Georgia Veterans State Park (Lake Blackshear)	Crisp, GA	1,308
John Gorrie State Museum (Apalachicola Bay)	Franklin, FL	1
Kolomoki Mounds State Park	Early, GA	1,294
Providence Canyon State Conservation Park	Stewart, GA	1,003
Florida Caverns State Park	Jackson, FL	1,306
Constitution Convention State Museum	Liberty, FL	13
Dead Lakes State Recreation Area	Gulf, FL	83
Fort Gadsden Historic Site	Franklin, FL	2,294
Seminole State Park	Seminole, GA	604
Senoia State Park	Coweta, GA	10
State Park-Forest Lands	Chambers/Jackson/Troup, AL/GA/FL	349
Smithgall Woods Conservation Area	White, GA	5,664
Sprewell Bluff State Park (on the Flint River)	Upson/Talbot, GA	1,372
Torreya State Park	Gadsden, FL	2,534
Three Rivers State Recreation Area	Jackson, FL	686
Lakepoint Resort State Park (Walter F. George Lake)	Barbour, AL	1,220
National Forest Lands		
Apalachicola National Forest	Franklin/Leon/Liberty/Wakula, FL	571,088
Chattahoochee National Forest	North Georgia	794,454

Sources: ASP 2011; Florida Park Service 2011; GSP 2011; USACE, Mobile District 1998a; USFS 2011.

2.4.1.2 Historic ACF Basin Land Use

Data on historic ACF Basin land use was available for 1992 from the USGS National Land Cover Database. Land-cover uses included categories such as water, developed, barren land, forested land, shrubland, pasture and row crop (i.e., agricultural), and wetlands. The overall proportions of these land-cover categories in the ACF Basin as of 1992 are summarized in Table 2.4-3.

Table 2.4-3.
ACF Basin Historic Land Use (1992)

Land Use Classification	Acres	Percent of Total Acreage
Water	391,305	3%
Developed	411,427	3%
Barren	547,235	4%
Forested	7,193,632	55%
Shrubland/grassland/herbaceous	11,489	0.1%
Agricultural	3,021,904	23.%
Wetlands	1,490,838	11.%
Total Basin	13,067,830	100.%

Source: USGS NLCD 1992

Direct comparison of the 1992 land-cover data with the 2001 data is not recommended. Each data set was mapped with different methods and slightly different classes. The differences in classifications, combined with the final accuracy of the mapping, result in two distinct products. The typical result of direct comparison will result in a change map showing a difference between mapping methods rather than real change on the ground (USGS NLCD 2009).

As of 1992, forested land, which includes evergreen, deciduous, and mixed forest, accounted for the largest percentage (55 percent) of total land in the basin. Agricultural land use represented the next highest percentage of total acreage, accounting for 23 percent, and includes pasture and hay areas; row crops; and orchards, vineyards, and other planted areas. Wetlands were 11 percent of total acreage. Barren land accounted for 4 percent of total land acreage and included barren land of rock, sand, or clay; quarries, strip mines, or gravel pits; and transitional areas of sparse vegetative cover. Developed land—which includes residential, commercial, industrial, transportation, and urban/recreation grasses (e.g., parks, lawns, golf courses, and airport and industrial site grasses)—and water each accounted for 3 percent of ACF Basin land use. The smallest percent of total acreage (less than 1 percent) was shrubland, grasslands, and herbaceous land (USGS NLCD 1992).

2.4.2 Buford Dam and Lake Lanier

The Buford Dam project is on the Chattahoochee River about 48 mi northeast of Atlanta, Georgia. At a normal summer lake level of 1,071 ft, the reservoir shoreline is 692 mi (see appendix A, appendix B – Buford Dam and Lake Sidney Lanier for pertinent project data). The Buford Dam and Lake Lanier occupy about 57,890 ac–38,425 ac of water at normal summer pool (1,071 ft) and 19,465 ac of land (Rainey 2014). Land was acquired to elevation 1,085 ft to provide an area necessary for flood storage.

The USACE *Lake Sidney Lanier Shoreline Management Plan* allocates the lake's shoreline into four categories: prohibited access areas, protected areas, public recreation, and limited development for shoreline and reservoir access. These shoreline land use allocations are described in the following paragraphs.

- *Prohibited access land* protects certain project operation areas for public safety reasons. No shoreline use permits or licenses are issued for these areas. This land is in proximity of the dam and spillway. Less than 1 percent of the lake's shoreline is categorized as prohibited access (USACE, Mobile District 2004).
- *Protected shoreline areas* are designated to preserve the scenic appeal of a reservoir that has become urban; to avoid conflict between public and private uses; to protect fish and wildlife habitat; to protect cultural, historical, and archaeological sites; to protect federally listed threatened and endangered species; to protect navigation channels; to restrict placement of

floating facilities in areas too shallow for navigation or too exposed to winds and currents; and to protect natural formations and vistas. Protected areas account for about 32 percent of Lake Lanier's shoreline. Shoreline use permits or licenses are not issued for protected shoreline areas, but passive recreational use is permitted provided that aesthetic, environmental, historical, and natural resources are not damaged (USACE, Mobile District 2004).

- *Public recreation areas* are specifically designated for public recreational development and use, such as campgrounds, day-use parks, primitive or natural areas, and marine services. No permits for private uses are issued in public recreation areas. Public recreation accounts for 21 percent of the lake's shoreline (USACE, Mobile District 2004). USACE manages a number of recreation areas around the reservoir with picnic and camping sites, playgrounds, swimming areas, hiking trails, a fishing dock, and boat ramps (USACE 2008). Hunting is permitted around the reservoir in USACE-managed areas but is generally limited to waterfowl only. At the north end of the reservoir is the GADNR 1,300 ac Don Carter State Park. The park has campsites, a beach, picnic shelters, trails, and a boat dock (GADNR 2014a). Recreational facilities associated with Lake Lanier also include marinas, boat ramps, picnic areas, playgrounds, golf courses, and campgrounds operated by county, city, or other organizations through outgrant arrangements with USACE. USACE leases the land to the county or city governments or other organizations that operate the facilities (USACE 2006, 2008).
- The last shoreline allocation category, *limited development*, allows for USACE to permit specific private uses of public lands along the reservoir shoreline. Limited development accounts for 47 percent of the shoreline. Certain private uses (e.g., floating or land-based facilities such as boat docks, picnic shelters, walkways) may be authorized in these areas if a permit is obtained from USACE. These facilities provide reservoir access to private property owners who have land adjoining the project land. Such personal property is not for public use; however, pedestrian traffic and general public use of the reservoir and shoreline cannot be restricted by permit holders (USACE, Mobile District 2004). Per the *Lake Sidney Lanier Shoreline Management Plan*, the maximum number of docks allowed on the reservoir is 10,615 (USACE, Mobile District 2004). The USACE has reached that cap of 10,615 permit equivalents issued, with a wait list of applicants for permits should permits become available (Noe 2016, personal communication).

  The area around Lake Lanier is a popular vacation and retirement area and essentially serves as a suburb of Atlanta, Georgia. This area is heavily developed for residential use with some commercial establishments such as hotels, resorts, and golf courses. The lower lake, which is closest to Atlanta, has the highest density development; however, development around the upper reservoir is continuing and almost equals that of the lower lake.

2.4.3 The Chattahoochee River National Recreation Area

The CRNRA (which is also discussed in section 2.1.1.2.4.5) was established in 1978 by an act of Congress which states the "natural, scenic, recreation, historic, and other values of a 48-mi segment of the Chattahoochee River and certain adjoining lands in Georgia from Buford Dam downstream to Peachtree Creek are of special national significance, and that such values should be preserved and protected from developments and uses which would substantially impair or destroy them." The CRNRA, under the stewardship of the NPS, runs along 48 mi of the Chattahoochee River and consists of 10,000 ac. The park is in the northern suburbs of Atlanta and is surrounded by developing communities. The original park boundary of 6,300 ac was expanded to 6,800 ac in 1984 and then expanded again to 10,000 ac in 1999. Land use in the CRNRA is protected land for the preservation of natural and cultural resources to provide for the enjoyment of the public. Recreation uses at the CRNRA include picknicking, hiking, leisure walking, bike riding, horseback riding, rock climbing, nature watching (e.g., birdwatching, wetlands exploration), fishing, paddling, and boating. The park also has an environmental education center and an NPS park headquarters and visitor contact station (NPS 2009, 2010).

2.4.4 West Point Dam and Lake

The West Point project is on the Chattahoochee River on the Alabama-Georgia state line, about 3 mi north of West Point, Georgia. At normal summer pool elevation of 635 ft, the reservoir shoreline is 604 mi (see appendix A, appendix E – West Point Dam and Lake for pertinent project data). The West Point project consists of 54,748 ac of land and water at normal summer level—25,864 ac of water and 28,884 ac of land (USACE 2008). The project land was acquired to a water surface elevation of 641 ft to provide an area necessary for flood storage. In some areas around the lake, land above the flood storage elevation was purchased to provide recreational areas, natural resource protection areas, and public access areas. This land acquisition provides a continuous area of land around the reservoir and above the flood control pool to ensure public access along the shore and to accommodate project-related activities (USACE, Mobile District 1993b).

USACE's *West Point Lake Shoreline Management Plan*, like the Lake Lanier plan, allocates the lake's shoreline into four categories: prohibited access areas, protected areas, public recreation, and limited development. Prohibited access land is in the proximity of the dam and spillway. Less than 1 percent of the lake's shoreline is categorized as prohibited access for public safety and project operation purposes. About 29 percent of West Point Lake's shoreline is designated as protected areas to reduce conflicts between public and private use and to protect or restore aesthetics, fish or wildlife habitat, cultural resources, or other environmental values. Public recreation is the largest shoreline category, accounting for 46 percent of the shoreline. The last category, limited development, accounts for 25 percent of the shoreline and allows for private walkways and docks to be constructed for shoreline and reservoir access, if properly permitted (USACE, Mobile District 1993b). USACE does not have a policy limiting the number of docks on West Point Lake; there are 726 permitted docks and boat shelters on the reservoir (Parsons 2016, personal communication).

USACE manages a number of recreation areas around the reservoir with picnic and camping sites, playgrounds, swimming areas, hiking trails, a fishing dock, and boat ramps (USACE 2006). In addition, other private or public organizations manage recreation areas around the reservoir (on land leased from USACE). The facilities include camping sites, picnic areas, swimming areas, boat ramps, and marinas (USACE 2008). Hunting is permitted in a 10,000-ac wildlife management area operated by the GADNR at the upper end of the reservoir (USACE, Mobile District 2010d). The GADNR also manages two smaller areas on the lake, the Dixie Creek and the Lakeside Wildlife Management Areas.

The land bordering the West Point project land is primarily undeveloped land used for public recreation, with the exception of the southeast end of the lake. There is light-to-moderate residential development bordering the project near the city of West Point, Georgia, just south of the lake, and the city of LaGrange, Georgia, east of the lake.

2.4.5 Walter F. George Lock and Dam and Walter F. George Lake

The Walter F. George project is on the Chattahoochee River on the Alabama-Georgia state line, about 60 mi south of Columbus, Georgia. The project consists of 93,340 ac at normal summer level of 190 ft—41,800 ac of water and 51,540 ac of land (purchased in fee simple) (see appendix A, appendix C – Walter F. George Lock and Dam and Lake for pertinent project data). At normal summer lake level, the reservoir shoreline is 640 mi, 318 mi of which are in an easement estate and 47 mi of which are within the Fort Benning Military Reservation. USACE purchased easements on some portions of private land surrounding the lake. The most common easements in place give USACE the authority to perpetually or occasionally overflow, flood, and submerge property that lies below the easement. The acquired easement estate specifically prohibits structures for human habitation on this land and requires a permit for all other structures or improvements. The Fort Benning Military Reservation is at the northern end of the reservoir (USACE, Mobile District 2001).

The USACE *Walter F. George Lake Shoreline Management Plan*, like the Lake Lanier plan, allocates the lake's shoreline into four categories: prohibited access areas, protected areas, public recreation, and limited development. Prohibited access land is in the proximity of the dam, lock, and hydroelectric power generation structure. One percent of the lake's shoreline is categorized as prohibited access for public safety and project operation purposes. About 36 percent of the shoreline is designated as protected areas to protect or restore aesthetics, fish or wildlife habitat, cultural resources, or other environmental values; to protect channels for navigation; and to restrict structures from areas too shallow for navigation or too exposed to winds and currents. Public recreation accounts for 16 percent of the shoreline. These areas are designated for present or future intensive recreational development. The last category, limited development, accounts for 47 percent of the shoreline, and it allows for private structures or activities (e.g., docks, fixed piers, steps, walkways, vegetative modifications, utility rights-of-way) to be constructed on project land or waters, if properly permitted (USACE, Mobile District 2001).

USACE manages a number of recreation areas around the reservoir with picnic and camping sites, playgrounds, swimming areas, hiking trails, fishing docks, and boat ramps. Within the Walter F. George project area, there are also state, county, or privately operated recreation areas (on land leased from USACE) with camp sites, lodging, picnic areas, hiking trails, playgrounds, swimming areas, fishing facilities, boat ramps, and marinas (USACE 2008). Alabama operates the Lakepoint State Park, and Georgia operates the George T. Bagby State Park through outgrant arrangements with USACE. The USFWS owns and operates the 11,000-ac Eufaula NWR in the northern reaches of the reservoir on the project's Alabama shoreline and some limited acreage on the Georgia side north of Soapstone Creek (USFWS 2009a).

Land use bordering the Walter F. George project land is a mix of residential, commercial, recreational, farmland, and military land (Fort Benning). The highest density development borders the central portion of the lake, where the project is bound by the cities of Eufaula, Alabama, on the west and Georgetown, Georgia, on the east. The lower portion of the reservoir is bordered primarily by residential, commercial, and recreational land use. The upper portion of the reservoir is bordered primarily by farmland.

2.4.6 George W. Andrews Lock and Dam and Lake George W. Andrews

The George W. Andrews project is east of Columbia, Alabama, on the Alabama-Georgia state line. The reservoir extends up the Chattahoochee River about 28 mi to the Walter F. George Lock and Dam, remaining mostly within the original river banks. At normal summer lake level of 102 ft, the reservoir shoreline is 65 mi (see appendix A, appendix D – George W. Andrews Lock and Dam and Lake George W. Andrews for pertinent project data). The George W. Andrews project contains 2,735 ac at normal summer level—1,540 ac of water and 1,195 ac of land (USACE 2006).

USACE does not have a shoreline management plan for Lake George W. Andrews as it is a run-of-river project and most of the land around the reservoir is in easement (Jernigan 2010, personal communication).

USACE manages several recreation areas around the reservoir with picnic sites, fishing sites, and boat ramps. In addition, other private or public organizations to operate recreation areas around the reservoir with campsites, boat ramps, and picnic areas. There are no marinas on Lake George W. Andrews (USACE 2008).

The land bordering the George W. Andrews project land is primarily farmland or undeveloped forested or open land. There are a few private residences on the Alabama side, just east of Columbia, Alabama.

2.4.7 Jim Woodruff Lock and Dam and Lake Seminole

The Jim Woodruff project is on the Apalachicola River, just below the confluence of the Chattahoochee and Flint rivers, and 1.5 mi northwest of Chattahoochee, Florida. At normal summer lake level of 77 ft, the reservoir shoreline is 532 mi (see appendix A, appendix A – Jim Woodruff Lock and Dam and Lake Seminole for pertinent project data). The Jim Woodruff project consists of 97,572 ac at normal summer level—37,500 ac of water and 60,072 ac of land (purchased in fee simple). USACE purchased easements on some portions of private land surrounding the lake. The easements give USACE the authority to perpetually or occasionally overflow, flood, and submerge land within certain elevations (USACE, Mobile District 1995).

USACE's *Shoreline Management Plan—Lake Seminole*, like the Lake Lanier plan, allocates the lake's shoreline into prohibited access areas, protected areas, public recreation, and limited development. Prohibited access land is in the proximity of the dam, lock, and hydroelectric power generation structure. Less than 1 percent of Lake Seminole's shoreline is categorized as prohibited access for public safety and project operation purposes. The largest land use category at Lake Seminole is protected shoreline, with about 60 percent designated to protect or restore aesthetic values, fish or wildlife habitat, cultural resources, or other environmental values; to protect channels for navigation; and to restrict structures from areas too shallow for navigation or too exposed to winds and currents. No permits for new private structures or utilities are authorized in protected shoreline areas. Public recreation accounts for 19 percent of the shoreline. No permits are issued for private uses in these areas because they are specifically designated for present or future intensive public recreational development. The last category, limited development, accounts for 20 percent of the shoreline and allows for private structures to be built or activities to be conducted (e.g., docks, steps, walkways, vegetative modifications, utility rights-of-way) on Jim Woodruff project land or waters, if a permit is obtained (USACE, Mobile District 1995). USACE does not have a policy limiting the number of docks on Lake Seminole; there are 970 permitted docks on the reservoir (Timmons 2016, personal communication).

USACE manages a number of recreation areas around the reservoir with picnic and camping sites, hiking trails, fishing docks, and boat ramps (USACE 2008). Within the Jim Woodruff project land, there are also state, county, or privately operated recreation areas (on land leased from USACE). The facilities include camp sites, lodging, picnic areas, hiking trails, playgrounds, swimming areas, fishing areas, boat ramps, and marinas (USACE 2008). There are two state parks on the lake—Seminole State Park in Georgia and Three Rivers State Park in Florida. Seminole State Park, operated by GADNR, is 604 ac in the northern reaches of the lake. Three Rivers State Park, operated by the Florida Park Service, is 686 ac along the western shoreline of the reservoir (Florida Park Service 2006). The Apalachee Wildlife Management Area along the western shore of the reservoir in Florida and various tracts in Georgia is managed by the respective states as game management areas (USACE, Mobile District 2010e).

The land bordering the Jim Woodruff project is characterized by a mix of residential, commercial, recreational, undeveloped forested land, farmland, and institutional (state correctional facility) land uses. The highest density residential and commercial development is in the central portion of the reservoir on the northern and southern shores near Chattahoochee, Florida.

The Apalachicola River Basin south of Jim Woodruff Dam has numerous recreation areas offering public land use opportunities. The upper Apalachicola River basin has the Torreya State Park and the Apalachicola Bluffs and Ravines Preserve (FNAI 2011). In the Apalachicola River lower basin, the Apalachicola National Forest, Tate's Hell State Forest, Apalachicola Wildlife and Environmental Area, and Apalachicola River Water Management Area together compose more than 850,000 ac of public lands open to all (FNAI 2011). The Florida Fish and Wildlife Conservation Commission Boating and Waterways Section boat ramp inventory lists 152 boat ramp facilities in the counties that border the Apalachicola River basin—Calhoun, Franklin, Gadsen, Gulf, Jackson, and Liberty (FWC 2016). The Big

Bend Scenic Byway is a 220-mi driving trail in northern Florida (including part of the Apalachicola River Basin) that has received recognition and designation as a Florida Scenic Highway and a National Scenic Byway (Delaney and Lesh 2012). The Apalachicola River Paddling Trail System is an American Canoe Association recommended water trail with 11 paddling trips mapped by the Florida Fish and Wildlife Conservation Commission (FWC 2016).

2.4.8 Nonfederal-Owned Dams

As discussed in more detail in section 2.1.1.1.6, there are 9 dams in the ACF Basin that are not owned or operated by USACE. GPC owns and operates seven of the projects on the Chattahoochee River: Morgan Falls, Langdale, Riverview, Bartletts Ferry, Goat Rock, Oliver, and North Highlands. The City Mills Dam and the Eagle-Phenix Dam were downriver on the Chattahoochee from the North Highlands Dam and both owned by Columbus, Georgia. The dams were removed for aquatic ecosystem restoration under the USACE section 206 program in cooperation with the city of Columbus and other partners. The Eagle-Phenix Dam was removed in 2012, and the City Mills Dam removal was completed in 2013. Lake Blackshear Dam, owned and operated by the CCPC, impounds the Flint River near Warwick, Georgia. GPC also operates one project, the Flint River (or Lake Worth) Dam, on the Flint River. GPC maintains shoreline management guidelines to manage all shoreline property within its project boundaries. Adjacent landowners must receive a GPC permit before conducting any construction, renovation, clearing, tree removal, or grading on GPC land. The objective of this management approach is to have a consistent position on lakeside development and to protect the environmental and aesthetic qualities of the lakes (GPC 2008).

- ***Morgan Falls and Bull Sluice Lake.*** The Morgan Falls project is in Roswell, Georgia, just north of Atlanta, on the Chattahoochee River. The project reservoir, Bull Sluice, has 580 ac of surface area at full pool and 13 mi of shoreline (see appendix A for pertinent project data). The predominant land uses in the vicinity of the project are residential, commercial, and forest or open space. Privately owned residential homes with docks line most of the shoreline. A country club with a golf course is on the eastern shore of the reservoir just upstream from the dam. Three land units of the CRNRA, managed by NPS, border the reservoir. These recreation areas are used for the preservation and protection of natural, scenic, recreation, historic, and other values of special national significance (GPC 2004).
- ***Langdale Dam.*** Langdale Dam has a small reservoir (152 ac of surface area at full pool) that remains mostly within the original river banks (see appendix A for pertinent project data). The project is in the city of Valley, Alabama, on the Chattahoochee River, downriver from the USACE West Point Dam. At this point, the river forms the boundary between Alabama and Georgia. The primary land use on the Georgia side of the project is undeveloped forested land, and on the Alabama side is the city of Valley with residential, commercial, institutional, and recreational development. The city of Valley is planning to revitalize the former Langdale Textile Mill, which is on the Alabama riverbank next to the dam, into a mixed-use facility.
- ***Riverview Dam.*** The Riverview Dam, about 1 mi downstream on the Chattahoochee River from the Langdale Dam, has a small reservoir (75 ac of surface area at full pool) contained mostly within the original riverbanks (see appendix A for pertinent project data). As with the Langdale Dam, the predominant land use on the Georgia side of the project is undeveloped forested land, and on the Alabama side is the city of Valley with residential, commercial, institutional, and recreational development. The Riverdale Textile Mill, no longer in operation, is on the Alabama riverbank next to the Riverview Dam. The city of Valley is planning to revitalize this mill into a mixed-use facility.

- ***Bartletts Ferry Dam and Lake Harding.*** The Bartletts Ferry project is on the Chattahoochee River on the border of Alabama and Georgia. The project is about 14 mi north of Columbus, Georgia, and 20 mi south of the USACE West Point project. The reservoir has a surface area of 5,850 ac at full pool and 156 mi of shoreline (see appendix A for pertinent project data). GPC owns and manages 3,200 ac of forest adjacent to the reservoir and leases an additional 4,800 ac in the upper reaches of the reservoir to the GADNR for use as the Blanton Creek Wildlife Management Area. All project lands are available for public recreation and access and provide a reservoir buffer for aesthetics, wildlife habitat, and water quality protection. GPC leases 1,080 parcels of land adjacent to the project shoreline for private residential land use (GPC 2009).
- ***Goat Rock Dam and Lake.*** The Goat Rock project is on the Chattahoochee River on the border of Alabama and Georgia. The project is about 10 mi north of Columbus, Georgia. Goat Rock Lake has a surface area of 1,050 ac and 25 mi of shoreline (GPC 2010b; see appendix A for pertinent project data). The predominant land use in the vicinity of the project is undeveloped forested or open land. The Goat Rock Marina and Goat Rock Recreation Area provide public recreation access. There is some light residential development on the Alabama and Georgia shorelines, primarily in the lower portion of the reservoir near the dam.
- ***Oliver Dam and Lake.*** The Oliver project is north of the city of Columbus, Georgia, on the Chattahoochee River bordering Alabama and Georgia. Oliver Lake has a surface area of 2,150 ac and 40 mi of shoreline (GPC 2010c; see appendix A for pertinent project data). Predominantly residential land use borders the lake's southern half, with undeveloped open or forested land bordering the lake's northern half. A country club with a golf course is on the southeast shore of the lake. The Standing Boy Creek State Park, operated by the GADNR, is at the northern end of the reservoir on the eastern shore.
- ***North Highlands Dam.*** The North Highlands Dam impounds Bibb Pond, which has a surface area of 131 ac and 3 mi of shoreline (GPC 2010d; see appendix A for pertinent project data). The project is in Bibb City, Georgia, just north of Columbus, on the Chattahoochee River. Across the river is Phenix City, Alabama. Land use bordering the project is high-density residential, commercial, and industrial.
- ***City Mills Dam and Eagle-Phenix Dam.*** The City Mills and the Eagle-Phenix dams were on the Chattahoochee River between Columbus, Georgia, and Phenix City, Alabama. USACE, in conjunction with Columbus and Phenix City, breached the Eagle-Phenix Dam in March 2012 and the City Mills Dam in March 2013 for aquatic ecosystem restoration under the USACE section 206 program, and created the opportunity for recreational use of the river such as urban kayaking and whitewater rafting. The land use adjacent to the City Mills and the Eagle-Phenix dams is high-density residential, commercial, and industrial.
- ***Lake Blackshear Dam.*** Lake Blackshear Dam is on the Flint River in southwest Georgia about 25 mi northeast of Albany, Georgia. The dam impounds an 8,700 ac reservoir with 77 mi of shoreline (see appendix A for pertinent project data). The land use around the project is a mix of residential, farmland, and undeveloped forested land. The CCPC implemented a lakeshore management plan that includes a pier and dock permit program, a public information program, and recreational and wildlife conservation programs in cooperation with other state and local entities. The intent of these programs is to ensure that the scenic, environmental, and recreational aspects of Lake Blackshear are maintained and preserved for use by the public. There are a number of public recreation areas around the lake, including boat ramps, county parks, and the Georgia Veterans State Park (1,300 ac), operated by the GADNR. Recreational facilities include cottages for rent, campsites, and picnic areas, swimming beaches, boat ramps, and fishing docks (CCPC 2010).

- ***Flint River (or Lake Worth) Dam*.** The Lake Worth project is in Albany, Georgia, on the Flint River. It is operated by the GPC. The reservoir has a surface area of 1,400 ac and 36 mi of shoreline (GPC 2010e; see appendix A for pertinent project data). Land use along the lake's shoreline is a mix of commercial development (e.g., lodging facilities), residential, and undeveloped land. Recreational facilities at the reservoir include boat ramps, fishing piers, picnic areas, and swimming beaches.

2.5 Biological Resources

This section addresses the flora and fauna of the ACF Basin with an emphasis on the vegetative communities surrounding the mainstem of the Chattahoochee and Apalachicola rivers. Current conditions of the biological resources are described for the area and include vegetation resources/wetlands, wildlife resources, fish and aquatic resources, protected species, and fish and wildlife management facilities. All of these biological resources are components of the communities and ecosystems where they survive and reproduce. It is important to recognize that divisions between and among ecosystems and ecosystem types are artificial, and some of the most important ecological processes—from aquatic to riparian to terrestrial—operate across these boundaries (Bailey 1996; Hunter 1997). Riparian zones form the interface between the aquatic and terrestrial components of the landscape and, therefore, protect and enhance many important ecological connections. The terrestrial forests in the riparian zones of the southeastern United States are among the most biologically productive in the world, due largely to the temperate climate, long growing season, nutrient input from flooding, productive soils, and abundance and diversity of plant and animal communities (Dickson and Warren 1993). As these relationships become more widely recognized, so does the importance of documenting and maintaining multidimensional connectivity (i.e., longitudinal, lateral, and vertical) among the components of the ecosystems for effective watershed management (Allan 2004; Cote et al. 2009; Cloern 2007; Fausch et al. 2002; Freeman et al. 2007; Kondolf et al. 2006; Pringle 2001; Thorp et al. 2006; Ward 1989; Weins 2002).

2.5.1 Vegetation Resources Affected Environment

This section discusses the terrestrial vegetation communities in the basin, as well as freshwater and estuarine wetland communities. The descriptions of terrestrial habitats along the ACF Basin are largely based on information from Martin et al. (1993) and Jordan, Jones, & Goulding, Inc. (2000).

2.5.1.1 Terrestrial Communities

The ACF Basin contains parts of the Blue Ridge, Piedmont, and Coastal Plain ecoregions. The headwaters of the Chattahoochee River in parts of Lumpkin, White, and Habersham counties in Georgia are in the Blue Ridge ecoregion. The river passes through the Piedmont ecoregion from north of Lake Lanier to Columbus, Georgia. The Fall Line, the topographic demarcation between the Piedmont and Coastal Plain ecoregions, passes just south of Columbus. From Columbus to the Gulf of Mexico, the Chattahoochee River flows through the Coastal Plain ecoregion. By spanning these three major ecoregions, each relatively distinct from the other two and internally homogenous, the ACF Basin is rich in biological diversity.

The ACF Basin contains a variety of native terrestrial vegetative communities, from the Appalachian oak forest in the Blue Ridge ecoregion to the oak-hickory and oak-hickory-pine forests of the Piedmont and the bottomland hardwood swamp along the Apalachicola River in Florida (Jordan, Jones, & Goulding, Inc. 2000; Martin et al. 1993). In addition, areas modified for agriculture, forestry, and development contain their own distinct vegetative assemblages. The dominant terrestrial communities along the rivers are described briefly below.

2.5.1.1.1 Appalachian Oak Forests

The Appalachian oak forests in the ACF Basin are limited to the Blue Ridge ecoregion in north-central Georgia and the northernmost headwaters of the Chattahoochee River. Dominant canopy species in these forests include deciduous oaks (*Quercus* spp.), hickories (*Carya* spp.), buckeyes (*Aesculus* spp.), and magnolias (*Magnolia* spp.), as well as evergreen species. Specific species found on drier slopes and ridges in Appalachian oak forests include chestnut oak (*Quercus prinus*), northern red oak (*Q. rubra*), southern red oak (*Q. falcata*), white oak (*Q. alba*), black oak (*Q. velutina*), blackjack oak (*Q. marilandica*), pignut hickory (*Carya glabra*), sand or pale hickory (*C. pallida*), mockernut hickory (*C. tomentosa*), and tulip poplar (*Liriodendron tulipifera*). Also present are pitch pine (*Pinus rigida*) and red maple (*Acer rubrum*). The subcanopy typically includes saplings of the canopy species, as well as shrub species such as mountain laurel *(Kalmia latifolia*), various azaleas (*Rhododendron* spp.), blueberries (*Vaccinium* spp.), strawberry-bush (*Euonymus americanus*), and sweet-shrub (*Calycanthus floridus*). Wildflowers found on dry sites include asters (*Aster* spp.), violets (*Viola* spp.), trilliums (*Trillium* spp.), yellow star-grass (*Hypoxis hirsuta*), and spiderwort (*Tradescantia ohiensis*). The oak-hickory forests of the Piedmont ecoregion are very similar in composition to the Appalachian oak forests of the Blue Ridge ecoregion, with the primary difference being the flatter topography of the Piedmont ecoregion. Many consider these oak-hickory forests the climax community for the Piedmont ecoregion (Wharton 1978).

Sites on very rich soil slopes typically have more moisture and are dominated by red maple, American beech (*Fagus grandifolia*), basswood (*Tilia herterophylla*), hickories, tulip poplar *(Liriodendron tulipifera)*, white ash (*Fraxinus americana*), and eastern hemlock (*Tsuga canadensis*). Shumard's oak (*Quercus shumardii*), yellow buckeye (*Aesculus flava*), cucumber tree (*Magnolia acuminata*), and Fraser's magnolia (*M. fraseri*) also occur on these sites. Mountain-like microclimates often form on steep slopes and ravines in the Piedmont ecoregion and support oak-hickory forests that are similar to the Appalachian oak forests of moist sites in the Blue Ridge ecoregion (Jordan, Jones, & Goulding, Inc. 2000).

The moist, rich slopes often associated with the Blue Ridge ecoregion and the steep slopes and ravines in the Piedmont ecoregion support a wide variety of wildflowers, ferns, and shrubs (Jordan, Jones, & Goulding, Inc. 2000). Rhododendrons, azaleas, and mountain laurel are common shrubs on moist sites in the Appalachian oak forest, and include the species mountain rosebay (*Rhododendron catawbiense*), rosebay rhododendron (*R. maximum*), dwarf rhododendron (*R. minus*), flame azalea (*R. calendulaceum*), and mountain laurel. Other shrubs in these forests include bush honeysuckle (*Diervilla sessilifolia*), spice bush (*Lindera benzoin*), sweet shrub (*Calycanthus floridus*), mountain pepperbush (*Clethra acuminata*), and red buckeye (*Aesculus pavia*). Some of the wildflower species occurring in this area are trout-lily (*Erythronium americanum*), violets, trilliums, bee-balm (*Monarda didyma*), blood root (*Sanguinaria canadensis*), mountain jewelweed (*Impatiens pallida*), giant chickweed (*Stellaria pubera*), fire pink (*Silene virginica*), and false Solomon's seal (*Smilacina racemosa*). Ferns in these communities include maidenhair fern (*Adiantum pedatum*), southern lady fern (*Athyrium filix-femina*), marginal shield fern (*Dryopteris marginalis*), broadbeech fern (*Phegopteris hexagonoptera*), mountain spleenwort (*Asplenium montanum*), and New York fern (*Thelypteris noveboracensis*).

2.5.1.1.2 Oak-Hickory-Pine Forests

Oak-hickory-pine forests are the most abundant native vegetative community in the ACF Basin (Martin et al. 1993). This forest type can be found throughout the area occupied by the Chattahoochee River in central and western Georgia. The community type is similar in composition to the Appalachian oak forest communities on drier sites; the major difference is the occurrence of pine species (Jordan, Jones, & Goulding, Inc. 2000). Pine species typical of the oak-hickory-pine forest include shortleaf pine (*Pinus echinata*) and loblolly pine (*P. taeda*). The dominant deciduous canopy species in the oak-hickory-pine forests of the uplands are white oak, northern red oak, post oak (*Quercus stellata*), several hickories, tulip

poplar, persimmon (*Diospyros virginiana*) and eastern red cedar (*Juniperus virginiana*). In areas managed primarily for forestry products, dominant canopy species are often limited to loblolly and short-leaf pine. Subcanopy species in the upland forests typically include flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), eastern redbud (*Cercis canadensis*), shadbush (*Amelanchier canadensis*), black gum (*Nyssa sylvatica*), American holly (*Ilex opaca*), blackberries (*Rubus* spp.), viburnums *(Viburnum* spp.), sumacs (*Rhus* spp.), greenbriars (*Smilax* spp.), grapes (*Vitis* spp.), and Japanese honeysuckle (*Lonicera japonica*).

The oak-hickory-pine community type in the Piedmont ecoregion is similar in composition to that of the Blue Ridge ecoregion; the major difference is the occurrence of pine species (Jordan, Jones, & Goulding, Inc. 2000). Pine species typical of the community type in the Piedmont ecoregion include Virginia pine (*Pinus virginiana*) and white pine (*P. strobus*), as well as the shortleaf pine and loblolly pine found in the Blue Ridge communities.

A special area referred to as the *Pine Mountain District* is on the border of the Piedmont and Coastal Plain ecoregions on Pine Mountain (Jordan, Jones, & Goulding, Inc. 2000). The area is typified by quartzite caps along ridges from Alabama east into Georgia. Stretching from the Chattahoochee River to the Flint River, Pine Mountain has been characterized as a pine-hardwood xeric ridge and slope forest. The vegetation of the district consists of shortleaf pine, blackjack oak, rock chestnut oak (*Q. montana*), Piedmont azalea (*Rhododendron canescens*), and low-bush blueberry (*Vaccinium pallidum*).

2.5.1.1.3 Rock Outcrop Communities

Rock outcrop communities are highly specialized plant communities associated with either granite or limestone outcrops (Martin et al. 1993). The ACF Basin contains small areas of both communities. These plant communities are found in areas that lack sufficient soil to support large shrubs or trees, thus maintaining communities dominated by herbaceous species. Because of the temperature and moisture extremes associated with rock outcrop areas, a number of different vegetative communities have evolved to take advantage of the varying moisture and soil conditions. Each of these communities is composed of a unique assemblage of plants, although some species can be found in more than one community type. Many of these outcrop-adapted plant species are either officially protected or considered rare where they are found, and many are classified as endemic.

2.5.1.1.4 Grass-Dominated Communities

The grass-dominated communities in the ACF Basin are limited to the middle Chattahoochee River in Alabama, in an area called the *Black Belt* (Martin et al. 1993). These communities are typically dominated by little bluestem (*Andropogon scoparius*), although 58 other herbaceous species have been documented in the remnant Black Belt grasslands in Alabama. Although occasionally invaded by sweet gum and eastern red cedar, the remnant grass-dominated communities are maintained by periodic droughts, floods, and burns that prevent most tree and shrub species from becoming established.

2.5.1.1.5 Longleaf Pine-Turkey Oak Sand Hill Community

The longleaf pine-turkey oak sand hill community is common in the lower portions of the Apalachicola River Basin. The dominant plant species in this community are typically longleaf pine (*Pinus palustris*), turkey oak (*Quercus laevis*), bluejack oak (*Q. incana*), mockernut hickory, flowering dogwood, and wiregrass (*Aristida stricta*). This community is typically maintained by periodic burns. In areas where longleaf pine has been selectively removed, turkey oak and mockernut hickory dominate the canopy. Fire-intolerant species, such as magnolia and holly, can invade areas that do not burn regularly.

2.5.1.1.6 Maritime Shrub Community

The maritime shrub community is limited to the coastal areas of Alabama and Florida. This community type is typically divided into two subcommunities—dune oak-buckthorn and oak scrub—that can be distinguished by their dominant canopy species and typical location along the coast. The dune oak-buckthorn community typically occurs on the tops and landward slopes of dunes. The canopy of this community is typically composed of live oak (*Quercus virginiana*), tough buckthorn (*Bumelia tenax*), red bay (*Persea borbonia*), slash pine (*Pinus elliotii*), and loblolly pine. Understory species include saw palmetto (*Serenoa repens*), Hercules club (*Zanthoxylum clava-herculis*), myrtle (*Myrica* spp.), yaupon (*Ilex vomitoria*), rusty lyonia (*Lyonia ferruginea*), muscadine grape (*Vitis rotundifolia*), laurelleaf briar, pepper-vine (*Ampelopsis arborea*), and juveniles of the dominant canopy species.

Evergreen maritime forests are found along the coast in Alabama. These forests are dominated by sweetbay magnolia (*Magnolia virginiana*), laurel oak, and live oak. Subcanopy species are often limited to juveniles of the dominant canopy species, red bay, cabbage palm (*Sabal palmetto*), and slash pine.

2.5.1.1.7 Ruderal Communities

People have profoundly affected the vegetation of the Piedmont region through agriculture and development. Anthropogenic (human-maintained) habitats, also referred to as *ruderal habitats*, occupy a large area along the Chattahoochee River in the Piedmont ecoregion, particularly in the Metro Atlanta (Jordan, Jones, & Goulding, Inc. 2000). Examples of ruderal habitats include residential yards, road rights-of-way, power line rights-of-way, and ballparks. Although not to the same extent as in the Piedmont ecoregion, people have also altered the vegetation in the Blue Ridge ecoregion. The development of extensive ruderal communities in the Blue Ridge ecoregion has been limited because of the steeply sloping channels characteristic of the northern extents of the Chattahoochee River.

2.5.1.2 Wetlands

Wetlands are transitional lands between terrestrial and deep-water habitats in which the water table is at or near the land surface or the land is covered by shallow water (Cowardin et al. 1979). *Palustrine wetlands* include all nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens (e.g., freshwater marshes, swamps, bogs, fens, and wet prairies). *Estuarine wetlands* include deepwater tidal areas and adjacent tidal wetlands that are usually semienclosed by land but have access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Estimates of the wetland acreage in the ACF Basin as a whole vary because of differences in the methods used to classify and inventory wetlands. The 2008 GLUT indicates that 13 percent (1,711,561 ac) of the total basin is wetlands, including woody wetlands (GLUT 2008). A 1996 USGS study approximates 5 percent (633,600 ac) of the basin was wetlands in the 1970s (USGS 1996). Despite the differences in the classification methods of these two studies, the USFWS has assessed trends nationwide in wetland loss since the mid-1950s (Dahl 2000, 2006, 2011; Dahl and Johnson 1991; Frayer et al. 1983). USFWS estimated that during that period in the United States, 296,000 ac (5 percent) of the estuarine vegetated wetlands, 6.96 million ac (21 percent) of freshwater emergent wetlands, and 3.7 million ac (6.6 percent) of freshwater forested wetlands were lost to agriculture, urban development, and other land use and landcover conversions. Florida, including the Apalachicola Bay area, has frequently ranked high among states in loss of wetland acreage in the assessments.

Because of hilly topography, wetlands in the Blue Ridge and Piedmont ecoregions are small and scattered. Most wetlands of significant size are in the Coastal Plain ecoregion, and most of the wetland area in the ACF Basin is represented by forested palustrine wetlands in the floodplains of rivers. These

riparian (river-associated) forested systems are often referred to as *bottomland hardwoods*. The riparian palustrine systems (inland wetlands without flowing water) in the ACF Basin also include small areas of nonforested wetlands such as marsh or shrub wetlands. The remaining wetland area consists of estuarine (estuary-associated) wetlands and the palustrine wetlands that occur along reservoirs (reservoir-associated). Estuarine wetlands constitute a relatively small percentage of the total wetland area within the basin; however, because of the economic value of the estuarine ecosystem to coastal communities in the basin, the potential environmental impacts on estuarine wetlands associated with reservoir operations are assessed in this EIS.

2.5.1.2.1 Freshwater Wetlands

The Piedmont ecoregion, because of its wider floodplains, has larger wetland systems along the Chattahoochee and Flint rivers than the Blue Ridge ecoregion (Jordan, Jones, & Goulding, Inc. 2000). Most of the wetlands in the Piedmont ecoregion consist of large forested, scrub-shrub, emergent, or combination floodplain wetlands. Seep wetland systems, however, still occur along slopes (Jordan, Jones, & Goulding, Inc. 2000). Seep wetland systems are often found on steep slopes where the groundwater penetrates the surface of the slope. These systems often discharge water downstream as surface water. The soil conditions in the Fall Line District produce seep wetlands that are driven by groundwater and extend to the tops of slopes (Jordan, Jones, & Goulding, Inc. 2000). They often support a variety of ferns and herbaceous species. The vegetation component often resembles that of Coastal Plain areas. Dominant species might include laurelleaf greenbrier (*Smilax laurifolia*), sweetbay magnolia, swamp tupelo (*Nyssa biflora*), red maple, titi (*Cyrilla racemiflora*), and wax-myrtle (*Myrica cerifera*). Other dominant species include swamp chestnut oak (*Quercus michauxii*), cane (*Arundanaria gigantea*), and cinnamon fern (*Osmunda cinnamomea*).

A variety of tree species can be found in the Piedmont ecoregion forested wetland systems (Jordan, Jones, & Goulding, Inc. 2000). The most common are red maple, American sweetgum (*Liquidambar styraciflua*), black willow (*Salix nigra*), overcup oak (*Quercus lyrata*), swamp chestnut oak, water oak (*Quercus nigra*), river birch (*Betula nigra*), sweetbay magnolia, and green ash (*Fraxinus pennsylvanica*).

Piedmont emergent and scrub-shrub wetlands are typically dominated by annual and perennial herbaceous species, though scrub-shrub wetlands have a shrub overstory (Jordan, Jones, & Goulding, Inc. 2000). Typical herbaceous vegetation includes broadleaf cattail (*Typha latifolia*), wool-grass (*Scirpus cyperinus*), redtop panic grass (*Panicum rigidulum*), soft rush (*Juncus effusus*), climbing hempweed (*Mikania scandens*), sallow sedge (*Carex lurida*), blunt broom sedge (*C. tribuloides*), sharp-winged monkey-flower (*Mimulus alatus*), fowl mannagrass (*Glyceria striata*), smartweeds (*Polygonum* spp.), and a variety of other sedges (*Carex* spp., *Rhynchospora* spp., *Eleocharis* spp.). The primary dominant shrub in scrub-shrub wetlands is tag-alder (*Alnus serrulata*). Other shrub species include spice bush, black willow, highbush blueberry (*Vaccinium corymbosum*), red chokeberry (*Aronia arbutifolia*), and Virginia-willow (*Itea virginica*).

The Apalachicola River floodplain is a vast wetland system of bottomland hardwood forests and tupelo-cypress swamps, the largest floodplain forest in Florida. Approximately 15 percent of the Florida portion of the Apalachicola River Basin is floodplain; the rest consists of wetland (palustrine, riverine, and lacustrine [reservoir-associated]) and terrestrial habitats (Florida State University, n.d.). The Apalachicola River of the north Florida panhandle is the state's largest river by discharge and the fourth-largest river in the southeastern United States (Stallins et al. 2010). The floodplain forest of the Apalachicola River is Florida's largest, and it has long been recognized for its tree species richness. Disturbances have been limited primarily to logging, which began during the lumber boom of 1870 to 1925 and has continued at a lower level to the present. The floodplain supports 47 tree species. The dominant tree species on high, infrequently flooded areas of floodplains are American sweetgum, sugarberry (*Celtis laevigata*), and

American hornbeam (*Carpinus caroliniana*). Water hickory (*Carya aquatic*), overcup oak, diamond leaf oak (*Q. laurifolia*), and green ash increase in the low bottomland forest areas along the river. At the lowest elevations are the frequently inundated backswamps and their cover of water tupelo (*Nyssa aquatica*), Ogeechee tupelo (*N. ogeche*), swamp tupelo, bald cypress (*Taxodium distichum*), planer-tree (*Planera aquaticum*), and Pop or Florida ash (*Fraxinus caroliniana*) (Stallins et al. 2010).

Most of the floodplain wetland coverage of the Apalachicola River exists in the lower river delta, where the floodplain is the widest (Leitman et al. 1983). Dominant bottomland hardwood species include water tupelo, swamp tupelo, Ogeechee tupelo, bald cypress, Carolina ash, American sweetgum, and overcup oak. The upper floodplain is typically dominated by tupelo, American sweetgum, and cypress species. The lower floodplain is characterized by coastal plain pine flatlands, coastal dunes, and freshwater and brackish marshes.

The Apalachicola River has one of the most productive floodplain forests found in warm, temperate regions (Elder and Cairns 1982). Nutrients and detritus carried from the floodplain by river floods contribute significantly to the relatively high productivity of Apalachicola Bay (Mattraw and Elder 1984). The species composition of the Apalachicola River floodplain forest is largely organized by the flood characteristics of the river, with the most flood-tolerant species dominating the most flood-prone areas. The floodplain is generally inundated annually for a period of 1 to 5 months, typically from January through April. If the flooding cycle were significantly and permanently altered, the species composition and age structure of the floodplain forest would change.

Plant species composition and wildlife use both vary along a gradient of flooding frequency and duration in the floodplain. As a habitat situated between uplands and the river, the floodplain serves as habitat for numerous wildlife species during certain life stages or certain seasons. Light et al. (1995) documented that at least 80 percent of Apalachicola River fish species use floodplain habitats, especially for spawning and foraging.

The composition of floodplain forests along the Apalachicola River has been changing during the last 30 to 40 years. The USGS found that the present-day forest composition along the river has shifted toward drier conditions compared to data collected in the 1970s (Darst and Light 2008). Although water discharge data show that the average discharge from the river from about 1930 to the present has remained steady, the seasonal distribution of flows has changed (Light et al. 2006; Stallins et al. 2010). Fall and winter discharges have increased and spring and summer discharges have decreased, with the greatest changes in February and April. Long-term changes in the monthly discharge in the Apalachicola River are a reflection of natural climatic changes and anthropogenic activities in the ACF Basin, including flow regulation, agricultural use, industrial/municipal water use, reservoir evapotranspiration, and increases in impervious surface area in the basin. With this drying trend, the hydrological connectivity between the main channel and floodplain habitats along the Apalachicola River has decreased, resulting in a shift of species composition in floodplain habitats (Stallins et al. 2010).

Consistent with Darst and Light (2008), Stallins et al. (2010) found that there was a decrease in obligate wetland tree species (such as water tupelo, Ogeechee tupelo, and Pop ash) along corridors in the Apalachicola River Basin that experience reduced frequencies of overbank flows because of large impoundments. Obligate wetland tree species, such as the overcup oak and green ash (*Fraxinus pennsylvatica*), were also found in reduced stands. Furthermore, they documented what seems to be reduced success in upland species becoming established at lower elevations when those areas are exposed to sustained high flows, often because of undersized impoundments. Maintenance of floodplain connectivity is critical not only to provide appropriate moisture regimes to vegetative communities in the surrounding landscape, but also ultimately to support the wildlife assemblages dependent on the vegetation for habitat and nutritional resources. The moisture and vegetative characteristics of terrestrial floodplains and riparian wetlands in the ACF Basin were changed by the initial hydromodification

activity beginning over 50 years ago. Thus, it has been nearly the same length of time, at least, since the wildlife community could have been considered natural.

The Morgan Falls Project—a GPC project below Buford Dam and Lake Lanier on the Chattahoochee River—has a variety of wetland types that support species typical of the Piedmont region and can reasonably be expected to be typical of wetland areas in the Piedmont region of the basin (GPC 2005). The primary wetlands of the project are the vegetated palustrine wetlands, including the forested wetlands, scrub-shrub wetlands, and emergent wetlands. Dominant overstory vegetation in the forested wetlands includes black willow, river birch, red maple, black gum, and green ash. Dominant vegetation in the scrub-shrub wetlands includes black willow, button bush (*Cephalanthus occidentalis*), tag alder, and silky dogwood (*Cornus ammomum*). Dominant species in the emergent wetlands, which occur mostly along shorelines and on islands, include sedges, common rush, seedbox (*Ludwigia* spp.), and smartweeds. The project also has areas of lacustrine wetlands and deepwater habitats, which are permanently flooded and lack persistent emergent vegetation, and riverine wetlands, which have no emergent vegetation. Surveys of the project conducted in 2002–2005 documented 35 species of aquatic macrophytes and two species of algae in the project's wetland habitats. Commonly observed aquatic macrophytes included Brazilian waterweed (*Egeria densa*), common rush, green arrow-arum (*Peltandra virginica*), hornleaf riverweed (*Podostemum ceratophyllum*), softstem bulrush (*Schoenoplectus tabernaemontani*), and broadleaf cattail. Six exotic species found in the project area included alligatorweed (*Alternanthera philoxeroides*), Brazilian waterweed, wartremoving herb (*Murdannia keisak*), parrot feather watermilfoil (*Myriophyllum aquaticum*), true forget-me-not (*Myosotis scorpioides*), and yellow flat (*Iris pseudacorus*).

The size and distribution of wetland communities associated with two reservoirs in the ACF Basin, Walter F. George Lake and Lake Seminole, were determined for the Comprehensive Study (Dove and Kress 1997). At Walter F. George Lake, 2,698 ac of wetland are supported at or below the normal pool elevation. Emergent wetlands constitute 31 percent of this total; forested wetlands, 28 percent; lacustrine littoral (reservoir edge) wetlands and various other types, 24 percent; and scrub-shrub wetlands, the remaining 17 percent. The normal pool elevation at this reservoir is 190 ft, and the top-of-dam elevation is 209 ft. There are approximately 1,653 ac of additional wetlands between the normal pool and top-of-dam elevations. A list of native vegetation typical of floodplains and wetlands for Walter F. George Lake contains species typical of the southeast Coastal Plain area: green ash, river birch, black gum, bald cypress, pond cypress (*Taxodium ascendens*), red maple, swamp chestnut oak, and black willow.

As of the September 2010 macrophyte survey in Walter F. George Lake, there are approximately 14 ac of submersed, 446 ac of emergent, and 187 ac of floating macrophytes (hydrilla, giant cutgrass, and water hyacinth, respectively) (Mortimer 2010, personal communication). A follow-up survey in 2013 has shown an increase in coverage, especially of nuisance taxa. There is an active management program in place to manage these taxa as well as Brazilian elodea (*Egeria densa*) and giant cane (*Arundo donax*) using grass carp and chemical herbicides. The relatively restricted coverage of hydrilla is a result of high and muddy water during the late spring/early summer growing period and the stocked grass carp.

At Lake Seminole, 7,418 ac of wetland are supported at or below the normal pool elevation. Lacustrine littoral aquatic bed wetlands constitute 57 percent of this total; forested wetlands, 20 percent; emergent wetlands, 15 percent; and a variety of other types, the remaining 8 percent. The normal pool elevation at this reservoir is 77 ft, and the top-of-dam elevation is 79 ft. There are approximately 3,326 ac of additional wetlands between the normal pool and top-of-dam elevations.

Aquatic plant surveys of the Spring Creek arm of Lake Seminole were conducted in 2000 and 2002 (Stewart et al. 2005). The most commonly occurring aquatic plant found at the survey sites was hydrilla, followed by several species of pondweeds (*Potamogeton* spp.), muskgrass (*Chara* sp.), naiads (*Najas* spp.), and coontail (*Ceratophyllum demersum*).

Nuisance aquatic plants other than hydrilla known to occur in Lake Seminole include water hyacinth (*Eichhornia crassipes*), giant cutgrass (*Zizaniopsis miliacea*), Asian marshweed (*Limnophila sessiliflora)*, phragmites (*Phragmites australis*), American lotus (*Nelumbo lutea*), and fanwort (*Cabomba caroliniana)* (USACE, Mobile District 2009b).

2.5.1.2.2 Estuarine Wetlands

The only estuarine wetlands in the ACF Basin are within the Apalachicola Bay estuary system, which is composed of six major subdivisions: the Apalachicola River delta, East Bay, Apalachicola Bay, St. Vincent Sound, St. George Sound, and Alligator Harbor. The Apalachicola Bay estuary covers approximately 210 sq mi and is partially bounded seaward by four barrier islands: St. Vincent Island, St. George Island, Cape St. George Island, and Dog Island. These features form four natural openings to the Gulf of Mexico: Indian Pass, West Pass, East Pass, and the expanse between Dog Island and Alligator Point. The average depth in the estuary ranges from 3 ft in East Bay to 9 ft in Apalachicola Bay, with maximum depths up to 20 ft occurring toward the barrier islands. Florida has designated 60 percent of the estuary as the Apalachicola Aquatic Preserve. ANERR, which includes the bay, Cape St. George Island, and the Apalachicola River floodplain, is approximately 193,758 ac (Tonsmeire et al. 1996).

Muddy, soft-bottom substrates compose approximately 78 percent of the open-water areas of the Apalachicola Bay estuary system. Phytoplankton are recognized as the most important primary producers in the open waters of the estuary. The sedimentary floor of the basin is composed generally of quartz sand with a thin cover of clay (Tonsmeire et al. 1996). Certain open-water areas consist primarily of sand, whereas other areas have varying degrees of clay mixed with sand. Historically, the bay bottom was composed of silty clays, silty sands, and sand-silt-clay mixtures (Tonsmeire et al. 1996). Isphording (1985) hypothesized that the present scarcity of silt in estuarine sediments is due to upstream reservoirs altering the sediment load carried by the Apalachicola River, events in the estuary that have acted to remove or bury silt, or a combination of both.

Most of the intertidal areas around the Apalachicola Bay estuary are surrounded by freshwater, brackish, or saltwater marshes. Approximately 14 percent of the total aquatic area of the estuary is composed of marsh habitat. The primary forms of marsh habitat consist of freshwater and brackish marshes in the Apalachicola River delta above East Bay. These areas are dominated by sawgrass (*Cladium jamaicense*), bulrushes (*Scirpus* spp.), cattail (*Typha angustifolia*), brackish-water forms of cordgrass (*Spartina* spp.), and black needlerush (*Juncus roemerianus*). Mainland areas from Indian Lagoon to Alligator Point have limited marsh development; however, lagoon portions of St. George Island, Dog Island, and Alligator Point have light to moderate concentrations of fringing saltwater marshes, dominated by black needlerush and smooth cordgrass (*Spartina alterniflora*).

Seagrasses and other submersed vegetation, collectively known as *grassbeds*, account for approximately 10 percent of the total surface water area of the Apalachicola Bay estuary system. Grassbeds are highly productive and provide both food and habitat for various estuarine organisms. The naturally high rates of sedimentation in the estuary, together with the light-limiting potential of water color and turbidity resulting from river discharge, restrict the range of grassbeds in the estuary. In East Bay, the grassbeds consist primarily of brackish-water species, such as tapegrass (*Vallisneria americana*), widgeon grass (*Ruppia maritima*), and pondweeds. The introduced Eurasian watermilfoil (*Myriophyllum spicatum*) and hydrilla are also established in many of the bayous and inlets of the upper estuary. Submersed vegetation off St. George Island, Dog Island, and western portions of Alligator Point is dominated by shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudium*).These species are adapted to higher salinity than occurs in East Bay, and they are usually associated with macroalgal genera such as *Gracileria*, *Caulerpa*, and *Padina*. Very little grassbed coverage occurs in St. Vincent Sound.

2.5.2 Wildlife Resources Affected Environment

This section is focused on the wildlife resources in the ACF Basin, and specifically on species known, or likely, to occur in riparian or terrestrial areas. Fish species are described separately in section 2.5.3. The capacity for all terrestrial wildlife (i.e., birds, mammals, reptiles, amphibians, and insects and other invertebrates) to survive and reproduce is controlled by characteristics of their physical and chemical habitat, and by interactions with other wildlife species, such as predators, prey, and parasites (Southwood 1977). For the many wildlife species that rely on vegetation for food and shelter, changes in the vegetative characteristics of wetlands, riparian floodplains, and upland areas also change suitability of those areas as habitat. Some species are more sensitive to habitat changes than others, and can be loosely thought of as specialists and generalists (Stewart et al. 2010, Fahrig 2003).

2.5.2.1 General Basinwide Wildlife Assemblages

All organisms—whether aquatic, semiaquatic (i.e., spending at least a portion of their lives in water), terrestrial, or plant or animal—are dependent on immediate, local-scale habitat features, as well as broadscale environmental characteristics that influence the habitat. Different species also have different environmental and ecological requirements that control whether they can survive and reproduce in a given area (Southwood 1977). Vegetative communities provide not only shelter from severe weather events, nesting areas, and protection from predation, but also serve as food sources for plant-eating animal species. Thus, the characteristics of wildlife assemblages can strongly reflect vegetative resources. The ecological variability of the ACF Basin is acknowledged and reflected by its position within four level III ecoregions—the Blue Ridge Mountains, the Piedmont, the Southeastern Plains, and the Southern Coastal Plain—within which are nested 18 level IV ecoregions (Griffith et al. 2001; Omernik 1995) (Figure 2.1-8). The ecoregional framework represents the diversity of habitat features (i.e., soils, topography, vegetation, and climate) contained within that landscape. Such variable landscapes as these ecoregions, and the ACF Basin in particular, have the capacity for supporting a wide variety of biota.

The USFWS (1998) reviewed the historical vegetative history of the ACF Basin, including changes that have occurred in the 500+ post-European years due largely to still-accelerating human activities. Historically, the Blue Ridge Province was covered by oak-chestnut-hickory forests, with hemlock in moist coves and white pine in drier ridges. Today the vegetation of the Blue Ridge Mountains is Appalachian oak forest, mixed mesophytic vegetation, grading to shrub balds in the highest elevations (Griffith et al. 2001). Large areas of public lands (e.g., Chattahoochee National Forest) are managed for mixed uses, such as tourism, recreation, hunting, and forest products. Native forests in the Piedmont Province were dominantly deciduous hardwoods and mixed stands of pine and hardwoods (USFWS 1998). The Piedmont was heavily cultivated and is dominated today by pine plantations; pasture; agricultural production of hay, poultry, but areas have reverted to oak-hickory-pine forest (Griffith et al. 2001). As far as potential natural vegetation, throughout the Southeastern Plains there was once an abundance of southern mixed forest, oak-hickory-pine forest, longleaf pine-turkey oak, and floodplain forests (Griffith et al. 2001); however, much of the region has been altered by historical logging, currently present as pine plantations, pasture and cropland, and urban and suburban development. The potential natural vegetation in the Southern Coastal Plains is Southern mixed forest, floodplain forest, and live oak-sea oats and coastal marsh vegetation, such as cordgrass, saltgrass, and rushes (Griffith et al. 2001). Much of the land use/land cover of this ecoregion remains forested wetlands, marshes, and beaches, and there is active fish and shellfish production.

As should be apparent, the diversity of potential habitats in the ACF Basin is substantial with elevations ranging 3,000–5,000 ft in the northern Blue Ridge and Piedmont to sea level in the lower Southern Coastal Plains. The substrate of rivers and streams ranges from cobble, boulder, and bedrock in the north to sand and silt in the south. Along with the diversity of the vegetation communities that the basin supports, it is an appropriate setting for a diverse wildlife assemblage.

2.5.2.1.1 Birds

Riparian forests typically support a wide diversity of birds; however, the exact makeup of a bird assemblage depends on specific characteristics of the forest. Suitability of a forest for birds is affected by age and size of a stand; in fact, Dickson and Warren (1993) note that bird assemblages are associated with vertical foliage layers, total foliage volume, habitat patchiness, stand successional stage, moisture gradient, and hydroperiod. Forested, poorly drained wetlands are known to support higher densities and more diverse assemblages of breeding birds, and in general, riparian zones with lower vegetative diversity support fewer birds from a less diverse assemblage (Dickson and Warren 1993). The oak-gum-cypress forest type exists throughout portions of the Southeastern Plain, in the midsection of the ACF Basin (Figure 2.1-8). Bird censuses have shown that yellow-billed cuckoos (*Coccyzus americanus*), Acadian flycatchers (*Empidonax virescens*), tufted titmice (*Baeolophus bicolor*), Carolina wrens (*Thryothorus ludovicianus*), red-eyed vireos (*Vireo olivaceous*), and Northern cardinals (*Cardinalis cardinalis*) are consistently abundant in mature forests of this type (Dickson and Warren 1993). Various raptors prefer living and hunting in riparian hardwood forests, including the Mississippi (*Ictinia mississippiensis*) and American swallow-tailed kites (*Elanoides forficatus*), bald eagles (*Haliaeetus leucocephalus*), and ospreys (*Pandion haliaetus*), whereas barred owls (*Strix varia*) and red-shouldered hawks (*Buteo lineatus*) are more frequently found in forested wetlands. Wood storks (*Mycteria americana*), purple gallinules (*Porphyrio martinicus*), and moorhens (*Gallinula chloropus*) rely on aquatic areas for habitat and for foraging zones; in addition, wood storks require tall cypress and hardwoods for nesting spots. Woodpeckers are adapted to more mature hardwood forests, and red- and white-eyed vireos live in the forest canopy and low, shrubby vegetation of riparian habitats, respectively. Bottomland hardwood forests support a diverse bird assemblage, which can include a number of warblers (i.e., prothonotary, Swainson's, Northern parula, Kentucky, and hooded), some of which nest in cavities of trees killed by floods (prothonotary warbler) or prefer bottomland understory thickets (Swainson's warbler) or Spanish moss (Northern parula warbler) (Dickson and Warren 1993). The Apalachicola Bay supports a wide variety of coastal shorebirds including least terns (*Sternula antillarum)*, black skimmers (*Rynchops niger),* and American oystercatchers (*Haematopus palliatus*) with essential habitats for breeding and foraging of fish (Hunter 2006).

2.5.2.1.2 Mammals

Fifty-nine species of mammals actually or potentially inhabit riparian and/or upland areas in the ACF Basin (USGS 2003) (appendix H, Table H-1). In addition to the larger species, such as black bear (*Ursus americana*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), wild pig (*Sus scrofa*), red fox (*Vulpes vulpes*), and American beaver (*Castor canadensis*), there are several species each of bats, squirrels, shrews and voles, otters, skunks, and mice. The extent to which each of these species uses riparian habitat differs by specific life history traits, especially their requirements for food, cover, protection from natural enemies, and refuge from extreme weather events. The black bear is omnivorous and thus has many options for food, including carrion, herbs, small mammals, reptiles, amphibians, and the fruits of different plants such as blackberries (Dickson and Warren 1993). These animals are frequently sighted in bottomland forests in the southeastern United States, as well as upland riparian areas. White-tailed deer exhibit an overwhelming preference for the bottomland hardwood in the Coastal Plain, and riparian zones apparently enhance the suitability of pine plantations as habitat for them.

Habitat features often present in riparian areas— such as ample forage, fruits, seeds, downed logs, debris, and stumps—have been found to be positively correlated to small mammal abundance and diversity, including for mice, rats, voles, and shrews (*Peromyscus* spp., *Mus musculus*, *Microtus* spp., *Napaeozapus insignis*, *Scalopus aquaticus*, *Sorex longirostris*, and others). The two species of squirrels, the eastern gray squirrel (*Sciurus carolinensis*) and the eastern fox squirrel (*S. niger*), have a solid association with riparian woodlands (Dickson and Warren 1993). The tricoloured bat (*Perimyotis subflavus*), formerly known by the synonym eastern pipistrelle [*Pipistrellus subflavus*]), occurs in the ACF Basin (USGS

2003) and has been documented as preferentially roosting in foliage, which is counter to the roost choice of most bats (i.e., in tree hollows) (Veilleux et al. 2003). Although mostly found in oak and maple trees in upland areas, they use those trees in riparian zones as well.

2.5.2.1.3 Reptiles

The diversity of the reptile fauna known, or likely, to occur in the ACF Basin is reflected by 68 species (USGS 2003), including the American alligator (*Alligator mississippiensis*), common and alligator snapping turtles (*Chelydra serpentine* and *Macroclemys temmincki*, respectively), 16 other turtles and tortoises, 38 species of snakes (six of which are venomous), the green anole (*Anolis carolinensis*), six skinks, and four lizards (appendix H, Table H-2). Many reptiles are associated with riparian areas because of their reliance on the moisture and/or on the locations of food sources, whether they are predators or herbivores. Dickson and Warren (1993, citing Wharton et al. 1981) noted that a gum-cypress forest in South Carolina had a diverse reptilian fauna including the eastern mud snake, yellow-bellied turtle, brown water snake, eastern cottonmouth, rat snake, green anole, river and Florida cooters, red-bellied water snake, banded watersnake, gray and green tree frogs, and 5-lined and brown-headed skinks. Similar habitats and forest types (tupelo-cypress) in the lower Apalachicola River Basin (Light et al. 1998) suggest a potential for substantial diversity of these organisms.

2.5.2.1.4 Amphibians

Slightly less diverse than reptiles, amphibians are represented by 58 species known, or likely, to occur in the ACF Basin (USGS 2003). Salamanders and frogs are the most diverse groups of amphibians in the basin. There are 23 species of salamanders representing eight genera (appendix H, Table H-3). Seven species of *Desmognathus*, five species of *Ambystoma*, and three species of *Eurycea* inhabit the area. These genera include species such as the Apalachicola dusky (*Desmognathus apalachicolae*), Ocoee (*D. ocoee*), blackbelly (*D. quadramaculatus*), flatwoods (*Ambystoma cingulatum*), marbled (*A. opacum*), tiger (*A. tigrinum*), southern 3-lined (*Eurycea guttolineata*), and dwarf salamanders (*E. quadridigitata*). The 21 frog species are in the genera *Rana*, *Hyla*, *Pseudacris*, and *Acris*; other than the American bullfrog (*Rana calesbeiana*), this group includes species such as the southern leopard, wood, pickerel, and gopher frogs. There are six tree frogs of the genus *Hyla*—the bird-voiced, Cope's gray, green, pinewoods, barking, and squirrel. The five chorus frogs (*Pseudacris*) are the spring peeper, the little grass, and the upland, southern, and ornate chorus frogs. Other than the salamanders and frogs, there are six toads, three sirens, two newts, the two-toed amphiuma (*Amphiuma means*), the hellbender (*Cryptobranchus alleganiensis*), and the Alabama waterdog (*Necturus alabamensis*). Although some salamanders and frogs can be found in upland areas, most amphibians require nearly constant contact with moisture, if not for their entire life cycle, then for most of it. Wharton (1981, in Dickson and Warren 1993) reported that some upland salamander species became established in the floodplain of the Chattahoochee River after dams were constructed, the drier floodplain becoming more suitable for those particular *Plethodon* species.

2.5.2.1.5 Fish

The fish fauna of the ACF Basin is covered in subsequent sections of the EIS, although the importance of riparian function should be noted here. Lateral dimensions of rivers and streams are emphasized for their importance in maintaining and enhancing ecological integrity (Allan 2004; Thorp et al. 2006; Fausch et al. 2002; Kondolf et al. 2006). From the aspect of freshwater riverine fish, lateral dimensions of rivers and streams are directly linked to food resources, including riparian areas contributing vegetative materials and other organisms to the water as well as periodic inundation of floodplains providing access to, for example, terrestrial insects (Dickson and Warren 1993).

2.5.2.1.6 Terrestrial Macroinvertebrates

Nonaquatic insects are hyper-diverse and abundant in the humid, subtropical zone of the southeastern United States, and even more so in riparian areas owing to nutrient-rich soils, substantial vegetative growth and productivity, and complexity of habitat structure. According to Borror et al. (1989):

> Insects are the most dominant group of animals on the earth today. They far surpass all other terrestrial animals in numbers, and they occur practically everywhere. Several hundred thousand different kinds have been described—three times as many as there are in the rest of the animal kingdom—and some authorities believe that the total number of different kinds may approach 30 million. More than a thousand kinds may occur in a fair-sized backyard, and their populations may number in the many millions per acre.

Insects feed on green vegetation, live and decaying woody materials, seeds, fungi, lichens, mosses, and algae (Slansky and Rodriguez 1987). They prey on each other and other invertebrates; they can be blood-feeders or ectoparasites on birds or mammals, scavengers feeding on dung or carrion, or parasitoids on other invertebrates. Many terrestrial insects can fly as adults, and in riparian areas they can accidently fall into water, becoming food for fish. Flooding of riparian zones gives fish immediate access to this substantial food source.

2.5.3 Fish and Aquatic Resources Affected Environment

2.5.3.1 Rivers

Riverine habitats associated with the mainstem channels of the ACF Basin were addressed under the Comprehensive Study (Freeman et al. 1997). The following description of significant river sections and riverine faunal resources in the ACF Basin is adapted from Freeman et al. (1997).

Fourteen dams in the ACF Basin impound approximate 340 mi of rivers, including roughly 275 mi in the Chattahoochee River and 65 mi in the Flint River. The remaining unimpounded river segments in the basin total about 548 RMs and differ widely in size and in the character of their natural resource values. Table 2.5-1 lists the river segments that do or could support diverse native faunal communities, protected species, or valued fisheries. These segments can be broadly categorized in three groups: unimpounded larger-river habitat, river subsystems with unregulated flow, and flow-regulated segments isolated between impoundments. The best available data were used to describe the natural resource values of these segments; however, these data remain incomplete and necessarily address the best-studied portions of the fauna (primarily fishes).

As part of the EPA National Aquatic Resources Surveys, 14 streams and rivers were sampled in the ACF Basin for benthic macroinvertebrates (Figure 2.5-1). In Alabama, Florida, and Georgia, there were, respectively, two, three, and nine locations sampled. These surveys produced a cumulative total of 50 families and 108 taxa, primarily at genus level (appendix H, Table H-4). The larvae of nonbiting midges (Insecta: Diptera: Chironomidae) were the most taxonomically diverse, with 41genera, followed by beetles (Insecta: Coleoptera) with eight genera in five families.

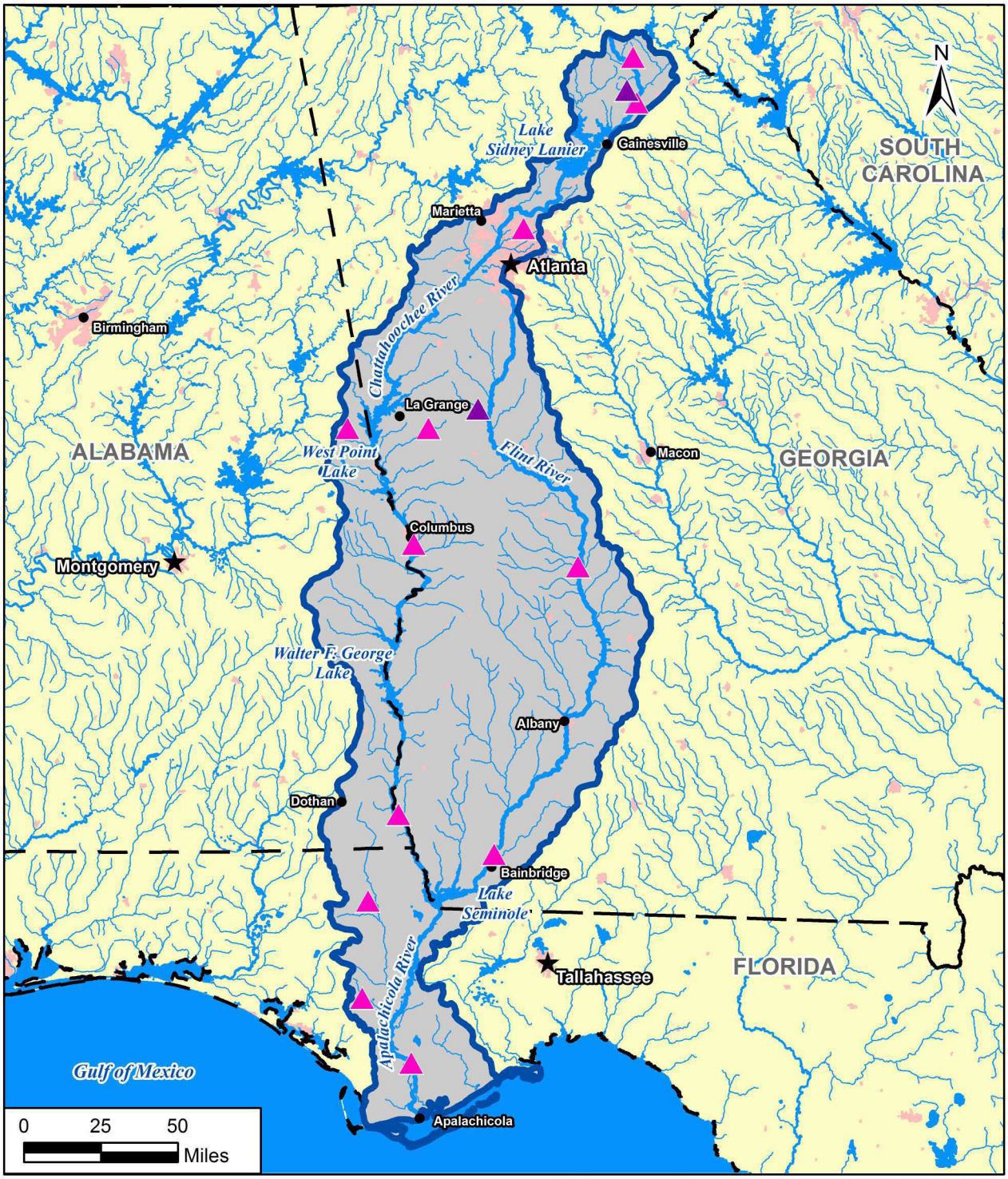
Riffle beetles (Elmidae) were represented by the genera *Ancyronyx*, *Optioservus, Promoresia*, and *Stenelmis*; and water pennies, by *Psephenus* (Psephenidae). Water scavenger beetles (Hydrophilidae) were also recorded. Caddisflies (Insecta: Trichoptera), typically recognized as a favorite prey item of insectivorous fish, are represented by eight genera in four families. The web-spinning caddisflies (Hydropsychidae: *Hydropsyche*, *Cheumatopsyche*, *Ceratopsyche, Diplectrona,* and *Nectopsyche*) build silken nets on substrate that filter suspended organic particles as foodstuff. The microcaddisflies (Hydroptilidae: *Hydroptila*) build sand cases that are carried around and used for refuge from predators. Another group of aquatic insects heavily fed upon by fish are mayflies (Ephemeroptera), of which there

were seven genera in six families. There are several other families of mites, crustaceans, and mollusks (limpets [Ancylidae: *Ferrissia*], fingernail clams [Sphaeriidae], and basket clams [Corbiculidae]). Although appendix H, Table H-4 is not an exhaustive list of benthic macroinvertebrates, it can be considered an example of what is present in the streams and rivers of the ACF Basin.

Table 2.5-1.
Inventory of Riverine Faunal Resources in the ACF Basin

River System Subsystem, or Segment	Aquatic Faunal Resources
Chattahoochee River system upstream of Lake Lanier	Supports populations of native species (including at least one endemic, undescribed fish species) eliminated downstream in the Chattahoochee by impoundment and water quality degradation. Headwaters support trout; lower reaches support a fishery for redeye bass and spawning habitat for walleye and white bass in Lake Lanier.
Chattahoochee River downstream of Buford Dam	Reach from Buford Dam to the confluence of Peachtree Creek supports a valued stocked trout fishery.
Chattahoochee River system between Morgan Falls Dam and West Point Lake	Extensive reach of riverine habitat including shoals in vicinity of Franklin, Georgia, provides spawning habitat for white bass migrating upstream from West Point Lake. Degraded water quality might affect faunal integrity.
Tributaries to middle Chattahoochee River	Provide habitat for species diminished in the mainstem by impoundment or degraded water quality; some tributaries, including Snake, Whooping, Centralhatchee, and Hillabahatchee creeks, retain high biotic integrity and function as refugia for Chattahoochee River fauna.
Flint River system upstream of Lake Blackshear	Supports a large fraction of the native ACF fish assemblage, including five endemic species and relict populations of imperiled mussels. Important habitat for fishes and mussels occurs in mainstem and in tributaries. Almost unique in retaining continuity of riverine habitat from Piedmont to the Coastal Plain, providing for downstream flow of energy and nutrients, exchange among populations, and natural inundation of riparian wetlands in the corridor above Lake Blackshear.
Tributaries to the Flint River	Represent potential sources of recolonizers to mainstem populations decimated by poor water quality or natural catastrophes. Ichawaynochaway Creek system supports a diverse fish assemblage of at least 55 species, including five endemic species, and summer refuge habitat for migratory striped bass (as, historically, did Spring Creek). Other tributaries (e.g., Kinchafoonee and Muckalee creek systems) support populations of mussels that have disappeared from the mainstem. Potato, Lazer, Auchumpkee, and Ulcohatchee creeks represent potential faunal fishes.
Lower Flint River system	Flow regulated by two upstream impoundments. Supports sport fisheries and contains summer refuge and spawning habitat for striped bass. Potential habitat for mussels and native nongame fishes.
Apalachicola River system	The system comprises, in addition to the mainstem, tributaries (including the Chipola River) and distributaries in a matrix of forested wetlands of exceptional extent. Historically supported diverse aquatic assemblages including abundant mussels and fishes. Flow is regulated by Woodruff Lock and Dam and upstream dams, and the channel is maintained for navigation. Diverse fish assemblages and populations of imperiled mussels persist in natural channel habitats. Anadromous Gulf sturgeon, striped bass, and Alabama shad ascend the river, with potential spawning habitat in upper portion of the river.

Source: Freeman et al. 1997



Sites in the ACF Basin Sampled for Benthic Macroinvertebrates during WSA and NRSA by EPA

Figure 2.5-1

Sources: USEPA 2006, USEPA 2009b. Notes: WSA = Wadeable Streams Assessment; NRSA = National Rivers and Streams Assessment.

2.5.3.1.1 Large River Habitat

The Apalachicola River flows freely from Jim Woodruff Lock and Dam and represents the only unimpounded large-river habitat remaining in the ACF Basin. This habitat is not pristine, however, because streamflow is regulated by upstream impoundments and dredging through the 1990s. The USFWS compared preimpoundment and postimpoundment hydrologic regimes in the Apalachicola River using the Range of Variability Approach (RVA) (Richter et al. 1997) to characterize existing altered flow conditions. The assessment showed significant postimpoundment hydrologic alterations, including increased February mean flow, decreased July mean flow, decreased duration of high flow pulses, and alterations in the rate and frequency of change in water conditions (Richter et al. 1997).

The main channel of the Apalachicola River and its tributaries provide important habitat for fish and mussels. Ninety-five species of fish are known to occur, including the anadromous Gulf sturgeon, striped bass (*Morone saxatilis*), and Alabama shad (*Alosa alabamae*) (appendix H, Table H-5; USGS 1996). Critical habitat has been federally designated recently for Gulf sturgeon (USFWS 2003a) and four mussel species: fat threeridge, Chipola slabshell (*Elliptio chipolaensis*), Gulf moccasinshell (*Medionidus penicillatus*), and shiny-rayed pocketbook (*Hamiota subangulata*) (USFWS 2007a). Ongoing studies by the USFWS in the Apalachicola River suggest that previous estimates likely underestimated the population of fat threeridge in the middle river reaches (Zettle 2014, personal communication).

Integral habitat features of the Apalachicola River extend beyond the main channel to include tributaries, backwaters (oxbow lakes, sloughs), and the floodplain (Light et al. 1995; Sparks 1995). At least 80 percent of the fish species found in the main channel also occupy floodplain habitats, especially for spawning and foraging from April through July (Light et al. 1995; USFWS 1998). Striped bass are reported to use at least 12 tributary streams in the upper reach of the river as cool-water thermal refugia from May through November (Light et al. 1998; USFWS 1998). At least 45 species are known to use the Apalachicola River floodplain for spawning and nursery habitats based on larval trap collections from 2002 to 2007. Fish community research at the Apalachicola River indicates that floodplain connection and inundation are important for fish communities in this river system (Dutterer et al. 2012).

Entrenchment of the Apalachicola River channel, which occurred after construction of Jim Woodruff Lock and Dam up until about 1981, has lowered river stages and decreased the accessibility of tributary streams to fishes in the main channel (Light et al. 1998). As measured at the Chattahoochee gage, a flow of about 11,000 cfs is required to provide sufficient depths at tributary mouths for fish to move between the tributaries and main channel, compared to a flow of about 5,500 cfs before impoundment (Light et al. 1998). Under present conditions, the extent of connected aquatic floodplain habitat increases substantially with flows exceeding 29,000 cfs.

2.5.3.1.2 Subsystems with Unregulated Flow

A second group of river segments have unregulated flow and maintain significant portions of native species assemblages. These systems and subsystems mostly occur in the upper-most portions of the drainages, and, in some cases, represent refugia for species eliminated from downstream segments by impoundments. The upper and middle Flint River system and the uppermost Chattahoochee River system, along with some tributary systems to the Flint and Chattahoochee rivers, are known to support significant remnants of the native riverine faunal communities (Yerger 1977; Barkuloo et al. 1987; Dahlberg and Scott 1971; Gilbert 1969). Unimpeded flow from the Piedmont to the Coastal Plain ecoregion contributes significantly to natural resource value in the Flint River system because river continuity between the distinct habitats above and below the Fall Line facilitates the natural flow of water, energy, and nutrients to downstream habitats and allows the potential exchange of individuals among populations experiencing different habitat regimes. Connectivity to tributary streams is valuable for the same reasons. In all cases,

the identification of high-quality segments implicitly includes tributary streams as important system components.

The Piedmont portion of the Flint River supports a diverse assemblage of 50 fish species (appendix H, Table H-5; Couch et al. 1996) and 20 species of mussels (Brim-Box and Williams 2000). The upper reaches of the river contain extensive shoal habitat, consisting of gravel, cobble, and bedrock substrate in areas of moderate to high gradient. Species generally found along the shoals include the rare highscale shiner (*Notropis hypsilepis*) and three endemic species: Halloween darter (*Percina crypta*), shoal bass (*Micropterus cataractae*) and bluestripe shiner (*Cyprinella callitaenia*) (Freeman et al. 1997). The bluestripe shiner (*Cyprinella callitaenia*) and the shoal bass (*Micropterus cataractae*) also are present in the upper reaches of the Apalachicola River and the Chipola River (Hoehn 1998). Critical habitat units are designated for three mussel species: fat threeridge, Gulf moccasinshell, and shiny-rayed pocketbook (USFWS 2007a). In 2006, seven live specimens of the fat threeridge were found, representing a rediscovery of the species in the Flint River (USFWS 2007a). The species was previously thought to have been extirpated from the system, but subsequent surveys in 2007 found an additional three specimens.

2.5.3.1.3 Flow-Regulated, Isolated Segments

The lower Flint River system is the sole representative of the third group of river segments that are flow regulated and isolated between impoundments, and it still maintains portions of native species assemblages and supports valued fisheries. Flows are regulated by the upstream Blackshear and Flint River dams, which principally operate in run-of-river mode. RVA analysis downstream of Flint River Dam at Albany reveals typical effects of hydroelectric power generation operations associated with patterns of storage and release; however, these effects are not as pronounced as in other regulated reaches in the basin. The lower Flint River supports a warm-water fishery of approximately 81 species (appendix H, Table H-5; USGS 1996), including sunfish, catfish, and largemouth bass, shoal bass, and striped bass. Twenty species of mussels are known to exist in this segment, including five federally listed species (Brim-Box and Williams 2000). Two federally designated critical habitat units have been established for the fat threeridge, Gulf moccasinshell, shiny-rayed pocketbook, oval pigtoe (*Pleurobema pyriforme*), and purple bank climber (*Elliptoideus sloatianus*), extending from Warwick Dam at Lake Blackshear to Jim Woodruff Lock and Dam at Lake Seminole (USFWS 2007a).

The Chattahoochee River downstream of Buford Dam includes the following flow-regulated, isolated, unimpounded reaches totaling 115 RMs:

- Buford Dam to the upstream end of Morgan Falls Lake (32 RMs)
- Morgan Falls Dam to the upstream end of West Point Lake (77 RMs)
- West Point Dam to the upstream end of Langdale Lake (6 RMs)

Cold-water hypolimnetic (bottom) releases from Buford Dam support a highly popular, urban put-and-take trout fishery in the 48-mi reach of the Chattahoochee River between Buford Dam and the bridge at I-285 west in Atlanta. The reach is classified by the GADNR WRD as secondary trout waters. *Secondary trout streams* show no evidence of natural reproduction but are capable of sustaining stocked trout throughout the year. The river is stocked annually with about 250,000 adult and juvenile rainbow trout and brown trout. Formerly a warm-water stream, this reach of the Chattahoochee River now supports one of the southernmost tailwater trout fisheries (Nestler et al. 1985).

Water quality criteria for secondary trout streams in Georgia specify that elevations of natural stream temperatures must not exceed 2 °F (GAEPD 2015b). For waters designated as trout streams, DO concentrations must be no less than 5.0 mg/L and average at least 6.0 mg/L on a daily basis. Based on an in-stream flow study conducted by Nestler et al. (1985), habitat values for trout in the Chattahoochee River generally peak at river flows less than 2,000 cfs and decline to minimum values at flows of

12,000 cfs. The largest area of suitable trout habitat in the reach occurs below Morgan Falls Dam in association with extensive rocky shoals. A principal factor limiting the downstream distribution of stocked trout in the Chattahoochee River is water temperature. Rainbow trout and brown trout generally require water temperatures below 77 °F (21 °C) for survival and prefer temperatures below 68 °F (20 °C) for feeding, growth, and reproduction (Eaton et al. 1995; Raleigh et al. 1984, 1986).

On the basis of RVA analysis comparing preimpoundment and postimpoundment conditions downstream of Buford Dam, significant hydrologic alterations reflected in current conditions include generally higher flows in late summer and autumn and lower or more variable flows in spring (USFWS 1998). Low flow pulses and high flow pulses are both more frequent yet shorter in duration, corresponding with current hydroelectric power generation peaking operations at Buford Dam. Daily releases typically vary between about 1,000 and 8,000 cfs, resulting in substantial downstream fluctuations in stream levels. These pronounced fluctuations destabilize the day-to-day distribution and availability of aquatic habitat for native aquatic biota and trout.

The Chattahoochee River, between Morgan Falls Dam and West Point Reservoir, also contains extensive riverine habitat but with degraded water quality. The low diversity and abundance of native riverine fishes in the Chattahoochee River downstream of Atlanta might be largely attributable to decades of industrial and municipal wastewater discharge, as well as sediment and other nonpoint source pollutants in runoff from the rapidly growing metropolitan area.

Collectively, the Chattahoochee River supports 79 species of fish in the middle and upper reaches (appendix H, Table H-5; USGS 1996). The upper reaches maintain a put-and-take trout fishery, while the middle Chattahoochee is characterized by a warm-water community dominated by sunfish, bass, and carp (Freeman et al. 1997). A 1992 survey in the vicinity of the Riverview and Langdale facilities found only one native cyprinid species, the bluestripe shiner (Freeman et al. 1997). Three native sucker species—spotted sucker (*Minytrema melanops*), greater jumprock (*Moxostoma lachneri*), and grayfin redhorse (*Moxostoma* n. sp. cf. *poecilurum*)—were also documented as part of the survey. Fifteen mussels are known to occur in the region (Brim-Box and Williams 2000). The shiny-rayed pocketbook is the only federally listed species, occurring along the mainstem of Uchee Creek in Russell County, Alabama. This segment was federally designated critical habitat in 2007 (USFWS 2007a).

A recent survey of the mussel and snail fauna in the Chattahoochee River mainstem from just upstream of Lake Oliver to downstream of Fort Benning found a total of 11 mussel and 2 snail species (Catena Group 2010). Of the 38 sites surveyed, there were no (zero) mussels found at 14, suggesting limited distributional continuity. However, the species was locally abundant and found in high numbers in the study area. Further, they indicate that historically there were 30 species of mussels recognized from this region of the Chattahoochee.

Seven dams impound nearly the entire reach of the Chattahoochee River between West Point Dam and Walter F. George Lock and Dam. Riverine habitat exists as short fragments isolated between an upstream dam and the backwaters of the next downstream impoundment. Fishes in the tailwater segments have at times suffered from scouring, the stranding effects of rapid flow fluctuations, and low DO levels resulting from hypolimnetic releases or from crowding of fish stranded by rapidly dropping water levels (USFWS 1998). RVA analysis shows that these segments experience substantially altered flow regimes from hydroelectric power generation operations (USFWS 1998).

Ninety species of fish are known to occur in the lower Chattahoochee River (appendix H, Table H-5; USGS 1996). Thirteen species of mussels exist, including the shiny-rayed pocketbook, Gulf moccasinshell, and oval pigtoe (Brim-Box and Williams 2000). A federal designation of critical habitat protects these species, extending along the mainstem of Sawatchee and Kirkland creeks to the mainstem of the Chattahoochee River.

2.5.3.2 Reservoirs

The effects of damming on river biota can occur at different scales, ranging from local losses of species intolerant of reservoir and dam-tailwater habitats to basinwide reduction of migratory fauna or regional losses of fisheries (see review by Dudgeon 2000; Pringle et al. 2000). Although many stream-dependent species might persist in dam-altered basins, populations are often reduced locally and are restricted to fragments of their former ranges (Freeman et. al 2001).

Barkuloo et al. (1987) reviewed fishery resources in the ACF Basin, surveying local and regional fisheries to determine critical species, critical habitat-use guilds (e.g., littoral spawning, rearing) and their associated optimal reservoir levels, and to define *acceptability levels* for a range of water levels departing from the designated optima. Data were compiled for 10 of the 16 facilities; the remaining 6 were omitted because of their small size and limited storage capacity. Table 2.5-2 presents the critical species identified by the survey.

Table 2.5-2.
Fish Species Identified as Critical in Evaluating Operating Alternatives for Reservoirs of the ACF Basin

Reservoir	Critical Species
Chattahoochee River	
Lake Lanier	Crappie, largemouth bass, spotted bass, striped bass, walleye, white bass
West Point Lake	Crappie, gizzard shad, striped bass-white bass hybrid (hybrid bass), largemouth bass, striped bass, threadfin shad, white bass
Harding Lake[a]	Bluegill, crappie, gizzard shad, hybrid bass, largemouth bass, spotted bass, striped bass, threadfin shad, white bass
Goat Rock Lake	Channel catfish, crappie, largemouth bass, threadfin shad
Oliver Lake	Bluegill, crappie, largemouth bass, threadfin shad
Lake George W. Andrews	Crappie, largemouth bass
Walter F. George Lake	Crappie, hybrid bass, largemouth bass, shad
Flint River	
Lake Blackshear	Bluegill, crappie, largemouth bass, shad, sunfish
Lake Worth	Bluegill, largemouth bass
Apalachicola River	
Lake Seminole	Bluegill, crappie, largemouth bass, redear sunfish, striped bass, threadfin shad

Note:
[a.] Harding Lake is referred to as Bartletts Ferry Reservoir in Ryder et al. (1995).

Because of its proximity to Atlanta, the largest metropolitan area in the Southeast, the reservoirs, rivers, and streams of the ACF Basin are heavily used for recreation (USGS 1996). Headwaters of the basin include several extensively used reservoirs, as well as numerous national forests and national and state parks. Lake Lanier, one of the largest reservoirs of the ACF Basin, maintains the highest visitation rate of among USACE reservoirs in the southeast, receiving more than 6.5 million visitors in 2012 (USACE 2016b). Angling opportunities are abundant, with most reservoirs supporting a quality warm-water sport fishery of bass, catfish, and sunfish. In 1991, however, EPA's *National Study of Chemical Residues in Fish* evaluated 60 chemical contaminants in fish tissue from 11 sites in the ACF Basin (USEPA 1991). Three sites on the Chattahoochee River contained chemical concentrations that were among the highest in the nation. One or more of these sites ranked in the top five for chemical concentrations, including four dioxin or furan compounds; pentachloranisole; 1,2,3 trichlorobenzene; chlordane; five chlordane congeners; chloropyrifos; and methoxychlor (USEPA 1991). Similarly, the *National Lake Fish Tissue Study* found elevated PCB levels exceeding the federal screening value of 12 parts per billion (ppb) in two ACF Basin reservoirs (USEPA 2009b). Channel catfish (*Ictalurus punctatus*) from Walter F. George Lake and West Point Lake contained concentrations of 55 ppb and 58 ppb, respectively.

Uncontrolled growth of aquatic vegetation and algae is common to reservoirs, where stable water levels, shallow depths, sedimentation, and nutrient enrichment produce favorable conditions for vegetative growth. In the ACF Basin, Lake Blackshear, Walter F. George Lake, and Lake Seminole have historically experienced noxious growth of aquatic vegetation. The problem is most severe in Lake Seminole, where as much as 68 percent of the reservoir's surface area has been covered by aquatic plants. USACE has documented more than 900 species of aquatic and wetlands plants at Lake Seminole (USACE, Mobile District 1998b). Several noxious exotic species have become well-established, including Eurasian milfoil, water hyacinth, and hydrilla. Hydrilla has exhibited the most prolific growth and range expansion (Burge et al. 2007), prompting USACE to issue a hydrilla action plan (USACE, Mobile District 1998b). In addition to traditional aquatic herbicide applications, several methods, including lowdose application of herbicides, mechanical harvesting, and even biological controls (the Asian hydrilla leaf-mining fly, *Hydrellia pakistanae* [Deonier 1978] [Insecta: Diptera: Ephydridae] and the sterile grass carp [*Ctenopharygodan idella*]) have been used in an attempt to control the spread of these plants, as suggested by Burge et al. (2007). Winter drawdowns, which are so effective in controlling many submersed weeds, have not proven successful with hydrilla, and mechanical control of hydrilla provides only temporary relief and may spread the weeds to other areas of the reservoir or waterway by releasing vegetative fragments. Sterile grass carp have been used extensively in many states to control hydrilla and other submersed aquatic weeds. Grass carp may live as long as 10 years and are usually very effective in suppressing hydrilla in ponds and small lakes, particularly if the fish are stocked in the fall. Aquatic herbicides can be used for control of hydrilla, but can be toxic to fish. In large reservoir systems, it is not economically feasible to eradicate hydrilla by treating the whole reservoir with herbicides or other control methods (NCSU 1992). Due to the limited effectiveness of these control measures, hydrilla management is very challenging.

As part of EPA's National Lakes Assessment, a tributary reservoir in the ACF Basin—Mahaffey Lake in Harris County, Georgia—was sampled for phytoplankton and zooplankton (USEPA 2009b). Table 2.5-3 lists taxa identified from the plankton samples, including 20 zooplankton and 18 planktonic diatoms. Although this is not an exhaustive list of plankton, it shows some of the taxa that can be expected to be found in lakes and reservoirs of the ACF Basin.

Table 2.5-3.
List of Zooplankton and Planktonic Diatoms Collected at Mahaffey Lake (Harris County, GA) as Part of EPA's National Lakes Assessment (NLA06608-0207)

Zooplankton (20 taxa)		Planktonic Diatoms (18 taxa)	
Family	**genus/species**	**Family**	**genus/species/variety**
Brachionidae	*Brachionus angularis*	Achnanthaceae	*Achnanthes pseudoswazi*
	Kellicottia bostonensis	Achnanthidiaceae	*Achnanthidium minutissimum*
	Kellicottia longispina	Aulacoseiraceae	*Aulacoseira ambigua*
	Keratella cochlearis		*Aulacoseira granulata angustissima*
	Keratella crassa		*Aulacoseira italica*
Hexarthridae	*Hexarthra mira*	Berkeleyaceae	*Parlibellus protracta*
Daphniidae	*Daphnia parvula*	Fragilariaceae	*Fragilaria crotonensis*
Asplanchnidae	*Asplanchna*		*Fragilaria crotonensis oregona*
Bosminidae	*Bosmina*		*Fragilaria* sp.
Collothecidae	*Collotheca*		*Synedra delicatissima*
Conochilidae			*Synedra* sp.
Cyclopidae	*Mesocyclops*		*Synedra ulna chaseana*
Daphniidae	*Ceriodaphnia*	Naviculaceae	*Navicula cryptocephala*
Diaptomidae		Stauroneidaceae	*Stauroneis tackei*
Filiniidae	*Filinia*	Stephanodiscaceae	*Cyclotella comensis*
Sididae	*Diaphanosoma*		*Cyclotella* sp.
Synchaetidae	*Polyarthra*	Tabellariaceae	*Tabellaria flocculosa*
	Ploesoma	Thalassiosiraceae	*Discostella stelligera*
	Polyarthra		
Trichocercidae	*Trichocerca*		

2.5.3.3 Apalachicola Bay and Estuary

Estuaries are semienclosed coastal water bodies with a free connection to the ocean and one or more influent rivers or streams. As a result, they contain both freshwater and marine features but generally have a range of salinities. These unique and highly productive ecosystems include a variety of habitat types, such as marine waters, brackish bays and marshes, submerged aquatic vegetation beds, and inland rivers and swamps. The formation, maintenance, and productivity of these habitats are dependent on the flow of freshwater and sediment delivery from the rivers and on the regular flushing of the marine system. Because of their habitat diversity and great productivity, estuaries provide spawning, nursery, and feeding grounds for a great number of estuary-dependent invertebrate and fish species and the food webs that depend on them. Unfortunately, due to their productivity and hydrology, estuaries provide great opportunities for human development, and of the 32 largest cities in the world, 22 are on estuaries (NSTA 2015). As a result, these systems are often affected by a variety of stressors and sources generated both locally and remotely.

The Apalachicola Bay estuary is one of the largest estuaries in the southeastern United States as well as one of the most important estuaries, in terms of productivity, in the entire United States. The Apalachicola Bay estuary is part of a tri-river system that includes the Apalachicola River in Florida and the Chattahoochee and Flint rivers in Alabama and Georgia. The bay itself covers an area of approximately 210 sq mi behind a chain of barrier islands; the four principal barrier islands are St. Vincent Island, Cape St. George Island, St. George Island, and Dog Island (Gorsline 1963). The average depth across the bay is

approximately 9 ft, and tidal ranges vary from 0.43 ft to 0.75 ft (Livingston 1984). As the second-largest of the 28 existing NERRs, the Apalachicola Reserve encompasses 246,766 ac, 135,680 of which are state-owned submerged lands.

In 1969, the State of Florida designated Apalachicola Bay as one of 18 aquatic preserves, followed in 1979 by the lower river and bay system being designated by NOAA as a NERR. Simultaneous actions by the state designated the lower and upper Apalachicola River (1979 and 1983, respectively) as an Outstanding Florida Water. In 1984, the United Nations Education, Scientific, and Cultural Organization (UNESCO) designated the reserve a Biosphere Reserve under the International Man and the Biosphere (MAB) program. These actions provide protection and management for the system that help ensure long-term sustainability.

Of the variety of important ecological characteristics of the Apalachicola Bay estuary, the following are of particular note (Edmiston 2008; Apalachicola Riverkeeper 2010):

- The river and bay watershed is one of the most important bird habitats in the southeastern United States.
- More than 50 species of mammals, including the threatened Florida black bear, the endangered West Indian manatee, the Indiana bat, and the gray bat, are found in the Apalachicola drainage basin.
- More than 1,300 plant species (103 federally or state listed), 40 amphibian species, and 80 species of reptiles live within the Apalachicola River Basin. This is the highest diversity of amphibians and reptiles in the United States and Canada.
- More than 360 marine mollusk species—many of which are federally listed as threatened and endangered—are found in the watershed.
- One hundred thirty-one species of freshwater and estuarine fish have been found in the nontidal and tidal portions of the Apalachicola and lower Chipola rivers. More than 140 species have been found within the boundary of the bay itself, and the area is a valuable spawning and nursery ground for many important commercial and sport fishes.
- The federally listed Gulf sturgeon (threatened) and blue shiner (special concern), and the state-listed (AL) shoal bass are found in the Apalachicola River Basin.

The Apalachicola Bay estuary is one of the most productive estuaries in the northern hemisphere. It provides 90 percent of Florida's commercial oysters and over 10 percent of the total United States production. It is a major nursery for penaeid shrimp, blue crabs, and many fish species, including striped bass, Gulf sturgeon, grouper, red fish, speckled trout, and flounder. The harvest and sale of shrimp, crab, fish, and oysters is the driving economic force for Franklin County.

The physical features of the Apalachicola Bay estuary include both common and unique features. Over a 14-year period of record (1978–1992), the Apalachicola River had the highest average discharge (25,960 cfs [Frick et al. 1996]) of any river in Florida. It is 21st in magnitude among conterminous rivers in the United States, and its discharge accounts for 35 percent of the total freshwater runoff on Florida's west coast (from Florida Bay to Perdido Bay) (McNulty et al. 1972). Seasonal flow variation is high, with peak flows from January through April and low flows from September through November (Livingston 1984). Mean daily discharge from 1972 to 1992 at Sumatra, Florida, ranged from 5,800 cfs in 1981 to 178,000 cfs in 1990 (USGS 1996). Eighty percent of the Apalachicola River flow is contributed by the Chattahoochee and Flint rivers, 11 percent from the Chipola River, and less than 10 percent from groundwater and overland flow (Elder et al. 1988; Frick et al. 1996). The Chipola River—the Apalachicola River's largest tributary—drains one-half of the Apalachicola River Basin below Jim Woodruff Lock and Dam. The sediment load is deposited in the delta, which has been prograding

approximately 6.5 ft per year since 1892 (Bedosky 1987). In-filling rates range from less than 0.04 in/yr to over 0.67 in/yr, depending on location (Bedosky 1987; Hendrickson 1997; Isphording 1985).

River flow is the primary determinant of salinity concentrations in the estuary (Livingston 1984), but other factors include local rainfall, basin configuration, wind speed and direction, and water current. The bay is divided into two main features with regard to salinity concentrations: the open gulf waters of eastern St. George Sound and the brackish portions of western St. George Sound, Apalachicola Bay, East Bay, and St. Vincent Sound. This second group is brackish because of river discharge diluting salinity concentrations. The mouth of the river and the East Bay have the lowest mean salinities. The lower reaches of the Apalachicola River compose the limnetic zone. During high river discharge and/or local precipitation events, the limnetic zone can extend to the East Bay and include considerable portions of the Apalachicola Bay.

Salinity concentrations in the limnetic zone can reach 0.5 ppt. Because of seasonal and climatic variability, salinity gradients can move through the bay area. The East Bay is typically oligohaline with salinity concentrations reaching 0.5 to 5.0 ppt. The Apalachicola Bay, St. Vincent Sound, and western portions of St. George Sound can range from mesohaline to polyhaline with salinity concentrations ranging from 5 to 18 ppt and 18 to 30 ppt, respectively. These conditions depend on river discharge, upland runoff, and local precipitation events. In the eastern sections of St. George Sound and near the passes, salinities can range from polyhaline to euhaline when salinity concentrations increase to more than 30 ppt. Vertical stratification of salinity concentrations can range from 5 to 10 ppt. Salinity is one of the major limiting factors in oyster production. Prolonged high salinities due to drought or other factors affect freshwater flow and allow for increased predation (from the southern oyster drill, *Thais haemostoma*, and the stone crab, *Menippe mercenaria*) and decreased food availability. Prolonged low salinities from flooding or other factors are similarly stressful, resulting in indirect and direct mortality such as those from the pathogen Dermo (*Perkinsus marinus* [Menzel 1983]).

Furthermore, juvenile Gulf sturgeon habitat and oyster habitat are of primary importance within the Apalachicola Bay ecosystem and depend principally on salinity regime largely driven by discharge from the Apalachicola River. Oysters thrive in salinities below 26 ppt, while juvenile Gulf sturgeon prefers regions of the estuary with salinities below 10 ppt. Three regions within Apalachicola Bay are of particular interest with regard to these requirements. Cat Point and Dry Bar sustain a vital oyster fishery and are, therefore, of economic as well as ecological importance. Optimal salinities in these areas (conducive to oyster growth from the months of May through October) should remain below the 26 ppt threshold. East Bay has been identified as important juvenile Gulf sturgeon habitat and salinity levels are optimal when below 10 ppt in this region.

There is little thermal stratification in the estuary because of its shallowness (average depth is 9 ft with up to a 1-ft tidal amplitude) and wind mixing. Water temperature is highly correlated with air temperature. Summer temperature highs usually occur in August, with similar maxima from year to year. Water temperature lows occur from December to February; the highest monthly variance occurs in winter.

DO concentrations typically reach a high during winter and spring months due primarily to low water temperatures and secondarily to low salinity concentrations. Vertical stratification of DO concentrations can be seen in the summer and fall months. Spatial distributions of DO concentrations are highest in the upper reaches of East Bay, such as Round Bay; near St. George Island, such as Nick's Hole; and along the east side of St. Vincent Island.

In terms of physical habitat, wetlands compose a major part of the Apalachicola Bay ecosystem. The river floodplain regions are composed of coastal plain flatland floodplain wetlands, coastal dunes, and freshwater and brackish marshes. In the lower reaches of the river, tupelo/cypress forests are common floodplain associations (Livingston 1984). Entering the bay, marshes compose a large portion of the tidal

fringe wetlands, and freshwater, brackish, and saltwater marshes are all represented, accounting for 14 percent of the total water surface area (Livingston 1984). Fresh and brackish water marshes are composed largely of bull rushes, cattails (*Typha* spp.), saw grasses (*Cladium* spp.), cordgrasses, and needlerush. True saltmarsh habitats are typified by black needlerush, cordgrass, *Distichlis spicata*, and *Salicornia* spp. The Apalachicola marshes are important breeding and reproductive areas for a large variety of aquatic and terrestrial species, that are both ecologically and commercially important, a reflection of the high productivity of this system.

Seagrass beds account for 10 percent of the total water surface area (Livingston 1984). Seagrasses are largely light-limited over large portions of the Bay due to turbidity and color, except along the eastern portion of St. George's Sound, where they are concentrated in shallow-depth areas (< 3.5ft) along the fringe. Species in the East Bay area include freshwater and brackish taxa and are dominated by *Valisneria americana*, *Ruppia maritima*, and *Potamogeton* species. Along the mainland, east of the river, seagrass beds are dominated by *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum*. *Gracilaria* species are also found in some seagrass beds (Livingston 1984). Similar to marshes, seagrasses are highly productive habitat providing organic matter and shelter for a variety of resident and migratory species of ecological and commercial importance.

The Florida DEP Apalachicola-Chipola Basin report indicates that hydrilla is in the Apalachicola River, Lake Wimico, Chipola River, and the Apalachicola Bay. The presence of submerged and floating plants fluctuates, which is largely a function of drought and salinity (FLDEP 2011). Increased salinity during drought suppresses hydrilla because of its vulnerability to elevated salinities. In areas of the bay where salinities average above 12 ppt and wave action is high, likely no or little hydrilla would be present. However, in slackwater, open areas, and portions of the river with average salinities less than 12 ppt, hydrilla might be more evident. In more lentic, freshwater portions of the bay with salinities less than 7 ppt, hydrilla would be expected (Haller et al. 1974; Twilley and Barko 1990).

Oyster bars are obviously commercially important, but also ecologically important habitats. They cover approximately 1 percent of the surface area of the bay. Major beds are found in St. Vincent Sound and St. George's Sound, which compose the principal commercial beds, as well as in East Bay (Livingston 1984). Waters surrounding those beds are characterized by current and salinity conditions that are optimal for oyster development and growth (Livingston 1984). Again, more than 90 percent of the state's oyster production (and up to 10 percent nationally) comes from the Apalachicola Bay estuary.

Soft, shallow, unvegetated sediments represent the dominant habitat of the bay (78 percent of surface area) (Livingston 1984). Though not nearly as productive as marshes and seagrass beds, these habitats host a variety of resident and migratory species. The epibenthic and infaunal species are largely determined by sediment composition and water quality conditions.

The biological resources of the Apalachicola Bay estuary are abundant and diverse and range from those inhabiting freshwater, nearshore habitats to open-water bay species, and from obligate resident to migratory taxa. The organisms in nearshore areas are part of a temperate sand community (Jones et al. 1973; Smith 1974). The shallow shelf benthos (30 to 65 ft) reflects the intrusion of tropical species in both sandy areas and rocky outcrop substrates. The northeastern gulf lies in the Carolina Zoogeographic Region. The region has a warm temperate fish fauna, and the fish assemblages are characterized by a high diversity including substantial representation by native species found nowhere else, and by the presence of a number of tropical species tolerant of a wide range of temperatures (Livingston 1984).

Submerged and emergent taxa compose the highly productive vegetative habitats of the bay (Table 2.5-4). Submerged vegetation covers about 10 percent of the bay system, as mentioned earlier (Livingston 1984). This vegetation includes at least nine known species, one of which, the Eurasian water milfoil, is an invasive. The marsh habitats contribute at least six dominant taxa as well (Table 2.5-4).

Table 2.5-4.
Partial List of Submerged/Emergent Vegetation of the Apalachicola Bay and Estuary

Scientific Name	Common Name	East Bay	Nearshore	Shallow Lagoon	Fresh/ Brackish Marsh	Saltwater Marsh
Cladium spp.	Sawgrasses				X	
Cladium jamaicense	Sawgrass				X	
Distichlis spicata						X
Gracilaria spp.	Graceful red weed			X		
Halodule wrightii	Shoal grass		X	X		
Hydrilla verticillata	Hydrilla		X			
Juncus roemerianus	Needlerush				X	X
Myriophyllum spicatum[a]	Eurasian water milfoil	X			X	
Naias quadalupensis	Southern waternymph	X				
Potamogeton sp.	Pond weed	X				
Ruppia maritime	Widgeongrass	X				
Salicornia spp.						X
Scripus spp.	Bullrushes				X	
Spartina spp.	Cordgrasses				X	X
Syringodium filiforme	Manatee grass		X	X		
Thalassia testudinum	Turtle grass		X			
Valisneria americana	American eel grass or tape weed	X				

Sources: Livingston 1984; FLDEP 1992, 2010c (draft)
Note:
[a.] Invasive.

Phytoplankton is composed of the highly productive water column algae that are important to the estuarine food web, especially oyster production. Productivity is highest beginning in spring, through summer, and into fall, when river discharge brings large nutrient loads (especially of nitrogen), temperatures are ideal for growth, and wind-driven resuspension provides important phosphorus contributions. Phytoplankton productivity and high marsh productivity combine to provide the energy that drives the productive and diverse estuarine food web. Evidence of this productivity is exhibited by the phytoplankton itself (appendix H, Table H-6), where the taxonomic diversity reflects not only the nutrient supply but also the dynamic water quality and flow conditions created by the intersection of fresh and marine waters of this highly confined estuary.

Zooplankton species are water column consumers that link phytoplankton to higher trophic levels, including commercially important fish species. They have not been as well studied as other groups; however, not surprisingly, the same dynamic water quality, flow, morphometry, and high productivity that provide for a diversity of other taxa have contributed to similarly diverse and productive zooplankton (Livingston 1984). This group of organisms is composed largely of holoplankton (plankton for the entire life cycle) and meroplankton (temporary plankton), of which relative percentages are approximately 90 percent and 10 percent, respectively (Livingston 1984). Copepods, cladocerans, larvaceans, and chaetognaths are the dominant groups of the holoplankton. Decapod larvae, primarily crab zoeae, polychaete larvae, ostracods, amphipods, isopods, mysids, echinoderms, ctenophores, and coelenterates are the dominant groups of the meroplankton (Livingston 1984).

Fish are abundant and diverse in the Apalachicola Bay estuary (appendix H, Table H-7). There are more than 130 species of fish, including many commercially and recreationally important species, some state- and/or federally listed species, and several introduced or nonindigenous taxa within the boundaries of the bay. The fish species of the Apalachicola Bay include taxa as diverse as the obligate estuarine bay anchovy (*Anchoa mitchilli*) and migratory striped mullet (*Mugil cephalus*), flounder (*Paralichthys lethostigma*), speckled seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), croaker (*Micropogon undulates*), spot (*Leiostomus xanthurus*), and sand seatrout (*Cynoscion arenarius*), all of which use the estuary as nursery and/or feeding grounds during part of their life cycles. Anadromous taxa, which spend a portion of their lives in the estuary before migrating upstream from the ocean to spawn, include the Gulf sturgeon, striped bass (*Morone saxatilis*), Alabama shad (*Alosa alabamae*), and skipjack herring (*Alosa chrysochloris*). Several species for which the Apalachicola Bay has essential fish habitat are covered under a fishery management plan, as required by the Magnuson-Stevens Fishery Conservation and Management Act. These species are the red drum (*S. ocellatus*), gray snapper (*Lutjanus griseus*), brown shrimp (*Penaeus aztecus*), white shrimp (*Penaeus setiferus*), pink shrimp (*P. duorarum*), and stone crab (*M. mercenaria*).

The invertebrate fauna of the Apalachicola Bay estuary are numerous and too diverse to cover adequately in this review (appendix H, Table H-8). Many of these taxa, which play an integral part of the estuarine food web connecting plankton and detritus to higher consumers, rely on the estuary for all or part of their life cycles and may inhabit different parts of the estuary during different stages (appendix H, Table H-8). The invertebrate fauna include crustaceans (e.g., shrimp and crabs), insects, mollusks, annelids, isopods, amphipods, coelenterates, and echinoderms, among others. Many of these species are commercially important, especially the brown, white, and pink shrimp; the blue crab (*Callinectes sapidus*); and the American oyster (*Crassostrea virginica*).

2.5.4 Protected Species Affected Environment

Sensitive species are unique plants and animals that have been observed to be declining toward extinction. Using available scientific research, state, federal, and nongovernmental organizations have assigned conservation priority to many rare or declining species. The most significant protection for sensitive species is the ESA (16 U.S.C. 1531 *et seq*.), passed in 1973 to address concerns about the decline in populations of many unique wildlife species. Supporters of the ESA argued that America's natural heritage was of aesthetic, ecological, educational, recreational, and scientific value to the nation and, therefore, worthy of protection. The purpose of the ESA is to rebuild populations of protected species and conserve "the ecosystems upon which endangered and threatened species depend." The law offers two classes of protection for rare species in decline: endangered and threatened.

Endangered status means a species is in danger of extinction throughout all or a significant portion of its range. *Threatened status* indicates that a species is likely to become endangered within the near future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. All federal agencies are required to protect threatened and endangered species while carrying out projects and to preserve the habitats of such species on federal land (USFWS 2001).

Under the ESA, it is illegal to *take* threatened and endangered species. As defined in the ESA, the term take "means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." The Secretary of the Interior, through regulations, defined the term *harm* in this passage as "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." Because it is unlawful to hunt or collect threatened and endangered species, habitat degradation is the primary reason for population declines in listed species (USFWS 2001).

Critical habitat is defined in the ESA. Species listed as threatened or endangered under the ESA are afforded protection within specific areas of their geographic range that offer physical or biological features essential to their conservation and that might require special management considerations. Habitat not used by the species might also be included if doing so is deemed necessary for recovery. Proposed designations and the final determination of critical habitat are published in the *Federal Register*.

This section describes the federally protected species of the ACF Basin that would reasonably be expected to be affected by changes in water management. The basin supports a wide variety of wildlife and is home to approximately 166 species that are protected or included as candidate species by the states and federal government. USFWS reviewed the 37 federally protected species with presence in the ACF Basin in the May 2012 BO for the RIOP for Jim Woodruff Lock and Dam (USFWS 2012) and found that only four of them would potentially be affected by changes in water management.

Figure 2.5-2 depicts the location of designated critical habitat units for federally protected fish in the basin, and Figure 2.5-3 depicts the location of designated critical habitat units for federally protected mussels in the basin. Table 2.5-5 provides the federally listed species in the ACF Basin, including the four species that would reasonably be expected to be affected by changes in water management are discussed below.

2.5.4.1 Protected Fish Species

2.5.4.1.1 Gulf Sturgeon

The Gulf sturgeon is an anadromous species, with adults ascending freshwater rivers for 8–9 months of the year and descending to estuarine or nearshore areas during the late fall to overwinter (Fox et al. 2002; Wooley and Crateau 1985; Huff 1975). Before the completion of the Jim Woodruff Lock and Dam, Gulf sturgeon inhabited all three rivers of the ACF Basin, migrating approximately 202 mi from the mouth of the Apalachicola River up the Flint River to Albany, Georgia (Huff 1975). Today, the species is limited to the mainstem of the Apalachicola River, downstream of Jim Woodruff Lock and Dam (USFWS 2009b; Wooley and Crateau 1985).

Critical habitat was established through the issuance of a final rule in March 2003, designating 14 critical habitat units comprising approximately 1,729 mi of riverine habitat and 2,333 sq mi of estuarine and marine habitat (USFWS 2003a). Within the ACF Basin, the Apalachicola River mainstem, from the Jim Woodruff Lock and Dam and downstream to its discharge at Apalachicola Bay, defines units 6 and 13 (Figure 2.5-2). All Apalachicola River distributaries, including the East River, Little St. Marks River, and St. Marks River, are included, as is the mainstem of the Brothers River.

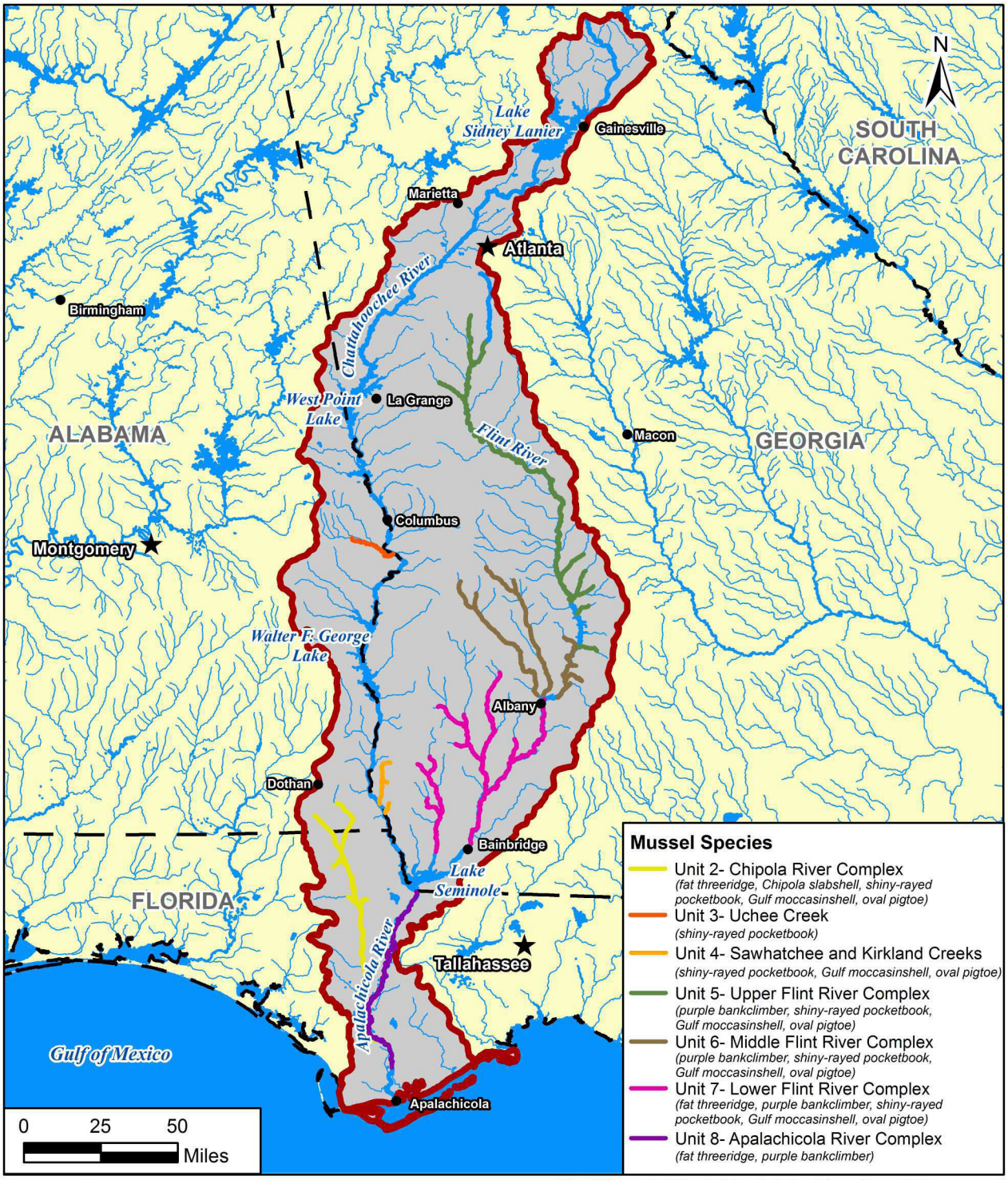
A recent 5-year review by the USFWS concluded that reclassification of the species is not warranted (USFWS 2009b). Many factors that led to the listing of the Gulf sturgeon continue to affect its existence, including impacts on habitat by dams, dredging, point and nonpoint discharges, climate change, catch, red tide, and collisions with boats. Furthermore, the populations appear to be stabilized, the long-lived, late-maturing, and intermittent spawning of adults, coupled with a largely unknown juvenile life history, make recovery of the species tenuous.



Critical Habitat Units for Fish Species Potentially Affected by Water Management Changes in the ACF Basin

Figure 2.5-2

Source: USFWS 2003a.



Critical Habitat Units for Mussel Species Potentially Affected by Water Management Changes in the ACF Basin

Figure 2.5-3

Source: USFWS 2007a.

Table 2.5-5.
Federally Protected Species Occurring in the ACF Basin

Scientific Name	Common Name	Endemic[a]	Federal Status[b]	Alabama Status[b]	Florida Status[b]	Georgia Status[b]	Subbasin[c]
Mammals							
Myotis grisescens	Gray bat		E	SP		E	AP
Myotis sodalis	Indiana bat		E	SP		E	F, UCA
Trichechus manatus	West Indian manatee		E	SP			AP
Birds							
Charadrius melodus	Piping plover		T	SP		T	AP
Mycteria americana	Wood stork		E	SP		E	LCA, AP, F
Fish							
Acipenser oxyrinchus desotoi	Gulf sturgeon		T	SP			AP
Mussels							
Amblema neislerii	Fat threeridge	Y	E			E	AP
Hamiota subangulata	Shiny-rayed pocketbook		E	SP		E	LCA, F, AP
Medionedus penicillatus	Gulf moccasinshell		E			E	AP, F
Pleurobema pyriforme	Oval pigtoe		E	SP		E	LCA, F, AP
Elliptio chipolaensis	Chipola slabshell	Y	T	SP			AP
Elliptoideus sloatianus	Purple bankclimber		T			T	AP, F
Amphibians							
Ambystoma bishopi	Reticulated flatwoods salamander		E	SP			AP, F, LCA
Ambystoma cingulatum	Frosted flatwoods salamander		T			T	AP, F, LCA
Reptiles							
Drymarchon corais couperi	Eastern indigo snake		T	SP		T	AP, LCA
Caretta	Loggerhead turtle		T	SP		E	AP
Lepidochelys kempii	Atlantic ridley		E	SP		E	AP
Plants							
Harperocallis flava	Harper's beauty	Y	E		E		AP
Isoetes melanospora	Black-spored quillwort		E			E	UCA, LCA, F
Lindera melissifolia	Pondberry		E				F
Oxypolis canbyi	Canby's dropwort		E			E	F
Ptilimnium nodosum	Harperella		E			E	F
Sarracenia oreophila	Green pitcherplant		E			E	F, LCA, UCA
Schwalbea americana	American chaffseed		E		E	E	LCA, AP, F
Thalictrum cooleyi	Cooley's meadowrue		E		E	E	F
Conradina glabra	Apalachicola rosemary		E		E		
Rhododendron chapmanii	Chapman rhododendron		E		E		AP, F
Torreya taxifolia	Florida torreya		E		E	E	F
Silene polypetala	Fringed campion		E		E	E	F, UCA
Spigelia gentianoides	Gentian pinkroot		E				LCA
Rhus michauxii	Michaux's sumac		E			E	F, UCA
Trillium reliquum	Relict trillium		E			E	F, LCA, UCA
Scutellaria floridana	Florida skullcap		E		E		AP
Amphianthus pusillus	Little amphianthus		T			T	UCA, LCA, F
Macbridea alba	White birds-in-a-nest		T		E		AP
Pinguicula ionantha	Godfrey's (violet) butterwort		T		E		AP
Euphorbia telephioides	Telephus spurge		T		E		AP

Sources: ALNHP 2014; CH2M Hill 2003; FWC 2014; GADNR 2014b; USFWS 2012, 2014
Notes:
[a.] Y = endemic to basin.
[b.] Status. C = candidate for listing as threatened or endangered, E = listed as endangered, R = rare, no legal status, SP = species formally protected, T = listed as threatened.
[c.] Subbasins (based on present known distributions): AP = Apalachicola River, F = Flint River, LCA = Lower Chattahoochee River, UCA = Upper Chattahoochee River.

2.5.4.2 Protected Mussel Species

Three federally protected mussel species found in the ACF Basin would reasonably be expected to be affected by the proposed changes in water management in the basin. Therefore, these are the only three species discussed in the EIS. These species consist of the endangered fat threeridge and the threatened Chipola slabshell and purple bankclimber.

2.5.4.2.1 Fat Threeridge

The fat threeridge was historically found in the mainstem reaches of the Flint, Apalachicola, and Chipola rivers of the ACF Basin in southwest Georgia and north Florida (Ziewitz et al 1997). There are no records of the species in the Chattahoochee Basin (USFWS 2012). It is typically found in small to large rivers of slow to moderate water velocity (Brim Box and Williams 2000). It prefers substrates ranging from gravel to cobble but is also found in a mixture of sand and sandy mud (Ziewitz et al 1997). The fat threeridge is currently known throughout much of its historical range, but it has been extirpated from localized portions of the Apalachicola and Chipola rivers. It does not occur in Lake Seminole and the population below the Jim Woodruff Lock and Dam appears to be reduced for quite some distance downstream of the dam. The species persists in the Flint River, but appears to be extremely rare in the river. Surveys in the Apalachicola and lower Chipola rivers indicate that the species is common to abundant in suitable habitat and that recruitment is occurring, demonstrating that the mussel is more abundant than previously believed.

The USFWS designated three critical habitat units in the ACF Basin, effective December 17, 2007. The units encompass approximately 489 mi in the Lower Flint River in Georgia, the Chipola River Basin in Alabama and Florida, and the Apalachicola River in Florida (Figure 2.5-3) (USWFS 2007a).

A 5-year review determined that the status of the fat threeridge should remain unchanged. Despite the discovery of several live specimens previously thought to be extirpated in the Flint River (USFWS 2007b), reclassification criteria require three viable subpopulations. The extent and viability of this subpopulation is unknown, as is the generation time of the species. The USFWS is determining the age structure of the fat threeridge to better evaluate the status of the species.

2.5.4.2.2 Chipola Slabshell

The Chipola slabshell has one of the most limited distributions of the Apalachicola region mussel species, extending throughout much of the Chipola River mainstem and into several headwater tributaries. Historically, it was thought to be endemic to the Chipola River system; however, Brim Box and Williams (2000) identified a single specimen from Howards Mill Creek, a Chattahoochee River tributary in southeastern Alabama. More recent surveys suggest that the Chipola slabshell is now extirpated from Howards Mill Creek. The species is associated with clean or silty sand substrates in slow to moderate currents along sloping banks of the stream channel (Ziewitz et al 1997).

The USFWS designated one unit as critical habitat in the ACF Basin, effective December 17, 2007. The unit encompasses the Chipola River Basin in Alabama and Florida, extending from the confluence of the Chipola River with the Apalachicola River, upstream 90 mi to the confluence of Marshall and Cowarts creeks (Figure 2.5-3) (USFWS 2007a).

A study is under way to determine the status and distribution of the Chipola slabshell in the Chipola River Basin (USFWS 2007b). Preliminary surveys have collected more than 300 specimens from 10 new subpopulations and six subpopulations that were previously documented. Final results of the study are not yet available. Note also that USFWS is conducting genetic analysis as part of an ongoing slabshell study,

and preliminary results suggest that the Chipola slabshell is not a unique subspecies but is genetically identical to another more common slabshell species (Zettle 2014, personal communication).

2.5.4.2.3 Purple Bankclimber

The purple bankclimber is endemic to the Apalachicola region. Within the ACF Basin, it was historically found along the mainstem of the Flint River and two of its larger tributaries, the Chattahoochee and Apalachicola rivers, and near Dead Lake along the mainstem of the Chipola River. The present distribution in the ACF Basin has been reduced to the Flint River and just one tributary, and the Apalachicola River (USFWS 1998, 2003b). The purple bankclimber prefers sand, fine gravel, or muddy sand in moderate currents of larger streams and rivers (Clench and Turner 1956). Brim-Box and Williams (2000) found that 80 percent of the specimens encountered in a survey of the ACF Basin inhabited sand/limestone substrates in water over 10 ft deep. The species is intolerant of impounded conditions.

The USFWS designated four critical habitat units in the ACF Basin, effective December 17, 2007. These units include approximately 771 mi of the Upper, Middle, and Lower Flint River and the Apalachicola River (Figure 2.5-3) (USFWS 2007a).

Recent surveys suggest that purple bankclimber populations are relatively stable in the Flint and Ochlockonee rivers, but the species remains the rarest mussel in the Apalachicola region (USFWS 2007b). The extent and viability of many subpopulations is unknown, and thus the species remains listed as threatened.

2.5.5 Fish and Wildlife Management Facilities Affected Environment

2.5.5.1 Fish and Wildlife Management Facilities

An inventory of fish and wildlife management facilities was completed for the Comprehensive Study (Ziewitz and Luprek 1996), and it was used as the primary source of information for this evaluation, Table 2.5-6. Table 2.4-2 presents national and state parks in the ACF Basin. The key facility in the ACF Basin is the Eufaula NWR, which is managed by USFWS.

2.5.5.1.1 Eufaula National Wildlife Refuge

The Eufaula NWR was established in 1964 on the Walter F. George Lake (also known as Lake Eufaula) in cooperation with USACE. The objectives of the refuge are to provide habitat for migratory waterfowl and other birds, to provide habitat and protection for federally listed threatened and endangered species, and to provide recreation and environmental education for the public. The refuge lies on the upper reaches of the reservoir from Chattahoochee RM 104 to 116 within Barbour and Russell counties, Alabama, and Stewart and Quitman counties, Georgia. The 11,184-ac refuge was once heavily forested with longleaf and slash pine ridge tops and hardwood bottoms, but past land use practices have changed the land cover and habitat. The refuge contains 4,260 ac of open water, 3,025 ac of wetlands, 2,110 ac of woodlands, and 1,814 ac of croplands and grasslands. It is managed intensively to meet the needs of migrating and wintering waterfowl, nesting wood ducks, colonial nesting birds, neotropical migrant birds, and wood storks (USFWS 2008b).

Pump systems, dikes, and water control structures are used to manage a constructed system of impoundments to create off-reservoir wetland areas. Water levels are manipulated seasonally to provide desirable food plants for wildlife. Vegetation is also manipulated by burning, mechanical, and chemical control methods.

Table 2.5-6.
Wildlife Management Facilities in the ACF Basin

Wildlife Management Area	County, State	Area (ac)
Apalachicola National Estuarine Research Reserve[a]	Franklin/Liberty/Gulf, FL	246,000
Apalachee Wildlife Management Area	Jackson, FL	7,952
Albany Nursery WMA	Dougherty, GA	300
Beaverdam Creek WMA	Liberty, FL	1,317
Big Lazer Creek WMA	Talbot, GA	5,850
Blanton Creek WMA	Harris, GA	4,500
Box-R WMA	Franklin, FL	11,216
Chattahoochee WMA (CNF)	White, GA	250
Chestatee WMA (CNF)	Lumpkin, GA	250
Chickasawhatchee WMA	Dougherty, GA	130
ELMODEL WMA	Baker, GA	1,576
Flint River WMA	Dooley, GA	2,500
Hannahatchee Creek WMA	Stewart, GA	5,640
Joe Kurz WMA	Meriweather, GA	3,654
Mayhaw WMA	Miller, GA	4,718
Swallow Creek WMA	White, GA	190
West Point WMA	Heard, GA	9,999
Wilson Shoals WMA	Hall, GA	2,800
Apalachicola Bluffs and Ravine Preserve	Liberty, FL	6,248
Apalachicola National Forest	Liberty/Wakulla/Leon/Franklin, FL	581, 290
Apalachicola Savannah Research Natural Area	Liberty, FL	448
Cape St. George State Reserve	Franklin, FL	2,294
St. George Island State Park	Franklin, FL	1,962
Judges Cave Wildlife and Environmental Area	Jackson, FL	37
Rock Hill Preserve	Washington, FL	373
St. Joseph Bay State Buffer Preserve	Gulf, FL	701
Tate's Hell State Forest	Frankin/Liberty, FL	202,437
Chipola River Water Management Area	Calhoun/Jackson, FL	9,094

Source: USACE, Mobile District 1998a
Note:
[a.] Includes the Apaplachicola River Wildlife Environmental Area (ARWEA), St. Vincent NWR, and Apalachicola River Water Management Area.

The Eufaula NWR supports a diversity of flora and fauna of the Gulf Coastal Plain region. Habitat management focused on waterfowl also benefits other species. The refuge has 281 documented bird species, 36 mammal species, 95 herptile species, and roughly 30 fish species. Species that use the refuge are the protected bald eagle and peregrine falcon and the federally listed American alligator and wood stork. A complex of impounded areas, ephemeral wetlands, and reservoir backwaters constitutes a significant foraging area on the refuge for wood storks.

Forty-nine species of shorebirds, gulls, and tents have been observed along the mudflats and sandbars of the reservoir, and within the ephemeral wetlands and agricultural fields of the refuge. Ten of these—killdeer; greater and lesser yellowlegs; spotted, least and pectoral sandpiper; dunlin; common snipe; ring-billed gull; and Forster's tern—are considered common. Wood storks use the shallow and backwater areas of the reservoir, while herons and egrets consistently forage in all wetland areas. Bald eagles have been observed on the mudflats, feeding on carrion.

The refuge supports three major heron rookeries. Ideal conditions for these rookeries are high reservoir levels in spring for nest protection and lower levels in late spring and summer for foraging.

Waterfowl populations in the winter range from 10,000 to 15,000 birds. Historically, the population peaked at 35,000 ducks and geese. The refuge provides wintering waterfowl foraging and resting habitat. Croplands flooded in the fall may attract 75 percent of all waterfowl on the refuge. The river and reservoir at low water levels provide significant foraging and resting habitat.

Water management is the most important technique that the refuge uses to enhance habitats for wildlife. The refuge has eight pump sites serving five different impoundments. Over 1,800 ac-ft of water is pumped annually into the impoundments from the river during late fall and returned to the river in early spring. This pattern of water use was described in the fish and wildlife facilities report of the Comprehensive Study (Ziewitz and Luprek 1996).

The refuge has a cooperative farming program that can put up to 1,200 ac under cultivation. Crops include hay, oats, rye, corn, sorghum, millet, and peanuts. Two farmers cultivate the land and leave up to 25 percent of all crops grown in the field as part of their lease agreement. The crops are flooded for waterfowl and other wildlife. Farming on the refuge is dependent on irrigation. Approximately 500 ac is irrigated with 3 to 4 in of water during the growing season for corn and peanuts.

2.5.5.2 Fish Hatcheries

The following four fish hatcheries in the ACF Basin use an average of about 10 mgd of water annually (Ziewitz and Luprek 1996):

- Buford Trout Hatchery on the Chattahoochee River below Buford Dam in Georgia, operated by the GADNR with a surface water withdrawal from the Chattahoochee River.
- Cordele Fish Hatchery in Cordele, Georgia, operated by the GADNR with a groundwater withdrawal.
- Steve Cocke Fish Hatchery in Dawson, Georgia, operated by the GADNR with a groundwater withdrawal.
- Warm Springs Regional Fisheries Center in Warm Springs, Georgia, operated by USFWS with a groundwater withdrawal.

Buford Trout Hatchery is the only fish hatchery in the ACF Basin that relies on surface flows for its operations, and it is the largest user of water.

2.6 Socioeconomic Resources

This section describes the affected environment, or the baseline conditions, for the economic resources in the ACF Basin. M&I water demands, navigation, power generation, agriculture, recreation, and flood risk management are discussed.

2.6.1 Municipal and Industrial Water Demands

The Chattahoochee River and the existing federal reservoirs are important sources of M&I water supply for a number of municipalities and industries within the basin. Municipalities draw water from the rivers and reservoir pools for their water supplies. Industrial plants such as pulp and paper mills and poultry processing operations use water in their production processes. Recreation-related businesses, such as country clubs, use water to irrigate golf courses. Various state and county parks use water for irrigation and water supply. In many ways, these water uses support local jobs and contribute to the economy.

Lake Lanier is the most heavily used USACE reservoir in the ACF Basin for M&I water supply and is the primary water supply source for Metro Atlanta. Lake Lanier, along with its Buford Dam operations, has been at the center of a longstanding water allocation controversy among Alabama, Florida, and Georgia as described in section 3.1. Lake Lanier has been used for M&I water supply since the project construction was completed in 1957. Two Georgia cities, Buford and Gainesville, originally withdrew water from the Chattahoochee River and both had existing intake structures and water treatment plants on riparian lands before and at the time of project construction. Consequently, contracts for the relocation, rearrangement, or alteration of municipal water works facilities (relocation contracts) were finalized for Gainesville on June 22, 1953, and for Buford on December 19, 1955.

As part of the compensation for the municipal property acquired for the Buford Dam project and under the resulting relocation contracts terms, each city was granted the right to withdraw, free of charge, specified maximum amounts of water from the reservoir. Buford was granted a maximum withdrawal amount of 2.0 mgd, and Gainesville, 8.0 mgd, as described in section 2.1.1.2.4.6.

2.6.1.1 Interim Water Withdrawal Contracts

The majority of the M&I water supply use in the ACF Basin occurs in Metro Atlanta, withdrawn either directly from Lake Lanier or immediately downstream of Buford Dam. However, several major water supply users are downstream of Metro Atlanta and withdraw directly from the Chattahoochee River, the federal reservoirs, or both.

2.6.1.1.1 Contracts for Direct Water Withdrawals from Lake Lanier

Beginning in 1973, USACE executed interim water supply withdrawal contracts with Gwinnett County and subsequently with Cumming and Gainesville—1978 and 1987, respectively—to further accommodate growing water supply needs by providing for additional direct withdrawals from Lake Lanier. The authority used to implement these contracts was the IOAA, 31 U.S.C. 9701, a statute that authorizes USACE to accept payment for services rendered, to include providing for water withdrawals. It does not provide for the reallocation of water supply storage space. These withdrawal contracts are discussed in more detail in section 2.1.1.2.4.6. USACE treated its accommodation of water supply withdrawals from Lake Lanier as services apart from the Lake Lanier project authority and collected payment pursuant to the IOAA. Table 2.6-1 provides a summary of the existing relocation contracts and prior interim water withdrawal contracts for the municipalities withdrawing water directly from Lake Lanier.

Table 2.6-1.
Water Supply Contracts Direct Withdrawals from Lake Lanier

Contract Type	Contract Party	Original Contract Amount (mgd)	Original Contract Date
Relocation	Gainesville	8[a]	June 22, 1953
Relocation	Buford	2	December 19, 1955
Interim Withdrawal[b]	Gwinnett County	53	July 2, 1973
Interim Withdrawal[b]	Cumming	10	June 27, 1978
Interim Withdrawal[b]	Gainesville	12	May 28, 1987

Notes:
[a.] The terms of the 1953 relocation agreement with the City of Gainesville have been interpreted as 8 mgd net during any 24-hr period. 10 mgd treated wastewater is returned to Lake Lanier.
[b.] The interim withdrawal contracts for Gwinnett County, Cumming, and Gainesville expired on January 1, 1990.

2.6.1.1.2 Operational Adjustments for Flows Downstream of Buford Dam

In 1974, the GAEPD established a minimum flow standard of 750 cfs downstream of Atlanta's water supply intake and just upstream of Peachtree Creek. Unlike earlier flow targets of 600, 650, or 750 cfs at Atlanta—which were minimum flows from which Atlanta was able to withdraw its water supply upstream of Peachtree Creek—the new standard required a continuous flow of 750 cfs after accounting for withdrawals by Atlanta and upstream water supply providers. This increased downstream flow target, along with increasing demand for M&I water supply in the region, and raised concerns that existing operations might not continue to yield sufficient flows for downstream water quality and water supply needs. These needs were accommodated by operational adjustments for flows downstream of Buford Dam, which are discussed in detail in section 2.1.1.2.4.6.

2.6.1.2 Lake Lanier—Direct Water Withdrawals

The existing M&I water supply withdrawals made directly from Lake Lanier by the municipalities listed in Table 2.6-2 totaled 132 mgd in 2006 and, according to a water use rate of 151 gpcd, serve an estimated population of approximately 875,000 (MNGWPD 2009). The year 2006 best represents the existing water supply demand for Metro Atlanta because during the drought years of 2007–2009, severe water use restrictions were imposed by the water utilities to maximize water conservation. Withdrawals at the 2007 level were used in the HEC-ResSim modeling because that was the year of greatest consumption basinwide. Of the total water supply withdrawals shown in Table 2.6-2, 20 mgd are covered by the previously described relocation contracts between USACE and the cities of Buford (2 mgd) and Gainesville (18 mgd). Current withdrawals, other than those stated for Buford and Gainesville, are not currently under an authorized storage agreement.

Table 2.6-2.
Direct Water Supply Withdrawals from Lake Lanier

Municipality	2006 Direct Water Withdrawals (mgd)	2007 Direct Water Withdrawals (mgd)	2008 Direct Water Withdrawals (mgd)
Buford[a]	1.53	1.47	1.31
Cumming[b]	11.95	11.65	10.93
Forsyth County	6.83	8.44	4.90
Gainesville[c]	19.00	18.76	16.37
Gwinnett County	92.67	88.27	73.59
Total	131.98	128.58	107.09

Notes:
[a.] A total withdrawal amount of 2.0 mgd gross withdrawal is authorized by the relocation contract.
[b.] Cumming also furnishes water to Forsyth County, Georgia, but Forsyth County's portion is reported separately.
[c.] Includes 8.0 mgd net withdrawal (18 mgd gross withdrawal) authorized by the relocation contract.

2.6.1.3 Downstream of Buford Dam—Existing Metro Atlanta Water Withdrawals

Metro Atlanta has four water utilities, represented by the ARC, downstream of Buford Dam (Table 2.6-3). Those utilities withdrew a combined average annual 280 mgd from the Chattahoochee River in 2006 (275 mgd in 2007) (according to withdrawal records provided by the states and compiled by USACE, Mobile District). The utilities are DeKalb County, Atlanta, Cobb County/Marietta Water Authority, and Fulton County. The residential water supply needs of a total estimated population of 2.1 million are served by those utilities, plus numerous commercial, industrial, and institutional enterprises. According to the 1975 Interim Plan, 327 mgd of water is supplied through incidental flows resulting from Buford Dam

hydroelectric power generation operations. Those incidental flows are sufficient to satisfy the existing downstream water supply demand below Buford Dam.

Table 2.6-3.
Direct Water Supply Withdrawals from Chattahoochee River

	Withdrawals from Chattahoochee River (mgd)		
Municipality	**2006**	**2007**	**2008**
City of Atlanta	102.54	100.90	87.78
Atlanta-Fulton Co. Water Res. Commission	43.76	44.07	36.07
Dekalb County Public Works	82.81	78.36	72.58
Cobb County Marrietta Water Authority	51.00	52.14	43.69
Total	280.12	275.46[a]	240.13

Note:
[a] In the HEC-ResSim model, 277 mgd was used as the gross river withdrawal value for 2007. 277 mgd was a carryover value from when modeling originally began and is representative of current river withdrawals.

In general, Buford Dam's weekly water supply/quality release decisions are based on the CRMS. Under the system, USACE, in coordination with GPC and the ARC, determines weekly the daily amounts of water to release from Buford Dam to accommodate the anticipated downstream river withdrawals for M&I water supply by DeKalb County, Atlanta, Cobb County/Marietta Water Authority, and Fulton County, and to ensure water quality at the confluence of the Chattahoochee River and Peachtree Creek. The weekly schedule of Buford Dam water releases is to ensure that sufficient water is available for Chattahoochee River water supply withdrawals, water quality flows at Peachtree Creek, hydroelectric power generation, and fish and wildlife conservation needs. During the winter and spring, releases from Lake Lanier can be reduced because of sufficient downstream tributary flows to meet the GAEPD's target water quality flow at Peachtree Creek. To the extent possible, the releases are in conjunction with peaking power operations and minimize effects on hydroelectric power generation.

2.6.1.4 Future Demand of Current and Potential Future Lake Lanier Users

Currently, 3.3 million users benefit from water withdrawals from Lake Lanier. GAEPD projects that, by 2040, more than 6 million users will rely on water supply storage from Lake Lanier. In 2011, the average water withdrawal directly from Lake Lanier was 115.3 mgd. Other than the entities listed above that currently withdraw from Lake Lanier, GAEPD has stated that Dawson, Habersham, Lumpkin, and White counties also are likely future users.

Water supply demand was projected for Metro Atlanta in the MNGWPD Water Supply and Conservation Management Plan, May 2009. Projections are forecasted through 2035 and 2050. Future withdrawals needed directly from Lake Lanier are projected to reach 297 mgd around 2040. River withdrawals in the Atlanta reach are expected to increase to 408 mgd by 2040. After release of the draft EIS, USACE received a revised water storage request from the State of Georgia during the draft EIS public comment period. The future withdrawals needed directly from the Lake Lanier were modified and reduced to 242 mgd. River withdrawals in the Atlanta reach were reduced to 379 mgd by 2050.

The USACE water demand analysis for the WSSA was developed only for the population publicly supplied that currently withdraws or is projected to withdraw water from Lake Lanier. While conservation measures are currently in place to reduce current and future demand, Metro Atlanta will continue to grow and see their water supply needs increase. Although water conservation measures have been implemented within the basin with the intent to decrease per capita water use, the degree to which the measures will be

effective is unknown. The USACE independent water demand analysis conducted for the WSSA (appendix B) assumed that per capita water use rates would remain constant over the period of analysis. As a result, the full impact of implementing water conservation measures in the basin might not have been adequately captured in the USACE water demand analysis; therefore, the water demand projections by USACE included in the WSSA are higher than the State of Georgia's request and are likely to be on the high end of the range of potential future water demands in the basin.

2.6.1.5 Other Major M&I Water Supply Users

The majority of the M&I water supply use in the ACF Basin occurs in Metro Atlanta either directly from Lake Lanier or immediately downstream of Buford Dam. However, several major water supply users downstream of Metro Atlanta withdraw directly from the Chattahoochee River or the federal reservoirs or both. They are described in the sections to follow. Details of their water withdrawals are provided in section 2.1.1.2.5.

2.6.1.5.1 LaGrange, Georgia

The City of LaGrange withdraws water directly from West Point Lake in an average amount of 20.96 mgd pursuant to a relocation contract. The city has an intake structure within the reservoir that houses a series of intakes at the following elevations: 628, 623, 618, and 600 ft. An inoperable intake that existed prior to the construction of West Point Lake is located at elevation 582 ft. The city has a water withdrawal permit from Georgia for 20 mgd (monthly average) and 22 mgd (maximum daily).

2.6.1.5.2 Columbus, Georgia

The City of Columbus withdraws water directly from Lake Oliver, one of the run-of-the-river GPC hydroelectric projects on the Chattahoochee River at Columbus. The city's intake is below the Lake Oliver permanent pool elevation of 337 ft. Columbus has a Georgia water withdrawal permit for 90 mgd.

2.6.1.5.3 WestRock (formerly Mead Westvaco) (Mahrt Mill—River Intake)

The WestRock plant is near Pittsview, Alabama. The plant's water intake is in Walter F. George Lake at elevation 178.8 ft and daily average withdrawals are 27.6 mgd. When the water surface elevation reaches 184.75 ft, the pumping capacity reduces to 75 percent. WestRock has installed emergency pumps at the intake to operate at or below pool elevation 178.8 ft to maintain pumping capacity. The plant is a flow-through facility where its discharge is generally assumed equal to the amount of water withdrawn from the river.

2.6.1.5.4 Georgia Pacific Corporation

The Georgia Pacific Corporation plant is on the Chattahoochee River near Jakin, Georgia. The plant uses six pumps with an intake elevation of 72.67 ft. Pumping capacity is reduced at pool elevations below 75 ft. The plant is a flow-through facility where its discharge is generally assumed equal to the amount of water withdrawn from the river.

2.6.1.5.5 Farley Nuclear Power Plant

The Farley Nuclear Power Plant is on the west bank of the Chattahoochee River near Columbia, Alabama. The plant becomes severely affected when the pool elevation at Lake Seminole drops below elevation 75.0 ft. Southern Nuclear defines 2,000 cfs and 74.5 ft as minimum conditions for operation.

2.6.1.5.6 Plant Scholz, Florida

The Scholz Electric Generating Plant is a coal-fired power station owned and operated by Gulf Power Company. The plant is 4 mi downstream of Jim Woodruff Lock and Dam near Sneads, Florida. The plant operated over much of the hydrologic period of analysis for the Master WCM update. In April 2015, Gulf Power Company ceased water withdrawals and permanently closed Plant Scholz, as discussed in section 2.1.1.2.5.4.

2.6.2 Navigation

The federal navigation project for the Apalachicola, Chattahoochee, and Flint rivers was originally authorized in section 2 of the RHA of 1945, and it was further modified by the Water Resources Development Act of 1986 (P.L. 99-662). This legislation provides for a 9-ft by 100-ft navigation channel from Apalachicola, Florida, to the Phenix City, Alabama/Columbus, Georgia, area on the Chattahoochee River and to Bainbridge, Georgia, on the Flint River. Channel dimensions are provided by dredging, cutoffs, training works, or other open-river methods; a series of locks and dams; and flow regulation from upstream storage projects.

The project authorization for navigation required local interests—consisting of six Florida counties bordering the Apalachicola River—to provide public port facilities and all lands, easements, rights-of-way, and disposal areas for construction and maintenance of the navigation channel in the Apalachicola River. Local interests were reluctant to provide perpetual easements for disposal of maintenance dredged material because of the potential financial liability for the counties. Accordingly, USACE approved 5-year disposal easements for the initial construction of the waterway project. After those easements expired, subsequent attempts to obtain further easements were unsuccessful. In 1988, the counties formally rescinded their commitments to provide local sponsorship for the project. Subsequently, USACE efforts to maintain the navigation channel in the Apalachicola River was largely conducted by using within-bank disposal areas subject to federal navigation servitude, which required no easements from local sponsors. Maintenance of the navigation channel in the Apalachicola River has not been performed since 2001, as discussed in section 2.1.1.2.4.3. Additionally, USACE's infrastructure maintenance needs far exceed its available budget, and navigation funding is primarily distributed based on a river system's commercial traffic. As a river with little-to-no commercial traffic, dredging of the Apalachicola River has not received funding and is not well suited to compete for funding in the future.

2.6.2.1 Port Facilities

There are two public ports in the lower Apalachicola-Chattahoochee-Flint river system. The Port of Columbus is located on the Chattahoochee River, and the Port of Bainbridge is located on the Flint River. Currently, there is no commercial barge traffic on the ACF system.

2.6.2.1.1 Port of Columbus

The Port of Columbus is owned by Georgia Ports Authority and operated by Nustart Energy LP. The terminal area is located on 14 ac with 402 ft of berthing space. The warehouse provides 27,280 sq ft of storage. The terminal processes liquid bulk commodities. Figure 2.6-1 provides an aerial view of the Port of Columbus.



Figure 2.6-1. Port of Columbus, GA.

2.6.2.1.2 Port of Bainbridge

The Port of Bainbridge also is owned and operated by Georgia Ports Authority. The facilities are located on 107 ac on the Flint River. The port has 421 ft of berthing area for liquid bulk and 529 ft of berthing space for dry bulk. The facilities include four warehouses that provide a total of 93,000 sq ft. The facility is equipped to handle a variety of barge traffic including nitrogen solution, gypsum, ammonium sulfate, urea, cottonseed and cypress bark mulch. Figure 2.6-2 provides an aerial view of the Port of Bainbridge.



Figure 2.6-2. Port of Bainbridge, GA.

2.6.2.2 Commercial Navigation

As much as 1.2 million tons of cargo moved on the ACF waterway as recently as 1985. The principal commodity was sand and gravel, which can move economically at shallower depths than can some other commodities. The next most important products were petroleum products and fertilizers. Presently, only sporadic commercial navigation use occurs on the ACF waterway.

Commercial waterborne traffic has continually declined in recent years as difficulties in maintaining the project and providing a reliable channel have increased. Repeated drought conditions since the 1980s have resulted in dramatic reductions in commercial traffic on the waterway. During sustained, low flow conditions when navigation on the system was restricted or eliminated, alternative contractual agreements were negotiated by the waterway users switching to truck or rail transportation. Commercial traffic is slow to return to barge transportation because of the alternative contractual agreements and unpredictable flow conditions in the basin. Because of the sustained drought conditions, dredging was not conducted in 2000, only limited dredging was completed in 2001 on the Apalachicola River, and no dredging has been conducted since then because of a combination of flow conditions, funding restrictions and, as of October 2005, the lack of water quality certification from Florida. Minor dredging occurred in 2010 on the Chattahoochee River portion of the waterway for intrasystem navigation movements. Therefore, since 2000, a reliable channel has not been provided, and channel availability has been dependent on available flows. As a result, commercial barge commodity shipments have fallen from near 600,000 tons before the start of drought conditions in 1998 to none in 2006 and later. In June 2016, USACE, Mobile District issued Navigation Bulletin No. 16-34 stating that (1) the Walter F. George Lock would remain closed for the foreseeable future due to extensive structural damage to the lower gates and lack of funding to make the needed repairs and (2) the George W. Andrews Lock would remain closed for the foreseeable future due to excessive sedimentation in the lock approach and around the lock gates and the lack of funding to

remove the sediment (USACE, Mobile District 2016). Thus, the presently available upstream limit for commercial navigation is Bainbridge, Georgia, on the Flint River and the base of George W. Andrews Lock and Dam on the Chattahoochee River.

Table 2.6-4 contains historic tonnage by commodity on the ACF waterway for the period 1995–2014. In addition to the commodities listed in Table 2.6-4, periodic, unscheduled shipments occur from certain users who must have waterborne transport for their large and usually oversized shipments, which cannot be transported by other modes. For example, Steward Machine of Bainbridge, Georgia, shipped two lock gates to USACE, New Orleans District, in February 2004. Also, in 2007, 480 tons of manufactured equipment and machinery were locked through Jim Woodruff Lock and Dam, which included two nuclear reactor vessel heads for Farley Nuclear Plant. It is also necessary for the Mobile District to use the navigation channel for project maintenance and rehabilitation purposes.

Table 2.6-4.
Historic Tonnage by Commodity on the ACF Waterway (1,000 Tons) 1995–2011

Commodity	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008-2014
Petroleum products	108	54	130	65	34	35	0	0	6	0	0	0	0	0
Fertilizers	166	181	138	91	60	22	0	0	2	0	0	0	0	0
Chemicals	28	25	14	10	13	3	0	0	0	0	0	0	0	0
Forest products	2	4	2	2	1	0	0	0	0	0	0	0	0	0
Sand and gravel	261	294	249	263	245	216	220	18	28	0	0	0	0	0
Farm products	21	9	7	0	3	0	0	0	0	0	0	0	0	0
Nonmetallic	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All others	2	0	1	0	2	0	1	0	0	3.1	0.1	0	0.48	0
Totals	588	567	541	431	358	276	221	18	36	3.1	0.1	0	0.48	0

Source: USACE 2016

The majority of traffic currently operating on the lower ACF system consists of recreation vessels. Many users of recreational vessels pass though one or more of the three locks on the lower ACF system while on the river. General boating, fishing, and rafting are popular activities on this part of the system. Lock data are provided in Table 2.6-5, Table 2.6-6, and Table 2.6-7 for the years 2000–2015.

Recreational traffic has fluctuated during the last decade with no discernible trends as to number of recreational vessels using the locks. The number of vessels is often double the number of actual lockages as several recreational vessels can lock through together.

Table 2.6-5.
Jim Woodruff Lock

Lock 21	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Type of vessel																
Dredge vessel	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Passenger boat or ferry	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
Nonfederal vessel	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal with barges	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Federal without barges	19	23	16	17	8	11	4	4	6	9	11	4	2	3	4	9
Recreational vessel	555	768	705	727	602	427	430	313	171	355	392	197	262	130	130	144
Towboats with barges	405	306	2	21	6	1	0	2	1	0	0	0	0	0	1	2
Towboats without barges	12	23	17	6	4	3	2	0	1	2	2	0	0	0	1	2
Total vessels	994	1138	744	774	629	444	436	319	179	366	405	201	264	133	136	157
Total nonvessel lockages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total assists	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0
Total lockages	715	745	431	479	423	229	256	190	146	188	196	113	116	55	56	64

Source: USACE, IWR 2016

Table 2.6-6.
George W. Andrews Lock

Lock 22	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Type of vessel																
Dredge vessel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Passenger boat or ferry	0	0	11	6	9	5	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nonfederal vessel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Federal with barges	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Federal without barges	0	9	18	13	8	9	6	9	14	21	29	10	8	8	52	30
Recreational vessel	0	47	390	237	437	604	392	420	307	446	533	427	383	261	386	282
Towboats with barges	0	12	1	3	1	0	0	0	1	0	0	0	0	0	0	0
Towboats without barges	0	2	47	28	6	1	2	1	7	16	0	0	0	2	0	0
Total vessels	0	70	467	287	461	624	401	430	329	483	562	437	391	271	439	312
Total nonvessel lockages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total assists	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
Total lockages	0	53	283	206	262	390	262	192	174	215	268	183	151	125	234	139

Source: USACE, IWR 2016

Table 2.6-7.
Walter F. George Lock

Lock 23	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Type of vessel																
Dredge vessel	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Passenger boat or ferry	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Nonfederal vessel	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Federal with barges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal without barges	0	24	24	25	9	13	13	10	24	20	20	10	11	7	22	15
Recreational vessel	0	423	321	209	368	294	593	486	321	611	648	531	359	335	209	131
Towboats with barges	0	30	1	2	2	0	0	0	1	0	0	0	0	0	0	0
Towboats without barges	0	1	2	12	3	4	1	96	2	0	0	0	0	1	0	0
Total vessels	0	491	350	250	384	311	607	592	348	632	668	541	370	343	231	146
Total nonvessel lockages	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total assists	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total lockages	0	344	318	221	311	267	292	256	252	299	333	241	194	180	117	57

Sources: USACE, IWR 2016

2.6.3 Power Generation

The ACF Basin is heavily developed for hydroelectric power generation. The power resources serve residential, commercial, agricultural, and industrial users. Some of the agricultural and industrial users are dependent on economic power sources for continued operations. Hydroelectric power generation facilities in the basin are operated by private power companies, municipalities, and USACE. The water withdrawals for thermoelectric power generation are presented in section 2.1.1.2.5. GPC is the primary private operator in the ACF Basin.

The ACF Basin lies within the Southern subregion of the SERC Reliability Corporation (SERC) and the larger North American Electric Reliability Council. The Southern subregion of the SERC is divided into five smaller areas identified as Central, Delta, Gateway, Southeastern, and VACAR. (Figure 2.6-3).

According to the EIA, the majority of SERC's electrical power resources are thermal generation, a process of heating water into steam and using the steam to move turbines. Coal accounted for 33 percent of the region's total electrical power generation in 2015. Nuclear power accounts for 29 percent and Natural Gas accounts for 33 percent of all generation in the area in 2015. Renewable power generation, which includes conventional hydroelectric, geothermal, wood, wood waste, municipal waste, landfill gas, other biomass, solar, and wind power, accounted for about 5 percent of generation in 2015. Total estimated 2015 generation for the SERC region was 1,001,267 gigawatt hours. (EIA, 2016)

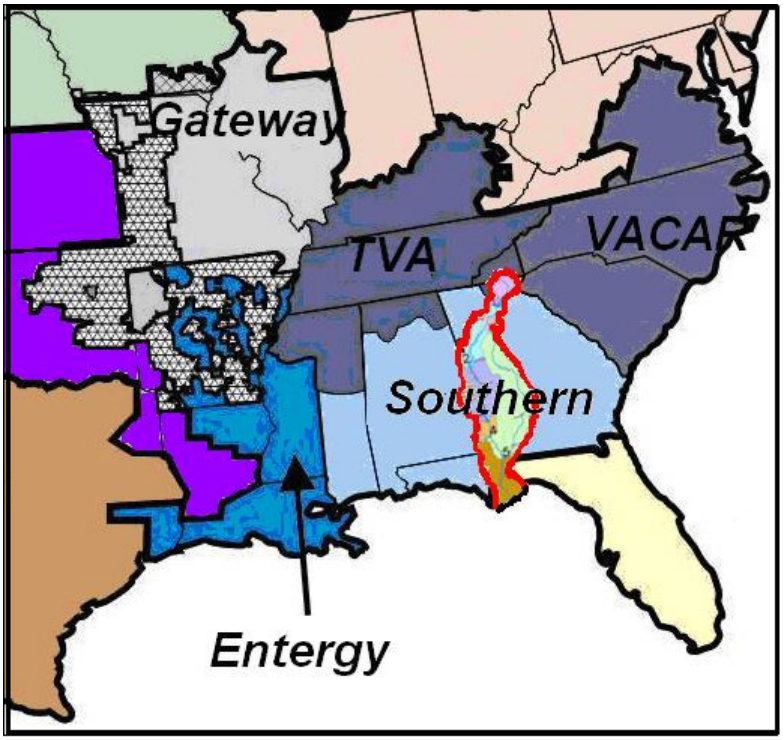


Figure 2.6-3. Southern Subregion of the SERC Reliability Corporation.

The EIA projects that SERC will generate an additional 26 percent by the year 2040, increasing to 1,259,997 gigawatt hours, averaging an increase of about 1 percent per year. In 2040, SERC's generation is still primarily projected to be thermal driven – though with the majority of the thermal power being generated by natural gas rather than coal. In 2040, 22 percent of power generation is expected to come from coal, 38 percent from natural gas, and 26 percent from nuclear. About 15 percent is projected to come from renewables in that year. (EIA, 2016)

USACE operates four dams with hydroelectric power capabilities in the ACF Basin: Buford Dam, West Point Dam, Walter F. George Lock and Dam, and Jim Woodruff Lock and Dam. The Buford, West Point, and Walter F. George projects are operated as peaking plants with an installed capacity of 382 MW, while Jim Woodruff Lock and Dam, near the confluence of the Chattahoochee and Flint rivers, is operated as a run-of-river plant with limited hydropower peaking operation and an installed capacity of 43.35 MW.

Seven nonfederal plants owned by GPC are also considered in this analysis. Morgan Falls, Bartletts Ferry, Goat Rock, Langdale, Riverview, Oliver, and North Highlands (listed in downstream order) all act as modified run-of-river plants. The GPC plants use small amounts of storage to help reregulate the variable releases of the upstream USACE reservoirs. These plants have a combined installed capacity of 307 MW. Their individual capacity is presented in Table 2.6-8.

In the Flint River Basin, the Albany Dam and Crisp County Dam both contain GPC hydroelectric power plants. However, those facilities were not included in the hydroelectric power analysis because any changes to the ACF water control operations would not affect those facilities.

Table 2.6-8.
Plant Characteristics for USACE and Nonfederal Hydroelectric Power Plants

Plant	Owner	No. of Units	Power Capacity (MW)	Type
Buford Dam	USACE	3	127.00	Peaking
Morgan Falls	GPC	7	16.80	Modified run-of-river
West Point Dam	USACE	3	87.00	Peaking
Langdale Dam	GPC	2	1.04	Run-of-river
Riverview Dam	GPC	2	0.48	Run-of-river
Bartletts Ferry	GPC	6	173	Modified run-of-river
Goat Rock Dam	GPC	6	38.60	Modified run-of-river
Oliver Dam	GPC	4	60.00	Modified run-of-river
North Highlands	GPC	4	29.60	Modified run-of-river
Walter F. George L&D	USACE	4	168.00	Peaking
Jim Woodruff L&D	USACE	3	43.35	Run-of-river

2.6.4 Agricultural Water Supply

Agriculture is a vital component of the regional economy and, therefore, the availability of adequate water supplies for agricultural purposes is important. The U.S. Census Bureau divides agriculture areas into agricultural districts. Table 2.6-9, Table 2.6-10, and Table 2.6-11 show the breakdown of the counties within the ACF Basin and the agricultural district to which they are attributed.

According to the 2012 American Community Survey, approximately 3.5 percent of the Alabama workforce was employed in the agriculture, forestry, and fisheries industries; in Florida, this figure was 4.3 percent; in Georgia, it was 3.6 percent (U.S. Census Bureau 2014). Potential shortages in meeting agricultural water demands could result in significant economic impacts on portions of the ACF Basin. Details of agricultural water withdrawals are provided in section 2.1.1.2.5.

Table 2.6-9.
Georgia Agricultural Districts

Central	CRAWFORD		CARROLL
	HOUSTON		CHATTAHOOCHEE
	MONROE		CLAYTON
	PEACH		COWETA
North Central	CHEROKEE		DOUGLAS
	COBB		FAYETTE
	DAWSON		HARRIS
	DEKALB		HEARD
	FORSYTH		HENRY
	FULTON		LAMAR
	GWINNETT	**West Central**	MACON
	HALL		MARION
	LUMPKIN		MERIWETHER
	WHITE		MUSCOGEE
Northeast	BANKS		PIKE
	HABERSHAM		SCHLEY
Northwest	PAULDING		SPALDING
South Central	COLQUITT		TALBOT
	CRISP		TAYLOR
	DOOLY		TROUP
	TURNER		UPSON
	WORTH		
Southwest	BAKER		
	CALHOUN		
	CLAY		
	DECATUR		
	DOUGHERTY		
	EARLY		
	GRADY		
	LEE		
	MILLER		
	MITCHELL		
	QUITMAN		
	RANDOLPH		
	SEMINOLE		
	STEWART		
	SUMTER		
	TERRELL		
	WEBSTER		

Table 2.6-10.
Alabama Agricultural Districts

BLACK BELT	BULLOCK
	MACON
UPPER PLAINS & PIEDMONT	CHAMBERS
	LEE
	RANDOLPH
WIREGRASS	BARBOUR
	GENEVA
	HENRY
	HOUSTON
	RUSSELL

Table 2.6-11.
Florida Agricultural Districts

NORTHWEST	BAY
	CALHOUN
	FRANKLIN
	GADSDEN
	GULF
	JACKSON
	LIBERTY
	WASHINGTON

2.6.4.1 Farming Operations

Farming operations and the number of ac farmed are shown by agricultural district in Table 2.6-12. A total of 14,574 farms are located within the Georgia portion of the watershed. The West Central agricultural district has the greatest number of farms within the Georgia portion of the watershed. However, approximately 50 percent of the ac farmed lay within the Southwest agricultural district. A total of 5,034 farm operations are located within the Alabama portion of the watershed. Sixty percent of the ac involved in a farming operation are in the Wiregrass agricultural district.

Table 2.6-12.
Farming Operations in the ACF Basin

	Number of Acres in Farm Operation	Number of Farm Operations
Georgia		
CENTRAL	136,942	754
NORTH CENTRAL	173,653	2,565
NORTHEAST	97,607	941
NORTHWEST	8,368	142
SOUTH CENTRAL	748,972	1,767
SOUTHWEST	1,827,812	3,667
WEST CENTRAL	757,547	4,738
Total	**3,750,901**	**14,574**
Alabama		
BLACK BELT	267,917	625
UPPER PLAINS & PIEDMONT	269,283	1,227
WIREGRASS	908,197	3,182
Total	**1,445,397**	**5,034**
Florida		
NORTHWEST	869,885	9,400
Total	**869,885**	**9,400**

Source: USDA 2012
Note: Information might have been omitted due to protection of proprietary information.

2.6.4.2 Agricultural Activities that Occur within the Watershed

The ACF region hosts many different types of agriculture activities, including both crop and animal production. Table 2.6-13 and Table 2.6-14 display the total sales related to agricultural activity that occurred in 2012. Georgia had more than $6 billion in sales related to animals and animal products. The Southwest and South Central districts account for the majority of crop sales in the Georgia portion of the ACF watershed. The largest portion of sales in Alabama is in the Wiregrass agricultural district, which accounts for the majority of crop sales in the Alabama portion of the watershed.

Table 2.6-13.
Animals and Related Products Sales (in thousands)

Georgia	**Georgia Total**	**$ 6,033,972**
	CENTRAL	$ 259,320
	NORTH CENTRAL	$ 1,693,307
	NORTHEAST	$ 993,928
	NORTHWEST	$ 51,282
	SOUTH CENTRAL	$ 436,358
	SOUTHWEST	$ 979,736
	WEST CENTRAL	$ 1,620,041
Alabama	**Alabama Total**	**$ 433,168**
	BLACK BELT	$ 23,720
	UPPER PLAINS & PIEDMONT	$ 115,691
	WIREGRASS	$ 293,757
Florida	**Florida Total**	**$ 29,045**
	NORTHWEST	$ 29,045

Source: USDA 2012
Note: Information might have been omitted due to protection of proprietary information.

Table 2.6-14.
Crops and Related Products Sales (in thousands)

Georgia	**Georgia Total**	**$ 4,514,848**
	CENTRAL	$ 200,234
	NORTH CENTRAL	$ 142,904
	NORTHEAST	$ 10,228
	NORTHWEST	$ 6,138
	SOUTH CENTRAL	$ 1,283,077
	SOUTHWEST	$ 2,566,491
	WEST CENTRAL	$ 305,776
Alabama	**Alabama Total**	**$ 232,383**
	BLACK BELT	$ 46,046
	UPPER PLAINS & PIEDMONT	$ 4,161
	WIREGRASS	$ 182,176
Florida	**Florida Total**	**$ 157,191**
	NORTHWEST	$ 157,191

Source: USDA 2012
Note: Information might have been omitted due to protection of proprietary information.

2.6.4.3 Employment within the Agricultural Sector

The Agricultural Census classifies agricultural labor into three groups: hired, migrant, and unpaid labor. The total number of laborers is shown in Table 2.6-15 by state and agricultural district. A large percentage of the labor force is employed in southwest Georgia, which mirrors where the most farm revenue is generated.

Table 2.6-15.
Agricultural Labor by District

Georgia	**Georgia Total**	**33,734**
	CENTRAL	2,311
	NORTH CENTRAL	4,844
	NORTHEAST	1,643
	NORTHWEST	246
	SOUTH CENTRAL	6,854
	SOUTHWEST	9,963
	WEST CENTRAL	7,873
Alabama	**Alabama Total**	**9,086**
	BLACK BELT	1,753
	UPPER PLAINS & PIEDMONT	2,091
	WIREGRASS	5,242
Florida	**Florida Total**	**8,193**
	NORTHWEST	8,193

Source: USDA 2012
Note: Information might have been omitted due to protection of proprietary information.

2.6.4.4 Oyster Industry of Apalachicola Bay

According to the FDACS, Apalachicola Bay provides 90 percent of Florida's oysters. As stated in the 2012 report, the greatest number of landings were reported in the early 1980s. As shown in Table 2.6-16, the oyster landings ranged from 1.4 million pounds of meats in 2003 to 2.7 million pounds of meats in 2009. The number of bags per trip was at its lowest in 2010. The National Agricultural Statistical Service reported sales revenue of oysters in Franklin County of $302,000 in its 2012 survey. This is down from over $600,000 in its 2007 survey.

Table 2.6-16.
Apalachicola Bay Oyster Statistics 2000–2012

Year	Pounds (meats)	Number of Trips Reported	AB Oyster Harvesting Licenses	Bags/Trip
2000	2,327,402	25,550	958	13.9
2001	2,333,968	25,261	1,135	14.1
2002	1,725,776	20,294	914	13
2003	1,449,890	18,467	759	12
2004	1,502,056	17,692	719	12.9
2005	1,260,996	12,663	714	15.2
2006	2,127,049	22,644	916	14.3
2007	2,645,359	29,104	1,142	13.9
2008	2,238,482	27,603	1,168	12.3
2009	2,695,701	39,942	1,433	10.2
2010	1,938,059	32,330	1,909	9.1
2011	2,380,810	39,176	1,799	9.3
2012			1,687	

Source: FDACS 2012

2.6.5 Flood Risk Management

Flood risk management has long been an important focus of USACE and the reservoirs it operates. Within the ACF Basin, Lake Lanier and West Point Lake provide important flood risk management storage with spillway capacities sufficient to discharge floods with return intervals of 500 years. This information was included to provide details regarding the structure inventory and damages prevented in the ACF basin under the Flood Risk Management project purpose. This information is not utilized in plan selection as a result of the initial screening criteria that any proposed measure (or alternative) considered in the update process for the Master Manual should maintain at least the current level of flood risk management.

Lake Lanier is primarily in Hall and Forsyth counties in northern Georgia. Construction of the Buford Dam began in March 1950 and was completed in June 1959. The project is described in sections 3.1.1 and 2.1.1.1.6.1. The 500-year floodplain south of Lake Lanier extends through Forsyth, Gwinnett, Fulton, and Cobb counties. It begins at Buford Dam and concludes downriver of the Chattahoochee River's confluence with Peachtree Creek. At the maximum flood control pool elevation of 1,085 ft, the reservoir has an area of 48,176 ac and a gross capacity of 2,551,064 ac-ft, of which 602,151 ac-ft is reserved for flood storage at elevation 1,071 ft.

Construction of the West Point Lake Dam began in June 1966 and was completed in 1975. The project is described in sections 3.1.1.2 and 2.1.1.1.6.3. West Point Lake, at the Georgia-Alabama state line, has a

500-yr floodplain that incorporates areas of Troup and Harris counties in Georgia and Chambers County in Alabama. At the maximum flood pool elevation of 641 ft, the reservoir has a total storage at maximum flood pool of 774,798 ac-ft, of which 170,271 ac-ft is reserved for flood storage between elevations 635 ft and 641 ft.

2.6.5.1 Flood Damages Prevented

Both Buford Reservoir and West Point Reservoir have provided millions of dollars in flood risk management benefits over the decades. Table 2.6-17 presents the flood risk management benefits that the projects have provided over the last five fiscal years. The total flood risk management benefits provided for both reservoirs for FY09–FY15 were valued at $11.7 million.

Table 2.6-17.
Flood Damages Prevented by ACF Projects, Fiscal Years 2009–2015 (October 2016 [FY2017] Price Levels)

Reservoir	*FY09*	*FY10*	*FY11*	*FY12*	*FY13*	*FY14*	*FY15*
Buford	$ 4,677,600	$ 1,223,000	$ 253,900	$ 0	$ 800,200	$ 2,499,100	$ 1,467,900
West Point	$ 568,200	$ 145,000	$ 0	$ 0	$ 38,400	$ 0	$ 0

2.6.5.2 Floodplain Characteristics

This section provides a summary of the ACF floodplain structure data. Because of time and funding constraints, the structure inventory information contained in this document was taken from the *Draft Environmental Impact Statement*, *Water Allocation for the Apalachicola-Chattahoochee-Flint River Basin*, Appendices Volume 2, September 1998. The price level was from fiscal year 1998, when the federal interest rate was 7-1/8 percent. It is recognized that development has occurred since 1998, and structure values have most likely increased. The recurrence interval assumed in the sections to follow is 500 years. The frequency floodplain is assumed with-project since the analysis year began in 1995, with Buford Dam being competed in 1959 and West Point Dam being completed in 1975. This information was included to provide details regarding the structures and damages prevented in the ACF Basin under the Flood Risk Management project purpose. This information is not utilized in plan selection as a result of the initial screening criteria that any proposed measure (or alternative) considered in the update process for the Master Manual should maintain at least the current level of flood risk management.

2.6.5.2.1 Floodplain below Buford Dam

The floodplain south of the Buford Dam consists of 5,108 residential structures, 16 public structures, and 218 commercial structures. Tax assessor-appraised residential structure values range from a $5,000 trailer to several $1.4 million dollar homes, with a floodplain residential structure value of over $1 billion. Residential structure content value is estimated to be over $466 million. Public structures in the floodplain have a total value of over $30.6 million. The structures range in value from a $7,500 storage building to a $14 million water treatment plant. Public structure inventory and equipment values total over $20 million and $6 million, respectively. The floodplain tax-appraised commercial structure values range from a $2,500 storage building to a $23 million power plant, with a floodplain total commercial value of over $109 million. Commercial structure inventory and equipment values total over $34 million and $209 million, respectively. The estimated floodplain totals for each category of structures are provided in Table 2.6-18.

Table 2.6-18.
Buford Dam Floodplain Value Data

Structure Type	Structure ($)	Content ($)	Inventory ($)	Equipment ($)
Residential	1,048,486,000	466,014,000	--	--
Public	30,642,000	--	19,723,000	5,653,000
Commercial	109,238,000	--	34,000,000	208,647,000
Total	**1,188,366,000**	**466,014,000**	**53,723,000**	**214,300,000**

2.6.5.2.2 Floodplain below West Point Dam

The floodplain south of West Point Dam consists of 171 residential structures, 18 public structures, and 220 commercial structures. Approximately 90 percent of the floodplain is on the Chattahoochee River between RMs 306.2 and 304.2. Tax assessor-appraised residential structure values range from $2,500 to $130,000, with a floodplain total residential structure value of approximately $5 million. Residential structure content values range from $1,091 to $58,000, with a floodplain total value estimated to be $2 million.

West Point floodplain public structures have an estimated total value of $3 million. The respective structures range in value from a $1,000 storage building to $500,000 municipal buildings. Public structure inventory and equipment values are estimated to total $893,000 and $2 million, respectively.

The floodplain tax-appraised commercial structures have a total value of approximately $28 million. Commercial structure values range from a $1,250 storage building to a $4 million industrial plant. Commercial structure inventory and equipment values total more than $89 million.

The floodplain totals for each structure type is provided in Table 2.6-19.

Table 2.6-19.
West Point Dam Floodplain Value Data

Structure Type	Structure ($)	Content ($)	Inventory ($)	Equipment ($)
Residential	5,361,000	2,363,000	--	--
Public	2,643,000	--	893,000	2,024,000
Commercial	28,453,000	--	60,153,000	88,819,000
Total	**36,457,000**	**2,363,000**	**61,046,000**	**90,843,000**

2.6.6 Recreation

The reservoirs, rivers, and streams of the ACF Basin are heavily used for recreation purposes. The basin contains several national forests, national and state parks, and resort communities that are favorite weekend and vacation destinations. Much of the area in the north portion of the basin (north of Lake Lanier) falls within the Chattahoochee National Forest. Solely because of the presence of Buford Dam, a world-class and highly used *put and take* trout fishery exists below Buford Dam. A description of the CRNRA is presented in section 2.1.1.2.4.5 of water resources and section 2.4 of land use. The Eufaula NWR is in southeast Alabama and southwest Georgia and straddles both sides of the Chattahoochee River. Hunting and fishing are among the recreational opportunities in this area. Wildlife management facilities in the basin are presented in Table 2.5-6. The area in the southern portion of the basin falls within the Apalachicola National Forest, the largest forest in Florida. These national forests provide both

developed and dispersed recreation opportunities. The developed sites provide a range of primitive to modern facilities; the dispersed activities include hunting, fishing, boating, hiking, and off-road vehicle riding.

Lake Lanier, north of Atlanta, had more than 6.5 million visitors in 2012 (USACE 2016b). Within Metro Atlanta, the CRNRA is a popular recreation area. South of Atlanta, several reservoirs in the basin, including West Point Lake, Walter F. George Lake, and Lake Seminole, are major recreational fishing destinations.

Seven reservoirs in the ACF Basin provide various recreation opportunities and receive varying degrees of usage. Six of the reservoirs are on the Chattahoochee and Flint rivers. Five reservoirs are operated by USACE and two by GPC. Recreation facilities on the reservoirs include public docks, fishing piers, and access sites; boat launches; swim areas; camping facilities; and playground areas. Additional information regarding the recreational facilities at the various reservoirs in the basin is provided in section 2.4. Table 2.6-20 summarizes the recreation facilities on each of the reservoirs.

Table 2.6-20.
Recreation Facility Descriptions

Reservoir/ Surface Area	No. of Parks	No. of Marinas	No. of Campgrounds	Recreation Components
Lake Lanier/ 38,425 ac	77	16	16	Public: Swim areas, boat ramps, picnic shelters/tables, restrooms, showers, campsites, and boat launches. Private: Lake Lanier Islands Beach and Water Park offers swimming; powerboat, sailboat, and bicycle rentals; water skiing; fishing; and horseback riding. An 18-hole, par-72 championship golf course is next to the water park.
West Point Lake/ 25,864 ac	36	2	7	Public: Boat launches, swim areas, picnic shelters/tables, restrooms, showers, and campsites.
Bartletts Ferry/ 5,850 ac	3	1	2	Public: Marinas, boat ramps, and fishing areas below the dam. Blanton Creek Wildlife Management Area has camping, nature trails, and wildlife viewing. Private: Marinas, fishing areas.
Lake Oliver/ 2,150 ac	0	1	0	Public: Boat ramp, parking, bank fishing areas, and access to the Goat Rock tailrace. City Marina (operated by City of Columbus). Common recreation activities at the marina include bank fishing, pier fishing, tournament fishing, picnicking, and hiking on the riverwalk. Facilities provided at City Marina include a bait shop, five boat docks, three boat launching lanes, a fishing pier, two expansive picnic areas, large parking area, and several bank fishing areas.
Walter F. George Lake/ 41,800 ac	31	4	6	Public: State parks on the lake, bank shore fishing, fishing piers, and boat ramp areas.
Lake George W. Andrews/ 1,540 ac	7	0	2	Three public use boat ramps are available on the lake.
Lake Seminole/ 37,500 ac	37	5	8	Two state parks that are known nationally as some of the best sites for sportfishing in America.

Sources: Brown and Smith 1997; USACE 1998; USACE project data updated in 2016 based on latest information from the USACE Operations and Maintenance Business Information Link (OMBIL)

2.6.6.1 Lake Lanier Impact Levels

Lake Lanier has impact levels defined at water surface elevations 1,066 ft (IIL), 1,063 ft (RIL), 1,060 ft (WAL), and 1,045 ft. The elevation range of 1,066–1,063 ft is the IIL range. Effects on swim areas include increased beach area and reduced swim areas. The swim line is set at 1,064 ft at full summer pool and cannot always be moved to accommodate a lower pool elevation. Nonfederally-operated swim areas might be affected at the 1,064 ft level. Recreational navigation hazards are marked at the 1,064 ft level. Rocks, reefs, and stumps below 1,064 ft are unmarked. Boat ramps are minimally affected at 1,066 ft; three boat ramps are unusable. Nonfederal boat ramps are not affected at that level. Approximately 10 percent of private boat docks are affected. Marina, clubs, and community docks are not affected at this level.

The elevation range of 1,063–1,060 ft is the RIL range. Most swim areas (USACE and nonfederal) will become unusable at this level. Recreational navigation hazards will increase, and boaters must exercise more caution to avoid hazards. USACE-operated boat ramps are affected, resulting in lanes at 14 boat ramps being unusable. Nonfederal boat ramps are less affected; one boat ramp is unusable. Twenty percent of private boat docks are affected. Boat slips in marinas are minimally affected; 142 slips, or 2 percent, are unusable. Roughly 15 percent of slips in community docks are unusable.

The elevation range of 1,060–1,045 ft is the WAL range. In general, most water-based recreation activities would be severely restricted and become increasingly dangerous. Most USACE swim areas are unusable. Nonfederal swim areas are all unusable. Recreational navigation hazards become more numerous, and vessels must be operated with increased caution. USACE boat ramps are significantly affected at this level. Twenty-nine boat ramps have lanes that are unusable. Nonfederal boat ramps are marginally affected; three boat ramps have lanes that are unusable. Approximately 50 percent of private boat docks are affected. Boat slips in shallow areas of marinas are marginally affected. Approximately 10 percent, or 920 slips, are unusable. Community docks are significantly affected; roughly 30 percent of slips are unusable.

2.6.6.2 West Point Lake Impact Levels

West Point Lake has impact levels defined at water surface elevations 632.5 ft (IIL), 629 ft (RIL), and 627 ft (WAL). At the IIL (632.5 ft) swim areas are only marginally usable. Docks must be shifted to deeper water, if allowable. Unmarked recreational navigation hazards begin to appear. Approximately 35 percent of private docks become marginally usable with only 2 ft of water beneath them. Lanes of boat ramps can partially silt in, in some areas.

At the RIL (629 ft), all swim areas become unusable. Approximately 40–50 percent of private docks become unusable. Unmarked navigation hazards continue to emerge. Activities such as water skiing and wakeboarding become unsafe in some areas. Approximately 10 percent of project boat launch ramps are affected with less than 6 ft of water at the end of the slab. Other ramps continue to have silt buildup. Approximately 30 percent of courtesy ramps become unusable.

At the WAL (627 ft), the water's edge is at least 50–100 ft from the normal shoreline, and access to water is limited by mud. Recreational navigation hazards continue to emerge, and water skiing and wakeboarding is limited to main bodies of the lake. The boat ramp at Highland Marina becomes unusable. Over 50 percent of courtesy docks at boat ramps become unusable. Silt buildup and drop-offs continue to increase at boat ramps. Approximately 70 percent of private boat docks are unusable at this level.

2.6.6.3 Walter F. George Lake Impact Levels

The Walter F. George Lake has impact levels defined at water surface elevations 187 ft (IIL), 185 ft (RIL), and 184 ft (WAL). At the IIL (187-ft), swim areas become only marginally usable. Unmarked recreational navigation hazards begin to emerge. Silt buildup can begin to occur at boat ramps. Approximately 30 percent of private boat docks become marginally usable with 2 ft of water under them. At the RIL (185 ft), all swim areas become unusable with only 1–2 ft of water within the buoy lines. Boat slips at some marinas become inaccessible, and 30-40 percent of private boat docks become unusable. Unmarked navigation hazards continue to appear, and some areas in the reservoir become unsafe for skiing and wakeboarding. Approximately 70 percent of boat docks have 4 ft of water or less at the end of the slab. Four ramps become unusable. All ramps are affected by silt buildup. Approximately 50 percent of courtesy docks become unusable. At the WAL (184 ft), water is at least 50–100 ft from the shoreline, and access to water is severely limited by mud. Recreational navigation hazards continue to emerge, and skiing and wakeboarding is limited to the main bodies of the lake. Swimming areas are unusable. Approximately 85–90 percent of private boat docks are affected, and 75 percent of boat ramps are affected.

2.6.6.4 Current Recreation Visitation at USACE Projects within the ACF Basin

USACE projects within the ACF Basin provide many opportunities for recreation. Peak recreation within the ACF Basin occurred in fiscal year 2006, when total visits reached 12.7 million. More than 50 percent of the visits to a project each year occur at Lake Lanier. Table 2.6-21 displays visitation by project from Fiscal Year 2003 through 2012. Visitation includes visits at both private and public facilities.

Table 2.6-21.
Visitation at ACF Projects, Fiscal Years 2003–2012

	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012
Buford Dam - Lake Sidney Lanier	7,697,482	7,698,005	7,725,328	7,552,119	7,738,041	6,857,691	6,863,752	7,112,961	7,195,417	6,548,130
George W. Andrews L&D – Lake George W. Andrews	253,289	304,412	269,801	241,980	231,869	240,062	271,535	271,435	249,870	221,346
Jim Woodruff L&D-Lake Seminole	925,323	1,039,952	1,223,736	1,223,532	1,253,639	1,149,491	1,292,092	1,259,556	1,345,410	1,531,659
Walter F. George L&D/Walter F. George Lake	4,384,766	4,423,694	3,693,899	4,340,890	3,792,794	3,919,741	3,799,469	3,952,851	3,645,445	3,268,987
West Point Lake	2,691,920	2,947,170	3,238,883	3,300,836	3,214,536	2,262,983	2,361,491	2,347,198	2,294,682	2,014,599
Grand Total	15,952,780	16,413,233	16,151,647	16,659,357	16,230,879	14,429,968	14,588,339	14,944,001	14,730,824	13,584,721

The CRNRA preserves a series of sites between Atlanta and Lake Sidney Lanier along the Chattahoochee River. The 48-mi stretch of the river affords public recreation opportunities and access to historic sites. The National Recreation Area, a National Park Service unit, was established on August 15, 1978, by President Jimmy Carter. Recreational opportunities include rafting, canoeing, wade and tube fishing, small boat fishing, hiking, and picnicking.

Table 2.6-22 provide the most recent 10 years of project visitation. Project visitation has increased slightly over the last decade with average visitation of around 3 million project visits a year.

Table 2.6-22.
Annual Visitation at Chattahoochee National Recreation Area, Calendar Years 2006-2015

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
2,842,670	2,836,077	2,826,171	2,830,655	3,011,393	3,161,297	3,168,137	3,039,892	3,119,160	3,173,204	3,000,866

Source: National Park Service 2016

2.6.7 Population

According to the U.S. Census Bureau, the population in the ACF Basin is 6,848,411 people. The population has more than doubled in the region over the last 50 years. The tables below show population estimates and growth rates over the last 40 years of the basin as a whole and of the portion of each state individually. As shown in Table 2.6-23, about 89 percent of the population in the ACF Basin resides in Georgia, with the remainder in Alabama and Florida. The compound annual growth rate over the last 40 years has averaged about 2.1 percent for the Georgia portion of the basin compared to less than 1 percent for the Alabama portion and 1.4 percent for the Florida portion. The overall annual growth rate for the ACF Basin was 1.96 percent for 1970 through 2012 (Table 2.6-24).

Table 2.6-23.
Population Estimates

Location	2012	2000	1990	1980	1970
ACF (AL)	456,912	419,766	372,502	359,273	312,309
ACF (FL)	340,381	305,561	263,444	224,950	188,518
ACF (GA)	6,051,118	5,036,182	3,790,659	3,056,484	2,526,697
ACF Basin	6,848,411	5,761,509	4,426,605	3,640,707	3,027,524

Source: U.S. Census Bureau 2009

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

Table 2.6-24.
Population Annual Growth Rates

Location	Total	1960–1970	1970–1980	1980–1990	1990–2000	2000–2012
ACF (AL)	0.96%	0.18%	1.41%	0.36%	1.20%	0.40%
ACF (FL)	1.42%	0.26%	1.78%	1.59%	1.49%	0.52%
ACF (GA)	2.10%	2.15%	1.92%	2.18%	2.88%	0.88%
ACF Basin	1.96%	1.80%	1.86%	1.97%	2.67%	0.83%

Note: Calculated from historical data. In addition, the table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

In Table 2.6-25, the population densities are given for the entire basin as well as for Georgia, Florida, and Alabama portions individually, along with the corresponding annual growth rates between 1980 and 2000. The data were gathered from the 1980, 1990, and 2000 U.S. censuses (latest available data). The growth rates for the population density similarly mirror the annual growth of the population as a whole. The Georgia portion of the basin includes the suburban areas of Metro Atlanta. When the Alabama, Florida, and Georgia portions are separated, it can be seen that between 1980 and 2000 the population density for the Georgia portion increased 63 percent versus a change of roughly 13 percent in the Alabama portion and 35 percent in the Florida portion.

Table 2.6-25.
Population Density

Location	Population per sq mi			Annual Growth Rate
	2000	1990	1980	1980–2000
ACF (AL)	66.5	60.8	58.8	0.62%
ACF (FL)	55.6	48.0	41.3	1.50%
ACF (GA)	262.7	200.2	160.8	2.48%
ACF Basin	216.3	166.7	135.5	2.37%

Source: U.S. Census Bureau 2009

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

Housing statistics were gathered for the ACF Basin during the last 50 years. Housing counts include single-family residential, mobile homes, and multi-family residential. For the year 2012, the total number of housing units was an estimate based on the American Community Survey, which is published by the U.S. Census Bureau in years when it does not conduct a census. Table 2.6-26 shows the housing counts for the entire basin, as well as for the Alabama, Florida, and Georgia portions. In 2012, there were a total of 2,875,431 housing units in the ACF Basin; of those, roughly 7.3 percent were in Alabama, 86 percent in Georgia, and the remainder in Florida. The annual growth rate for housing for the ACF Basin between 1960 and 2012 was 2.61 percent. However, housing has grown much faster in the Georgia portion of the ACF Basin (2.75 percent) than in the Alabama portion (1.67 percent). There was an even greater disparity in growth in the last seven years.

Table 2.6-26.
Total Housing Units

Location	2012	2000	1990	1980	1970	1960
ACF (AL)	210,049	187,517	155,556	136,405	101,797	88,875
ACF (FL)	177,712	148,804	123,736	91,681	64,063	56,065
ACF (GA)	2,487,670	1,976,786	1,552,261	1,138,693	809,632	606,402
ACF Basin	2,875,431	2,313,107	1,831,553	1,366,779	975,492	751,342

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

2.6.8 Income

Per capita income statistics were gathered for the ACF Basin over the past 50 years. According to the American Community Survey 5-year estimate (2008–2012), the average per capita income for the ACF Basin was $20,699 (Table 2.6-27). The average per capita income for the Georgia portion of the basin was $21,148; for Alabama, $19,667; and for Florida, $18,615. Table 2.6-27 gives a snapshot of per capita income in the ACF Basin over the last 53 years. It includes the annual growth rates for the region and the state portions of the basin separately.

The per capita income values displayed in Table 2.6-27 do not reflect the variability in income values in counties across the ACF Basin. The counties in the upper Chattahoochee River basin and upper Flint River basin in Georgia, generally associated with the Metro Atlanta area, have considerably higher average per capita incomes than the more rural areas of the lower Flint River basin in Georgia, the middle to lower Chattahoochee River basin in Georgia and Alabama, and the Apalachicola River basin in Florida, including the communities of Apalachicola and East Point on Apalachicola Bay. The principal exceptions to this general characterization of per capita income variability in the ACF Basin are the urban areas of Columbus, Georgia / Phenix City, Alabama along the middle Chattahoochee River and Albany,

Georgia along the lower Flint River. Within the ACF Basin, per capita incomes range from a low of about $14,000 per year in the poorest counties up to a high of about $36,000 per year in Metro Atlanta.

Table 2.6-27.
Income Statistics

Location	2012	Personal Income per Capita					1959–2012	Annual Growth Rate				
		1999	1989	1979	1969	1959		1999–2012	1999–1989	1989–1979	1979–1969	1969–1959
ACF (AL)	$19,667	$14,672	$9,594	$8,230	$5,972	$3,646	3.23%	2.28%	4.34%	1.55%	3.26%	5.06%
ACF (FL)	$18,615	$15,285	$9,952	$8,035	$5,825	$4,087	2.90%	1.53%	4.38%	2.16%	3.27%	3.61%
ACF (GA)	$21,148	$17,710	$11,100	$9,159	$6,646	$3,993	3.20%	1.37%	4.78%	1.94%	3.26%	5.22%
ACF Basin	$20,699	$17,071	$10,789	$8,925	$6,475	$3,958	3.17%	1.49%	4.70%	1.92%	3.26%	5.04%

Source: U.S. Census Bureau 2014

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

2.6.9 Employment

Employment statistics for the year 2012 were obtained from the 2012 American Community Survey. In 2012, there were 3,504,346 people in the labor force in the ACF Basin, 89 percent of which were in the Georgia portion, 6 percent in the Alabama portion, and 4 percent in the Florida portion. Also, 32,231 people served in the military over the survey period. In the ACF Basin, 44.9 percent of the population 16 and older were considered not in the workforce. The average unemployment for the basin was 6.6 percent. A few counties in the Alabama and Georgia portions of the basin had unemployment rates more than 10 percent. These areas tended to be more rural in nature. Table 2.6-28 provides employment statistics for the ACF Basin.

According to the 2012 American Community Survey, more than 90 percent of all jobs in the ACF Basin are provided by the private sector. The primary sources of employment are management and professional occupations and sales and office occupations; together, they account for more than 50 percent of the total employment in the ACF Basin. Government employment makes up more than 13.6 percent of total employment in the Florida portion of the ACF Basin. Table 2.6-29 provides a breakdown of employment in percentages by general occupations for the ACF Basin as a whole and with the state portions broken out.

Table 2.6-28.
Employment Statistics

Location	Civilian Labor Force				Armed Forces	Percent not in Labor Force
	Total	Employed	Unemployed	Percent Unemployed		
ACF (AL)	212,432	189,591	22,841	6.8	2,628	43.7
ACF (FL)	151,789	135,222	16,567	6.4	3,904	50.2
ACF (GA)	3,140,125	2,800,768	339,357	6.6	25,699	40.8
ACF Basin	3,504,346	3,125,581	378,765	6.6	32,231	44.9

Source: U.S. Census Bureau 2014

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

Table 2.6-29.
Employment by Occupation

		ACF (Alabama)	ACF (Florida)	ACF (Georgia)	ACF Basin
Percent distribution by occupation	Management, professional, and related occupations	26.7	26.5	29.2	27.5
	Service occupations	17.3	24.1	17.3	19.6
	Sales and office occupations	24.3	24.5	24.3	24.4
	Construction, extraction, and maintenance occupations	12.7	14.6	12.0	13.1
	Production, transportation, and material moving occupations	19.1	10.3	17.1	15.5
Percent in selected industries	Agriculture, forestry, fishing, and hunting	3.6	4.3	3.5	3.8
	Manufacturing	16.2	5.7	13.5	11.8
Percent of government workers (local, state, or federal)		5.7	13.6	6.8	8.7

Source: U.S. Census Bureau 2014

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

2.6.10 Environmental Justice

On February 11, 1994, President Clinton issued executive order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*. The order requires that federal agencies identify and address, as appropriate, disproportionately high and adverse human-health or environmental effects of its programs, policies, and activities on minority and low-income populations. By the memorandum of February 11, 1994, the President directed EPA to ensure that agencies analyze environmental effects on minority and low-income communities, including human-health, social, and economic effects.

The term *minority population* includes people who identify themselves in the census as African American, Asian, Pacific Islander, Native American or Alaska Native, or Hispanic. A minority population exists if the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population of the larger surrounding area (CEQ 1997). A minority community can be a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans). Either type of group experiences common conditions of environmental exposure or effect. A selected appropriate unit of geographic analysis might be a governing body's jurisdiction, a neighborhood, a census tract, or another similar unit with no artificial dilution or inflation of the affected minority population. A minority population also exists if there is more than one minority group and the aggregate minority percentage meets one of the above-stated thresholds.

Table 2.6-30 shows the demographic characteristics of the ACF Basin. This demographic information is derived from the 2012 American Community Survey 3-year estimate. An analysis of the demographic data shows that the population is almost 65 percent white. African Americans represent the next largest ethnic group, comprising 29.8 percent of the basin's population. For Alabama, the proportion of minority people living inside the ACF Basin (42.8 percent) is higher than for the state as a whole (30.7 percent). In Georgia, however, the proportion of minority people living within the basin (35.0 percent) is similar to that of the state as a whole (39.4 percent). Florida has a lower minority representation (23.7 percent) compared to the basin as a whole (35.4 percent). Other minority groups are represented in similar proportions in the basin and in surrounding states.

Table 2.6-30.
Basin Demographics (percent distribution)

Location	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino (of any race)
Alabama	69.3	26.4	0.5	1.2	0	1.2	1.4	4.0
Georgia	60.6	30.7	0.3	3.3	0.1	3.1	1.9	9.0
Florida	76.3	16.0	0.3	2.5	0	2.6	2.3	22.9
ACF (AL)	57.2	38.7	0.4	0.6	0.1	1.8	1.3	3.3
ACF (FL)	73.5	19.5	1.6	0.5	0.1	2.9	1.9	5.8
ACF (GA)	65.0	29.0	0.4	1.2	0.0	2.8	1.6	5.7
ACF Basin	65.2	29.1	0.8	0.8	0.1	2.5	1.6	4.9

Source: U.S. Census Bureau 2014

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

The presence of low-income persons in the ACF Basin was determined from the 2009 U.S. statistical poverty threshold, which is based on income and family size. The U.S. Census Bureau defines a poverty area as having 20 percent or more of the residents with incomes below the poverty threshold. Overall, 21.1 percent of the basin's population (including persons of all ages) is below the poverty level (Table 2.6-31). Within the basin, the proportion of persons below the poverty level is higher in Alabama (22.0 percent) than in Georgia (21.0 percent). For Alabama, the proportion of low-income residents is higher in the basin (22 percent) compared to the state as a whole (18.1 percent). For Georgia, the percentage of low-income persons is higher in the basin (21 percent) than in the state as a whole (17.4 percent) and is higher than the nationwide poverty rate of 12.8 percent. For Florida, the percentage of low-income persons is higher in the basin (20.9 percent) than in the state as a whole (15.6 percent) and the state rate is higher than the nationwide poverty rate of 12.8 percent.

According to Table 2.6-31, poverty rates with the ACF Basin tend be several percentage points higher than the state-wide poverty rates for Alabama, Florida, and Georgia. In general, the poverty rates vary considerably among the counties in the ACF Basin and tend to be higher in rural areas of the lower portion of the ACF Basin in all three states and concentrated in the city of Atlanta and other larger urban centers in the basin. These higher rates are particularly common in the smaller communities along the lower Flint, lower Chattahoochee, and Apalachicola rivers, including Apalachicola and East Point on Apalachicola Bay at the mouth of the Apalachicola River.

Table 2.6-31.
Basin Poverty Status

Geographic Area	Population for whom poverty status is determined									Families with income in 2012 below poverty level			
	Total	Income in 2012 Below Poverty Level								All families		Families with female householder with no husband present with related children under 18	
		All ages		Related Children				Population 65 and over					
				Under 18 yr of age		5–17 yr of age							
		Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Alabama	4,662,094	842,292	18.1	290,406	26.0	286,760	25.8	71,323	11.1	172,714	13.9	87,901	47.6
Florida	18,479,273	2,887,151	15.6	885,588	22.5	869,595	22.2	325,033	10.1	527,980	11.4	219,062	36.6
Georgia	9,448,393	1,645,272	17.4	589,734	24.1	581,183	23.8	114,940	11.3	321,231	13.4	153,291	41.5
ACF (AL)	442,323	93,119	22.0	29,756	33.0	29,481	32.8	7,500	14.7	17,482	13.1	9,645	51.0
ACF (FL)	315,267	55,389	20.9	17,923	29.1	17,439	28.1	5,429	12.8	10,913	13.2	4,853	45.1
ACF (GA)	5,916,658	934,555	21.0	346,135	30.2	341,052	30.0	60,107	13.7	181,891	12.2	87,267	37.8
ACF Basin	6,674,248	1,083,063	21.1	393,814	30.4	387,972	30.1	73,036	13.7	210,286	12.5	101,765	39.2

Source: U.S. Census Bureau 2014

Note: Table is derived from county-level data. Despite some overlap with adjacent drainage basins in certain counties, the data are considered to provide representative values for the ACF Basin.

2.6.11 Protection of Children

On April 21, 1997, President Clinton issued EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, which recognizes that a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health and safety risks. This order requires federal agencies, to the extent permitted by law and mission, to identify and assess such environmental health and safety risks.

While the EO does not provide guidance on the age to which children should be protected, the Federal Interagency Forum on Child and Family Statistics, which was founded in 1994 and formally established by the order, focuses on those aged 17 and under (FIFCFS 1997). In the ACF Basin, 1,759,298 children 17 and under were identified in the 2012 American Community 5-Year Survey. This represents more than 25.6 percent of the basinwide population. More than 89 percent of the children in the basin were residents of Georgia (1,580,536). The Alabama portion of the ACF Basin had 105,555 children (6.0 percent). The Florida portion of the ACF Basin had 73,207 (4.2 percent) (U.S. Census Bureau 2014).

2.7 Aesthetic Resources

Scenic views and vistas within the river and stream corridors of the ACF Basin encompass a wide range of river, stream, and reservoir settings, including cascading streams rising from the upper reaches of the Chattahoochee River watershed in the mountains and foothills of the Southern Appalachian highlands; rivers and streams in the Piedmont province and along the Fall Line in the middle Chattahoochee River and upper Flint River watersheds; and the larger meandering lower Flint, lower Chattahoochee, and Apalachicola rivers flowing through the Coastal Plain toward Apalachicola Bay and Gulf of Mexico. Interspersed along the rivers and primary streams throughout ACF Basin are both federal and nonfederal reservoirs, as discussed in section 2.1.1.1.6. The streams, rivers, and reservoirs of the ACF Basin provide valued aesthetic resources to the residents and tourists in the region, many of which are directly associated with a variety of water-based recreational pursuits.

These aesthetic values are institutionally recognized, as reflected by the establishment of many public access points and public use areas on USACE and nonfederal reservoirs as well as the establishment of numerous national, state, and local parks and protected areas within the basin (see section 2.4.1.1). There are no formally designated National Wild and Scenic Rivers within the ACF Basin. However, the river corridors throughout the basin are widely recognized for their scenic diversity and value. For example, several river and stream corridors within the upper Chattahoochee River Basin lie within the boundaries of Chattahoochee National Forest; a 48-mi stretch of the Chattahoochee River downstream of Buford Dam is designated as the Chattahoochee National Recreation Area (see section 2.4.3); and much of the lower Apalachicola River corridor consists of publicly owned lands and wetlands that are protected and managed for environmental purposes.

2.8 Air Quality and General Conformity

EPA Region 4 and ADEM regulate air quality in Alabama; EPA Region 4 and the Florida DEP regulate air quality in Florida; and EPA Region 4 and the GADNR regulate air quality in Georgia.

The Clean Air Act (42 U.S.C. 7401-7671q), as amended, gives EPA the responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) (Title 40 *Code of Federal Regulations* [CFR] Part 50) that set acceptable concentration levels for six criteria pollutants: particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), and lead. Short-term NAAQS (i.e., 1-, 8-, and 24 hour periods) have been established for pollutants contributing to acute health impacts, while long-term NAAQS (i.e., annual averages) have been established for pollutants contributing to chronic health impacts. Each state has the authority to adopt standards stricter than those established under the federal program; however, Alabama, Florida, and Georgia all have adopted the federal standards.

Federal regulations designate Air Quality Control Regions (AQCRs) in violation of the NAAQS as *nonattainment areas*. Federal regulations designate AQCRs with levels below the NAAQS as *attainment areas*. According to the severity of the pollution problem, nonattainment areas can be categorized as marginal, moderate, serious, severe, or extreme. EPA has designated 16 out of the 81 counties in the ACF Basin as nonattainment areas for at least one criteria pollutant (Table 2.8-1).

Table 2.8-1.
Counties in the ACF Basin Designated as Nonattainment Areas

State	Counties	Nonattainment Pollutant
Georgia	Carroll, Hall, Heard, Spaulding	$PM_{2.5}$
	Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding	$PM_{2.5}$ and O_3

Source: USEPA 2010b
Note: $PM_{2.5}$ = fine particulate matter.

EPA, ADEM, Florida DEP, and GADNR have established general conformity rules specifically to ensure that the actions taken by federal agencies in nonattainment and maintenance areas do not affect a region's ability to meet the NAAQS in a timely fashion. The conformity regulations play an important role in helping states and tribal regions improve air quality in those areas that do not meet the NAAQS. This is also true for federally supported activities that take place within the 16 nonattainment counties within the ACF Basin. The updates to the Master Manual are not expected to result in any reasonably foreseeable direct or indirect emissions. These types of federal activities are specifically exempt from the general conformity regulations. The requirements of the general conformity rule would not apply to the WCM

updates because the proposed activities would result in no emissions increase (40 CFR 93.153(c) (2)), or the emissions are not reasonably foreseeable, such as electric power marketing activities that involve the acquisition, sale, and transmission of electric energy (40 CFR 93.153(c)(3) (ii)). A Record of Non-Applicability of the general conformity rule has been prepared; it is provided in appendix I.

Although regional air quality and air emissions are partially a function of population and land use, for the purposes of this EIS, population and land use throughout the basin are not expected to change appreciably due to the proposed updates. As a result, it is assumed that any changes in air quality would have occurred under the NAA. It is for these reasons that air quality was not carried forward for detailed analysis in this EIS and is not discussed in section 6.

2.9 Noise

Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Human response to noise varies depending on the type and characteristics of the noise, the distance between the noise source and the receptor, receptor sensitivity, and time of day. Noise is often generated by activities that are part of everyday life, such as construction or traffic.

Sound varies by both intensity and frequency. Sound pressure level, described in decibels (dB), is used to quantify sound intensity. The *decibel* is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level. The *hertz* (Hz) is used to quantify sound frequency. The human ear responds differently to different frequencies. *A-weighing*, described in a-weighted decibels (dBA), approximates this frequency response to accurately express the perception of sound by humans. Sounds encountered in daily life and their approximate levels in dBA are provided in Table 2.9-1.

Table 2.9-1.
Common Sounds and Levels

Outdoor	Sound Level (dBA)	Indoor
Snowmobile	100	Subway train
Tractor	90	Garbage disposal
Noisy restaurant	85	Blender
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio
Normal conversation	60	Sewing machine
Rainfall	50	Refrigerator
Quiet residential area	40	Library

Source: Harris 1998

The dBA noise metric describes steady noise levels. Very few noises are, in fact, constant; therefore, a noise metric, *Day-Night Sound Level* (DNL), has been developed. DNL is defined as the average sound energy in a 24-hour period with a 10-dB penalty added to the nighttime levels (10 p.m. to 7 a.m.). DNL is a useful descriptor for noise because 1) it averages ongoing yet intermittent noise, and 2) it measures total sound energy over a 24-hour period. In addition, *Equivalent Sound Level* (L_{eq}) is often used to describe the overall noise environment. L_{eq} is the average sound level in dB.

The Noise Control Act of 1972 (P.L. 92-574) directs federal agencies to comply with applicable federal, state, and local noise control regulations. In 1974, EPA provided information suggesting that continuous and long-term noise levels in excess of DNL 65 dBA are normally unacceptable for noise-sensitive land uses such as residences, schools, churches, and hospitals. Alabama, Florida, and Georgia have not

implemented noise regulations at the state level. Many counties within the ACF Basin maintain nuisance noise regulations, but most do not outline specific not-to-exceed noise levels. The vast majority of county- and city-based noise ordinances exempt construction noise during the daytime hours.

Existing noise levels (L_{eq} and DNL) were estimated for the areas internal to, and on the perimeter of, the ACF Basin using the techniques specified in the *American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound Part 3: Short-term measurements with an observer present* (ANSI 2003), and they are provided in Table 2.9-2. People residing in urban areas in the ACF experience outdoor DNL values ranging from 45 to 65 dBA. The levels shown are the lowest provided by the American National Standards Institute standard, and noise levels in remote areas could be substantially lower. Very rural and remote areas are estimated to have DNL values ranging from 20 to 45 dBA.

The updates to the Master Manual are not expected to result in any appreciable changes in the noise environment. No new noise from man-made sources would be introduced from the proposed updates. Small changes in the natural soundscape, associated with water movement and with animal movement and vocalizations in and around the projects, might take place. Although noise is partially a function of population and land use throughout the basin, for the purposes of this EIS, noise is not expected to change appreciably due to the proposed updates. As a result, it is assumed than any changes in noise levels would have occurred under the NAA. It is for these reasons that noise was not carried forward for detailed analysis in this EIS and is not discussed in section 6.

Table 2.9-2.
Estimated Noise Levels for Varying Land Use Intensity

Example Land Use Category	Average Residential Intensity (people per acre)	DNL (dBA)	L_{eq} (dBA)	
			Daytime	Nighttime
Noisy Urban Residential	80	65	64	57
Quiet Commercial, Industrial, and Normal Urban Residential	25	60	58	52
Quiet Urban Residential	8	55	53	47
Quiet Suburban Residential	3	50	48	42
Rural Residential	1	45	43	37

Source: ANSI 2003

2.10 Traffic and Transportation (Nonnavigation and Nonrecreation)

This section briefly characterizes landside transportation systems in the immediate vicinity of the lakes and river corridors in the ACF Basin. It summarizes the existing traffic resources in the areas adjacent to the USACE projects, which include vehicles to support varying land uses, the operation and maintenance of the USACE-managed facilities, and personal operating vehicles for residents, recreational vehicles, and tourists.

Transportation infrastructure along the ACF Basin is highly variable. It supports a wide range of conditions and needs, including dense residential and second home development around lakes; highly urbanized development around Atlanta and Columbus; and remote and rural areas in southern Alabama and Georgia, and northern Florida. It provides direct access to the water's edge throughout the system to support public recreation, commercial navigation, project operations activities, and other water-related activities. In general, the existing land base transportation network around the ACF Basin is adequate for its current use.

When channel availability within ACF Basin deteriorates to where navigation is not supported, then a shift of transportation mode may occur. When channel depth availability is below 7.5-ft limited navigation to support the transport of goods and materials, the transportation mode shifts to the next least costly alternative, normally rail. Regardless, movements of goods would retain both their origins and destinations, and shift transportation modes to rail or truck. Historically, depending on the month, the percent of time the water depth has been sufficient to transport goods and materials ranges from 55 percent in November to 94 percent in March. Normally, the towing companies and their tow operators would have information with regards to depth availability, would load barges restricted only by depth availability, and would schedule shipments to coincide with periods of adequate water depth.

The connection (i.e., relationship) between water management activities on the ACF Basin in general, and nonnavigation and nonrecreation transportation resources is limited. The Proposed Action to manage pool levels and flow requirements would not affect the transportation resources immediately adjacent to the dams and lakes, such as limited development for shoreline and lake access, recreation (marinas, parks, and picnic areas), protected areas, and prohibited access areas.

The updates to the Master Manual are not expected to result in any appreciable changes in nonnavigation and nonrecreation traffic. No additional traffic would be directly introduced from the proposed updates. Small changes in traffic in and around the projects might take place due to incremental changes in shipping modes. However, nonnavigation and nonrecreation traffic is not expected to change appreciably due to the proposed updates. As a result, it is assumed than any changes in nonnavigation and nonrecreation traffic would have occurred under the NAA. It is for these reasons that nonnavigation and nonrecreation traffic was not carried forward for detailed analysis in this EIS and is not discussed in section 6. Existing recreational activities are covered in detail in section 2.6.6, and navigational activities are covered in detail in section 2.6.2.

2.11 Cultural Resources

The term *cultural resources* can be used to describe a wide variety of objects, locations, structures, records, or other associations with human activity. Cultural resources are significant for their association or linkage to past events, historically important persons, and design or construction value, and for their ability to yield important information about prehistory and history. They can include prehistoric or historic archaeological sites, battlefields, shipwrecks, structures, objects, landscapes, or other features deemed to have importance to past human activity. A number of federal laws and regulations provide for protection of significant cultural resources. Those include the National Historic Preservation Act (NHPA) of 1966; Archaeological Resources Protection Act (ARPA) of 1979; Antiquities Act of 1906; NEPA; Archaeological and Historic Preservation Act of 1960 (also known as the Reservoir Salvage Act); Abandoned Shipwreck Act of 1987; Native American Graves Protection and Repatriation Act (NAGPRA) of 1990; and American Religious Freedom Act of 1978. Section 106 of the NHPA and its implementing regulations in 36 CFR Part 800 specifically address the process that individual federal agencies must follow to identify, evaluate, and coordinate their efforts and determinations concerning significant cultural resources.

In accordance with NHPA, significant cultural resources are those that have been identified as being eligible for inclusion or listed on the National Register of Historic Places (NRHP). Sites that are found to meet at least one of the criteria for listing on the NRHP are considered significant and are referred to as *historic properties*. A significant impact is considered to occur to cultural resources under NEPA when the lead federal agency determines that a project will have an adverse effect on a historic property that cannot be avoided or resolved in accordance with the provisions in 36 CFR Part 800.

All the ACF Basin projects were authorized and constructed before NHPA was enacted, with the exception of West Point Lake. As such, consideration for the construction and operation of the various components on cultural resources were done under the guidance of the Antiquities Act of 1906 and the Reservoir Salvage Act. In accordance with those acts and others, USACE was aided by the NPS to begin a program of systematic archaeological surveys. The surveys were initiated in the Lake George W. Andrews area. In 1947, Wesley R. Hurt conducted an archaeological survey of the west (Alabama) side of the Chattahoochee River from the Florida state line to the Fall Line at Columbus, Georgia, for the Alabama Museum of Natural History (deJarnette 1960, 1963, and 1975). Subsequently, in 1959, more detailed excavations were conducted by Robert W. Neuman (Neuman 1961). The archaeological surveys and numerous excavation projects carried out by the NPS were done to satisfy the requirements concerning cultural resources.

The West Point Lake project was completed in 1974. Although the newly enacted NHPA became the overriding compliance driver, the mitigation was essentially the same as for the earlier projects. The NPS aided USACE in completing surveys for the reservoir area before construction and filling of the reservoir (Chase and De Baillou 1962; Huscher 1972; Hally and Rudolf 1982). More than 1,008 archaeological sites were identified. Potentially significant sites were subject to a testing program (Cantley and Joseph 1991). Mitigation through excavation was carried out on those sites that could not be avoided by the project.

The enactment of NHPA in 1966 did not directly affect the operation of the ACF Basin because the construction and operation were authorized and ongoing before its enactment. However, section 110 of the act requires that federal agencies establish a program to deal with historic properties under their jurisdiction or control. That includes conducting inventories and NRHP evaluations, and considering those properties during planning. Engineer Regulation (ER) 1130-2-540 *Cultural Resources Stewardship* and ER 1130-2-438 *Project Construction and Operation Historic Preservation Program* establish the policy for dealing with section 110, ARPA, NAGPRA, and other regulations at operating civil works water resources projects for USACE. The preparation of a *Historic Property Management Plan* (HPMP) also known as an *Integrated Cultural Resources Management Plan*, which details actions and procedures to be followed concerning cultural resources is mandated.

In recognition of the statutory and regulatory requirements, USACE established a cultural resources program for the ACF Basin. The program consisted of completing cultural resources inventories for all fee-owned land and reservoir shores. The inventories were completed between the late 1970s and the 1980s. A few areas missed by those surveys were inventoried in 2010 (Brockington 2010). Annual inspections of identified historic properties were also established for the projects. The details of the cultural resources program, history of consultation, and lists of standard operation procedures are provided in the project HPMPs, which have been completed for the entire ACF Basin project.

2.11.1 Method of Assessment

USACE contracted Brockington and Associates of Norcross, Georgia in July 2009 to complete the second phase of a cultural resources study of the ACF Basin, as a follow-up to the initial phase conducted in 1998 (USACE 1998b). The initial phase provided a general overview and large-scale archaeological sensitivity model and a definition of the potential impacts and comparative analysis of impacts projected for three hypothetical water regulation formulas devised at the time. The second phase of analysis focused on predicting the severity of impacts of the potential effects from changes in water level management. Those include the erosion of artifacts and features from known site locations, deposition of sediment atop known sites, and increased or decreased access to known sites by vandals or looters. The complete study is in the final report of the second phase study titled *Cultural Resources Investigations for the Apalachicola-Chattahoochee-Flint (ACF) River Basin Water Control Manual and EIS* (Brockington 2010).

The second phase of analysis focused on predicting the severity of impacts of the potential effects from changes in water-level management. Those include the erosion of artifacts and features from known site locations, deposition of sediment atop known sites, and increased or decreased access to known sites by vandals or looters. The results of the study include:

- An updated inventory of known sites along the waterway
- A review of regional histories, archaeological surveys, sensitivity models, and HPMPs that pertain to the areas of sensitivity
- Field visitation, geomorphological and geographical information system analysis of selected site locations that represent a sample of the recorded and potential site areas, and can give an indication of the severity of potential impacts

A background literature search was conducted of the study area and included an inventory of state archaeological site files from Alabama, Florida, and Georgia and a review of previously conducted archaeological studies in the basin. Site inventory includes all sites to within one-quarter mi of the government properties or jurisdiction at the lakes and river boundaries. The HPMP for each of the lakes was reviewed. The background research and context statements from previous studies conducted along the ACF were used to define contexts for the study and define the site inventory in the basin. The regional histories overview and historic context included a review of the prehistoric and historic periods; topics covered include Native American presence and movements in the ACF Basin (specifically the Creeks and Cherokees and others along the Chattahoochee and Apalachicola rivers) and river trade (including steamboat navigation and commerce). The industrial development along the waterway was studied, including the 1800s use of the river for textile and gristmills to the early 1900s with development of hydroelectric power and control of the basin through congressional legislation for floodwater management, power generation, and navigation.

Brockington conducted field investigations at 15 sites in lakeshore locations, or along the riverbank, to determine prior impacts and potential effects from proposed changes in water-level management. Selected sites include two sites at each of the USACE reservoirs (Lake Lanier, West Point Lake, Lake Walter F. George, Lake George W. Andrews, and Lake Seminole—one at pool level and one downstream of the dam) along with five sites spread throughout the basin (Table 2.11-1). USACE selected the sites in consultation with Brockington to provide the clearest understanding of observable water-level effects. The site descriptions in the report focus on the specific conditions of the known site (i.e., its integrity, observed ongoing effects, and indications of past effects) and identify the potential for effects from changes in management of water levels. Brockington addressed the potential of in-pool and downriver effects from water flows whether from maintaining existing conditions or, seasonal drawdowns, or during periods of power production or periods of tropical storm events.

Table 2.11-1.
2009 Sampled Lakeshore and Riverine Cultural Resource Sites

USACE Project	Position Relative to Federal Project[a]	Cultural Affiliation	Site Type	NRHP Status
Lake Lanier	Flood pool	Woodland; Historic, 19th-20th century[b]	Lithic reduction	Potentially eligible
Lake Lanier	Downstream	Historic (pre-1820)	Fish weir	Unknown
Chattahoochee River	Downstream	Late Woodland; Early Mississippian; Protophistoric	Village/mound	Determined eligible
West Point Lake	Flood pool	Archaic-Mississippian; General Historic	Scatter/dumpsite	Potentially eligible
West Point Lake	Flood Pool	Archaic-Mississippian; General Historic	Quarry	Potentially eligible
West Point Dam	Downstream	Protohistoric	Village/mound	Unknown
Walter F. George Dam	Downstream	Mississippian	Artifact scatter	Potentially eligible
Walter F. George Lake	Flood pool	Archaic-Mississippian	Village/mound	Potentially eligible
George W. Andrews Dam	Downstream	Archaic-Mississippian	Artifact Scatter	Potentially eligible
George W. Andrews Dam	Downstream	Woodland; Historic, Nineteenth century	Artifact scatter	Potentially eligible
Flint River	Downstream	Middle Woodland	Midden	Potentially eligible
Lake Seminole	Flood pool	Late Woodland	Artifact scatter	Potentially eligible
Lake Seminole	Flood pool	Archaic-Late Woodland	Artifact scatter	Potentially eligible
Apalachicola River	Downstream	Historic, 20th century (1940)	Wreck	Unknown
Apalachicola River	Downstream	Middle-Late Mississippian	Midden	Unknown

Notes:
NRHP = National Register of Historic Places.
[a.] Sites in the *flood pool* generally surround the lake. *Downstream* locations are downstream of federal dams.
[b.] A historic, 19th-20th century homestead complex was visited in an area adjacent to the selected site (Brockington 2010).

Geoarcheology Research Associates was retained to provide observations of geomorphic contexts for a select number of archaeological sites in conjunction with site inspections conducted by Brockington. Geoarcheology Research Associates visited sites to provide geomorphic insights for the archaeological evaluations. An effort was made to examine sites at or near the pool level of the lakes and sites downstream of the impoundment structures. Observations focused on recording landform configurations, properties of soils, vegetation patterns, and existing disturbances and conservation measures. The investigations provide a geomorphic perspective on the state of site preservation and assess the potential for future impacts. Seven sites in Georgia were investigated that represented a diversity of site types (from Prehistoric lithic scatters to Mississippian villages) in a variety of physical environments (from Piedmont uplands to the Coastal Plain) with varying degrees of preservation (e.g., heavily eroded pool-level sites, managed and protected slopes, and eroding scarp edges). The goal of geomorphic assessments was to examine how river channels downstream of reservoirs respond to changes in flow regulated by dams and how decreased sediment loads influence the cross section of the river channel. Channels typically respond to changes in flow by widening or degrading in the form of bank erosion (Knighton 1998; Williams and Wolman 1984). That process can affect archaeological sites when they are in areas of the floodplain that are actively eroding.

2.11.2 Result of Assessment

The research resulted in a finding that existing ACF Basin operations can and do result in effects (both adverse and unknown) on cultural resources, including significant ones (historic properties). Both the literature review and field assessments confirm that finding. For example, NPS conducted a study on the impact of inundation from reservoirs on archaeological sites. Originally authored by Lenihan et al. (1981), *The Final Report of the National Reservoir Inundation Study, Volume I,* provides a framework for categorizing effects on archaeological sites in reservoir settings. NPS identifies four categories of processes affecting archaeological sites: 1) mechanical—relating to physical erosion and deposition such as wave action, fluctuating shorelines, siltation, and saturation; 2) biochemical—alteration of site soils and degradation of archaeological contexts associated with changing ecosystems; 3) human factors, which consist of artificial impacts such as borrow pits, construction, and increased wave action from boat traffic; and 4) miscellaneous factors—inundation, submergence, or changes in floral and faunal components (Lenihan et al. 1981).

Mechanical and biochemical processes can displace or bury artifacts, or features. The process of displacement is generally defined by *erosion*, where the soil matrix supporting the site is removed, exposing archaeological material to other adverse effects. *Deposition* refers to the process of burying sites. Deposition alters the known context of sites or features preventing access to, or knowledge of, them. *Access* is defined as the relative ability for the site to fall subject to human processes of vandalism or artifact collection (including knowledge of sites as previously mentioned) that can destroy contexts or deplete significant materials. The existing condition of archaeological sites in the ACF Basin can be undergoing, or have undergone, any or all three sets of effects. The effects can be adverse or beneficial. For example, deposition can protect an archaeological site from erosion induced by human activities; however, the deposition can accelerate decay of significant materials at the site.

Using the NPS study as a framework for effects analysis, field research found that the most common effect at archaeological sites in the ACF Basin falls under the *mechanical* type, mainly erosion. Clear evidence of erosion was found at 14 of 15 sampled sites. The site not affected by erosion is far from the river. Extensive research has not been done on that site to determine the site's exact extent. A small edge of it is near the water's edge, and it is possible that the proximity to the riverbank would change given more information.

Eleven of 15 sites have been affected by access issues associated with looting or *human factors* in the past. Intentional and unintentional human effects are ongoing at some of the sites. Because the sampled sites are known locations, it can be assumed that the actual number of sites affected by access issues is a smaller percentage than what was reflected during the site visits. Further research based on Brockington's study illustrates the trend in access issues during the course of a year (Fedoroff 2014), highlighting in some instances no effects from access.

The effects of deposition were found at only five of the 15 sites. At those sites, artifacts and archaeological contexts are being buried at varying rates. At all the sites where soil is depositing on artifacts and archaeological contexts, erosion is also occurring. It is likely that soil is eroded from one area and depositing on another area of the site. The ability to interpret the content of a site is the greatest loss that can occur from deposition. Deposition can reverse temporal deposits, change preservation states, or chemically alter radiocarbon samples.

It appears that significant erosion is most common at lakeshore sites, especially those that are on exposed peninsulas or along steep shorelines. Those locations further upstream tend to have higher potential for being protected from wave action erosion by sinuous and dendritic bays. They also tend to be in shallow, inundated creek channels with more gradually sloping terrain. Upstream protected areas are also more likely to be farther from boat ramps and, therefore, human recreational access. Steep riverbanks that can

be severely undercut by the current are often found along river channels. However, the sites in the sample that are in those locations often do not appear to be significantly altered by erosion. It can be generally asserted that those sites in the Piedmont along waterway channels are the most likely to experience significant erosion, particularly along the outside of river bends. In the Coastal Plain, erosion is comparatively less damaging. Similarly, the greater average height of the riverbanks on the Coastal Plain waterways protects perched sites to an additional degree. Sites that are at points of river access are the ones most likely to undergo human-induced adverse effects.

2.11.2.1 Upper Chattahoochee River Basin

Three sites were investigated in the Upper Chattahoochee River Basin: 1) along the banks of Lake Lanier, 2) downstream of Buford Dam on the Chattahoochee River, and 3) along the Chattahoochee River in Fulton County, Georgia.

One site along the bank of Lake Lanier was documented extensively for evaluation in this study. The site is made up of stone tools and ceramics dating back to the Woodland period. It is in an area with heavy human activity in a public use area. Erosion has occurred down to bedrock, and riprap is being used to protect the shoreline. The banks have been built up and secured with riprap extending approximately 6.5 ft above the water level. Development and heavy public use have affected the site. Under existing conditions, however, the site is being well-managed and the riprap placed along the shoreline should prevent any future erosion.

Three additional sites near the documented site were also visited to compare conditions. The sites were briefly described but not documented extensively. One site is considered NRHP-ineligible and is inundated 130 ft out from the shoreline. The other documented sites are determined potentially eligible. One is a housing complex providing an example of rural life in northeastern Georgia. The third site visited includes Woodland lithic scatter in an area that is almost entirely washed away.

A historic fishing weir built before 1820 was visited downstream of Buford Dam on the Chattahoochee River. In 1821, a law was passed forbidding fishing traps and other obstructions reaching more than one third of the river. Traps in the area might have been built by the Cherokee but could have also been constructed by historic Anglo-Americans. The obstructions were used to catch both anadromous and catadromous fish—fish that migrate from oceans to spawn in freshwater and those that migrate from freshwater to spawn in the ocean, respectively.

The historic fishing weir site is in an area under management by the NPS. Review of aerial photographs indicates that no appreciable migration of the channel has occurred. Evidence does not point to destructive influences caused by the intensity of the streamflows or fluctuations in the water level. The water releases would not likely displace the large rocks used in the fish trap. Riverbanks upstream of the site are undercutting and could contribute to adverse effects from debris. However, increased recreational river activities are likely the greatest contributor to scattering of rocks. Recreational canoers, kayakers, and inner-tubers are heavy users of the area and could intentionally or unintentionally move or displace rocks because of the shallow depth along this reach.

The third site visited in the Upper Chattahoochee River Basin is on a high terrace that formed on the inside of a large river bend meander several mi downstream of Buford Dam. The site is a prehistoric village with Late Woodland, Early Mississippian, and Protohistoric components. Exposed soils indicate that the terrace was built by historic material deposited during flood events and now only rarely experiences high-magnitude flood events. Vegetation on the terrace is well established, and the Chattahoochee River channel form appears to be stable, suggesting that the channel is not meandering. The greatest existing threat to this site appears to be from road and utility construction.

2.11.2.2 West Point Lake and Downstream Area

Two sites were examined in the flood pool of West Point Lake, and another was visited downstream of the dam.

The first site visited around West Point Lake is an artifact scatter site near the flood pool. The historic artifacts include metal pots, glass bottles, jars, quartz and chert flakes, and tools. The water level did not appear to reach artifact areas. Water levels adjacent to the site indicate minimal erosive effect. Adjacent and old roads were also not noted to increase access.

The second site in the flood pool of West Point Lake is experiencing erosion. The site was once an upland ridge but is now an exposed peninsula in the lake. The peninsula has the appearance of a hardwood forest, but artifacts are exposed to fluctuations in water level, boat wake, and wave action. Those shoreline processes, the low relief, and absence of bedrock are the factors that influence active erosion in areas with artifacts. High-water marks around the peninsula extend up to 50 ft above the shoreline. Water is also making its way up an old dirt road that bisects the site, eroding greater portions of the site.

Downstream of West Point Dam, the Faulkner and Okfuskutchi-Tallahassee protohistoric village and mound site are on a terraced slope. Much of the site is on private property, but some areas extend onto USACE property. The historic river terrace rises above the water surface of the Chattahoochee River. The slope of the bank is sheer and vegetated in grasses and forbs, as is the site surface. A small tributary runs along the higher terrace where some erosion control features have been installed. No erosion control measures are being taken along the vegetated banks of the Chattahoochee River. Under existing conditions, the sandy soils that make up the terrace do not seem to be experiencing erosion. Review of historical aerial photographs suggests the river is moving laterally toward the site. However, given ongoing access to the site for fishing and posted signs announcing the site's location, it is clear that access and looting are affecting artifacts.

2.11.2.3 Walter F. George Lake

Sites in the headwaters of the lake and downstream of Walter F. George Dam were visited. The upstream site is at the mouth of a creek that flows into a backwater area of Walter F. George Lake. The site is set on a level ridge forming a bank of the creek. Debris along the reservoir side of the site indicates occasional flooding. The other side of the site is higher and does not appear to experience flooding. A previous investigation of the site allowed for comparison of changes. The site had been looted in the past, but there was no evidence of recent looting in 2009 (Brockington 2010). Sediment from upland sources has filled in the embayment of the lake, and new vegetation has been established. The sediment could have deposited over existing artifacts and contained intact archaeological deposits. At an area where water levels fluctuate, soils experience wetting and drying. At this location, artifacts can experience biochemical alterations because of seasonal fluctuation of the water table, or the sediment can protect the area from additional shoreline erosion.

The site downstream of Walter F. George Lock and Dam is adjacent to a power line with access to a picnic area that has been gated to protect wildlife. Access there appears easy, and looting could be an ongoing threat. Evidence of looting was found during the site visit, and no surface artifacts were visible. Tall, dense vegetation in the power line corridor and a 30-ft shear drop along the riverbank might limit access to some areas. The steep slope along the river becomes more gradual, and a sandbar has formed on the downstream area of the site. Review of photographs suggests that erosion of the riverbank began following completion of the dam and appears to be straightening. Intact deposits were found along the northern half of the site where erosion appears to be having the least effect.

2.11.2.4 Lake George W. Andrews

Two sites with scattered artifacts were visited near Lake George W. Andrews along the Chattahoochee River. One of the sites is upstream of the George W. Andrews Lock and Dam along a bluff above the flood level, and the second is a Fort Walton midden site on the Chattahoochee River terrace south of the George W. Andrews Lock and Dam.

The site upstream of the dam has stabilized since construction of the dam and when it was heavily affected in the 1970s. The site area has been used as a borrow pit, but young pine and hardwood trees have overgrown most of the area. In areas where there is limited to no ground cover, there is evidence of localized erosion. However, as a whole, an extensive effort has been made at the site to curb erosion. Steep slopes from the top of the bluff down to the water surface have been contoured and planted for stabilization. Well below the site, riprap has been added to the banks of the reservoir to inhibit shoreline erosion at the pool level.

The site downstream of the dam is on private land approximately 200–250 ft and nearly 50 ft higher than the river water level. The area was once farmed but has been covered in mixed hardwoods and pines in the south, and scrubby vegetation in the northern portion of the site. Natural erosion of the steep riverbank is severe, but the site remains unaffected because of its distance from the water surface. There is little to no evidence of looting, and if the site remains uncultivated, it will remain relatively unaffected.

2.11.2.5 Lake Seminole

Two recommended eligible NRHP sites were visited around Lake Seminole, and a third was visited along the Flint River just upstream of the reservoir at Bainbridge, Georgia.

The site along the Flint River has experienced looting, shoreline erosion, sheetwash and gully erosion, recreational traffic, and dumping. It is a midden site accessible on a dirt road from a highway. Aerial photographs indicate that water levels have increased in the area since the 1950s. Water levels could be contributing to shoreline erosion, but photographs also indicate that vegetation has increased in the area providing protection to the site from access and erosion. However, the site's use for fishing could make restricting access impossible.

The second site visited along Lake Seminole has been encroached upon by the lake, but little looting or degradation due to access was reported. The most evident pressure was from erosion caused by high water in the 1970s. During the current survey, lower water levels have reduced undercutting of the riverbank. However, proximity of midden deposits to the water edge indicates that loss of some artifacts and their context would be expected. Bank stabilization would benefit artifacts at this site.

Fort Scott prehistoric site was the second site visited in the flood pool of Lake Seminole. Artifacts from this site are from several periods including Historic Euro-American, Lower Creek, Swift Creek, Weeden Island, Late Archaic, and Indeterminate Mississippian. The site is accessible only by boat. The location of the site and forestation limit access. However, many of the sites of the island previously recorded as being exposed were underwater during the 2009 visit. Aerial photographs lead reviewers to suggest that the original riverbank might have been eroding into the site before the reservoir was constructed.

2.11.2.6 Apalachicola River

Two sites were visited downstream of Lake Seminole in the Apalachicola River—the Barbara Hunt wreck and Ocheessee Landing.

The *Barbara Hunt* was a steamboat with a regular passenger route in the ACF Basin after 1938. The steamboat sank in the summer of 1940. Today, the boat is exposed where the hull is used as a perch by local fisherman. Sediment has deposited on the upstream side of the wreck, and scouring is occurring around the downstream end. The scoured sediment has redeposited about 165 ft downstream behind another historic site, the Daniels Barge. Looting at the site is not evident, but continued human contact with the wreck is likely to cause both intentional and inadvertent degradation.

Ocheessee Landing is the site of a village midden dated to the mid-late Mississippian period. The site is in a public use area along an eroding river terrace and along an outside bend. An aerial photograph does not suggest much river migration along the reach, but the site is clearly being affected by fluctuations in water levels. Bank erosion is notably the most destructive force affecting the site.

2.12 Hazardous and Toxic Materials

Operating and maintaining USACE projects typically requires the use of hazardous and toxic materials. The use of materials such as pesticides, paints, solvents, and petroleum products would be expected during the operation and maintenance of USACE-managed facilities, shoreline, vehicles, and equipment. The use of petroleum products would also be expected from the operation of marinas and from recreational vehicle use. The handling, use, storage, and disposal of these materials must be in accordance with label recommendations; USACE regulations; and local, state, and federal regulatory guidelines. Notably, potential updates to reservoir operations would not be expected to have an effect on hazardous and toxic materials and are not discussed in section 6.

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3 Framework for Decision Making

3.1 Projects in the ACF Basin

As discussed in section 2.1.1.1.6, USACE operates five dams in the ACF Basin (in downstream order): Buford, West Point, Walter F. George, George W. Andrews, and Jim Woodruff. These dams and their associated reservoirs are shown on Figure 1.1-1. In addition to the five USACE projects, nine nonfederal reservoir projects are on the mainstems of the Chattahoochee and Flint rivers in the ACF Basin. Those nonfederal projects, operated by the Georgia Power Company (GPC) and others, are described in more detail in section 2.1.1.1.6. Limited amounts of water can be stored at some of the nonfederal projects. Table 2.1-3 provides an overview of all the dams (USACE and nonfederal) on the primary rivers in the ACF Basin and their current operating purposes.

3.2 Applicable USACE Guidance

The following USACE regulations and manuals apply to operation of the ACF Basin projects and management based on the WCMs. The directives can be found at http://www.publications.usace.army.mil/.

- Engineer Manual 1110-2-3600, *Management of Water Control Systems* (November 30, 1987). This manual provides guidance to field offices for managing water control projects or systems authorized by Congress and constructed and operated by USACE. It also applies to certain water control projects constructed by other agencies or entities.
- Engineer Regulation (ER) 1110-2-240, *Water Control Management* (May 30, 2016) (also published as Title 33 *Code of Federal Regulations* [CFR] section 222.5). This regulation prescribes policies and procedures to be followed by USACE in carrying out water control management activities, including establishing water control plans for USACE and nonfederal projects, as required by federal laws and directives.
- ER 1110-2-1150, *Engineering and Design for Civil Works Projects* (August 31, 1999). This regulation defines engineering responsibilities, requirements, and procedures during the planning, design, construction, and operation phases of civil works projects. The regulation provides guidance for developing and documenting quality engineering analyses and designs for projects and products on time and in accordance with project management policy for civil works activities.
- ER 1110-2-1941, *Drought Contingency Plans* (September 15, 1981). This regulation provides policy and guidance for preparing drought contingency plans as part of USACE's overall water control management activities. It prescribes the policy that water control managers will continually review and, when appropriate, adjust water control plans in response to changing public needs.
- ER 1110-2-8154, *Water Quality and Environmental Management for USACE Civil Works Projects* (May 31, 1995). This regulation establishes a policy for the water quality management objective at USACE civil works projects.
- ER 1110-2-8156, *Preparation of Water Control Manuals* (August 31, 1995). This regulation is standardizes the procedures to be followed when preparing WCMs.
- ER 1105-2-100, *Planning Guidance Notebook* (April 22, 2000). This regulation provides the overall direction by which USACE civil works projects are formulated, evaluated, and selected for implementation. It contains a description of the USACE planning process, USACE missions and programs, specific policies applicable to each mission and program, and analytical

requirements. Its fundamental purpose is to describe the planning process in a straightforward, plain-language manner. In particular, this regulation provides policy and guidance regarding water supply storage reallocation.

- ER-200-2-2, *Procedures for Implementing NEPA* (March 4, 1988). This regulation provides policy and procedures for USACE implementation of the National Environmental Policy Act in accordance with regulations promulgated by the President's Counicl on Environmental Quality (40 CFR 1500-1508).
- *The Water Supply Handbook* (revised IWR Report 96-PS-4). This report is a desk reference for water supply planning and management.

The Mobile District continually reviews the Master WCM as needed to ensure that the best use is made of available water resources. At a minimum, the District reviews the manual every 5 years to determine whether updates are needed (USACE 2010a).

In addition to the above guidance, USACE established Environmental Operating Principles (EOPs) in 2002 to guide and ensure that USACE mission activities include totally integrated sustainable environmental practices (USACE 2012). The EOPs are applicable to the Master WCM update. The following seven principles were reviewed, updated, and reissued in August 2012:

1. Foster sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all USACE activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE that may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.
6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

Application of the EOP to the Master WCM update process is summarized at the beginning of section 6.

3.3 Background on Atlanta Water Supply Needs

3.3.1 Metropolitan Atlanta Area Water Resources Management Study

The Metropolitan Atlanta Area Water Resources Management Study (MAAWRMS) was authorized by a resolution of the U.S. Senate adopted March 2, 1972. The study was initiated in 1973 with policy guidance and overall direction being provided by a 5-member executive group comprised of regional, state, and federal agencies. Although the scope of the study initially encompassed multiple water and related land resource needs, it soon became evident that a plan for ensuring a long-term water supply for Metro Atlanta was needed and study efforts were then focused on developing that plan.

The final MAAWRMS report in 1981 recommended construction of a reregulation dam approximately 6.3 miles downstream of Buford Dam for the purpose of reregulating peak power releases from the dam and providing a minimum flow to meet 2010 average summer water supply demands of 487 mgd, plus 750 cfs for water quality purposes. This plan, when compared to other alternatives evaluated, had the greatest net benefits and was the National Economic Development (NED) plan in accordance with

planning guidance then in effect. The Assistant Secretary of the Army for Civil Works recommended to Congress in 1985 that the reregulation project be constructed by nonfederal interests. The final report was never officially transmitted to Congress. Nevertheless, Congress authorized construction of the reregulation dam in the Water Resources Development Act of 1986 (P.L. 99-662), subject to approval of a general design memorandum (GDM) and with project costs shared by federal and nonfederal sources 25 percent and 75 percent, respectively.

The GDM investigations re-examined the benefits and costs of four plans investigated in the MAAWRMS report. When submitted to the South Atlantic Division in March 1988, the draft GDM confirmed that the plan recommending the reregulation dam still had the greatest net benefits of the four plans, but only by a small margin. Another plan that had almost the same net benefits was the reallocation of storage in Lake Lanier. Due to the closeness of the net benefits of the two plans, a more detailed evaluation of the hydropower impacts was conducted, and in October 1988, the reallocation of storage plan was designated the NED plan and recommended for implementation. This result was coordinated with the Governor of Georgia who, in November 1988, concurred with the recommendation. The appropriate procedure to pursue implementation of the reallocation plan was determined to be preparation of a Post-Authorization Change (PAC) report, which was initiated in March 1989. The report was to fully evaluate the future water needs for Metro Atlanta to the year 2010, determine the storage from Lake Lanier needed to satisfy these projected demands, and identify the associated impacts to all project purposes, both upstream and downstream of Lake Lanier. The PAC report is discussed in more detail in section 3.3.4.

3.3.2 Atlanta Withdrawals from the Chattahoochee River

As described in section 2.1.1.2.4.6, the original operational scheme adopted upon completion of the Lake Lanier project in the late 1950s provided for maximum (*peak*) hydropower generation on weekdays through one or both large turbines, with minimal (*off-peak*) hydropower generation through the small turbine on weekends. This mode of operation, in combination with inflows between Buford Dam and Atlanta and reregulation at Morgan Falls Dam north of Atlanta (owned and operated by GPC), generally yielded sufficient downstream flows to meet Atlanta's water supply needs for the first 15 years of project operations (Stockdale 2009). During the 1970s, as the MAAWRMS was underway, water supply demands in Metro Atlanta continued to grow and USACE began to adjust Buford Dam operations to provide increased downstream flows to accommodate the growing demand. By 1986, a long-term solution for the region's water supply needs had still not been developed and demands continued to increase to the point at which USACE determined that further adjustments in releases from Buford Dam would require a contract under separate authority. Accordingly, under the authority of the Independent Offices Appropriations Act (IOAA) (Title 31 United States Code [U.S.C.] part 9701), USACE entered into a withdrawal contract in 1986 with the Atlanta Regional Commission (ARC) that provided for withdrawals of up to 377 mgd from the Chattahoochee River with payment to the U.S. government required for withdrawals exceeding 327 mgd.

3.3.3 Additional Interim Water Supply Contracts

The 1970s also were a time of population growth in communities and counties around Lake Lanier, which led them to request to withdraw water from Lake Lanier while the MAAWRMS was underway. Gwinnett County was the first to make such a request. On July 2, 1973, an interim withdrawal contract was executed under the authority of the IOAA that allowed Gwinnett County to withdraw water from Lake Lanier at a rate not to exceed 40 mgd "until such time as the Government's study (MAAWRMS) of the area's water supply needs is completed." (Gwinnett Contract Article 1(a)). The contract was modified in 1988 to increase the withdrawal rate to an average rate of 53 mgd and, in 1989, to redefine the term of the contract to be "until such time as the Government establishes a basis for the determination of cost of

water storage space contract in the Project and is prepared to enter into a water storage space contract with the User, or until January 1, 1990, whichever occurs first."

Requests to withdraw water from Lake Lanier were received by USACE from other communities and similar interim withdrawal contracts were executed under the authority of the IOAA as follows:

- On June 27, 1978, an interim withdrawal contract was executed with the City of Cumming allowing withdrawal of up to 2.5 mgd until the completion of the MAAWRMS or a period of 5 years, whichever occurred first, and subject to extension by mutual agreement for additional periods not to exceed 5 years each. This contract was subsequently modified in 1985 to extend the contract term to July 1, 1989; increase the rate of withdrawal to 5 mgd through July 31, 1988; and to increase the rate of withdrawal to 10 mgd from July 1, 1988, through July 1, 1989.
- On May 28, 1987, an interim withdrawal contract was executed with the City of Gainesville allowing withdrawal of up to 20 mgd until July 1, 1989, and subject to extension by mutual agreement for additional periods not to exceed 5 years each.

In 1986, the Army General Counsel concluded that the IOAA, a statute that authorizes USACE to accept payment for services rendered in providing for withdrawals but does not provide for the reallocation of storage space, was not the preferable authority for accommodating water supply needs. This opinion led to revisions in USACE policies regarding water supply, and accordingly, USACE allowed the four contracts entered into under this authority (i.e., ARC, Gwinnett County, City of Cumming, and City of Gainesville) to expire in 1990, with the intention of entering into new contracts for storage space at Lake Lanier to meet existing and future water supply needs of Metro Atlanta under the Water Supply Act (WSA) of 1958. As described below, however, withdrawals by these communities have continued.

3.3.4 Post-Authorization Change Report

In March 1989, USACE initiated a PAC to implement the findings of the GDM for the reregulation dam. The PAC was conducted under the authority of the WSA of 1958, which provides that storage may be included for present and future municipal or industrial water supply in USACE projects; and section 216 of the Flood Control Act of 1970, which allows USACE to review the operation of completed federal projects and recommend project modifications "when found advisable due to significantly changed physical or economic conditions...and for improving the quality of the environment in the overall public interest." The purpose of the report was to fully evaluate the future water needs for Metro Atlanta to the year 2010, to determine the storage from Lake Lanier needed to satisfy the projected demands, to identify the associated impacts to all project purposes, both upstream and downstream of Lake Lanier, and to develop a water control plan that would consider balanced operations for all project purposes, including water supply.

The GAEPD, which has regulatory authority over water usage in the state, furnished estimates of the average water demands for 2010 for the various communities in Metro Atlanta that would utilize storage in Lake Lanier amounting to 150.96 mgd withdrawn from Lake Lanier and 178.4 mgd withdrawn from the Chattahoochee River below Buford Dam. The estimated demands for reservoir withdrawal did not include amounts associated with relocation contracts: 2 mgd for Buford and 8 mgd (net withdrawal) for Gainesville. Further, the estimated demand for downstream withdrawal was the amount that could not be met by authorized project operations of 600 cfs continuous release during the weekends. The storage required to provide the requested water supply amounted to 141,614 acre-feet (ac-ft) for the communities withdrawing from Lake Lanier and 65,225 ac-ft for the communities withdrawing from the Chattahoochee River. A draft reallocation and post-authorization change report and a draft environmental assessment (EA) were completed in October 1989, which recommended reallocation of 206,839 ac-ft of storage in Lake Lanier to water supply for municipal and industrial (M&I) purposes.

3.4 Background on Water Control Manuals

WCMs are guidance documents that assist federal water managers in operating individual and multiple interdependent USACE reservoirs on the same river system. They provide technical, historical, hydrological, geographic, demographic, policy, and other information that guides the proper management of reservoirs during times of high water, low water, and normal conditions. The manuals contain water control plans for each of the reservoirs in the basin system and specify how the various reservoir projects are to be operated as a balanced system. The manuals also contain drought operations plans and divide the amount of water in storage into zones to assist federal water managers in knowing when to reduce or increase reservoir releases and conserve storage in USACE reservoirs, and how to ensure the safety of dams during extreme conditions such as floods. The authority and guidance for USACE to prepare and update the manuals is in section 7 of the Flood Control Act of 1944 and the USACE regulations listed in section 3.2.

The original *Apalachicola River Basin Reservoir Regulation Manual* was completed in February1958, shortly after completion of the Jim Woodruff Lock and Dam and about the time Buford Dam was completed. The original 1958 Master Manual does not include WCMs for Buford Dam or for West Point Dam, Walter F. George Lock and Dam, or George W. Andrews Lock and Dam projects, all of which were completed later. The individual reservoir project WCMs were completed as the projects were constructed and placed into operation, and when approved, the project-specific WCMs were attached as appendices to the 1958 Master Manual. The following identifies the appendices to the Master WCM and their year of completion or most recent year of revision.

- Appendix A—Jim Woodruff Lock and Dam and Lake Seminole Water Control Manual, 1972
- Appendix B—Buford Dam and Lake Sidney Lanier Water Control Manual, 1991
- Appendix C—Walter F. George Lock and Dam and Lake Water Control Manual, 1993
- Appendix D—George W. Andrews Lock and Dam and Lake George W. Andrews Water Control Manual, 1996
- Appendix E—West Point Dam and Lake Water Control Manual, 1975

A draft update to the main body of the 1958 Master Manual for the ACF Basin titled *Apalachicola-Chattahoochee-Flint Basin Water Control Plan* was prepared in 1989, along with certain changes to the project manuals, and was included as an appendix to the PAC report described above. Those proposed updates, however, were never finalized or formally approved because of litigation that ensued in 1990 and thereafter. Section 3.5 summarizes the history of litigation on water resources in the ACF Basin. The 1989 update incorporated several operational adjustments, primarily focusing on adjustments gathered through experience and lessons learned during severe drought periods in the 1980s. These adjustments included the development of the action zones for Lanier, West Point, and Walter F. George lakes that are currently the basis for systemwide reservoir management.

USACE has continued to operate essentially in accordance with the 1989 Master Manual update, making minor adjustments as additional experience and circumstances have dictated. In addition, USACE has continued to accommodate water supply withdrawals from Lake Lanier and from the Chattahoochee River downstream, although USACE has never taken action to effect a formal reallocation of storage in Lake Lanier nor to accommodate the future water supply needs that were anticipated in 1989.

3.5 Negotiations and Litigation

3.5.1 Principal Efforts for Resolution

In 1989, at the same time the Lake Lanier reallocation was being considered, USACE also proposed to reallocate storage to M&I water supply at Allatoona Lake and Carters Lake in the Alabama-Coosa-Tallapoosa River (ACT) Basin. Additionally, Georgia was proposing to develop a regional reservoir near the Alabama state line (i.e., the West Georgia Regional Reservoir). These proposals caused controversy among water user groups; Alabama, Florida, and Georgia; and various federal agencies. Alabama filed a lawsuit against USACE in June 1990 to halt the proposed actions. As a result of the litigation, the proposed storage reallocations were deferred while the parties negotiated.

After a period of negotiation, the governors of Alabama, Florida, and Georgia and the Assistant Secretary of the Army for Civil Works addressed the issues of concern by signing a memorandum of agreement (MOA) on January 3, 1992. The MOA specified that a comprehensive study of the water resources of the basins would be conducted under a partnership involving the states and USACE to develop the needed water resources data and to investigate the feasibility of implementing an interstate coordination mechanism (compacts) for resolving water resources issues in the ACT and ACF basins. The MOA contained a *live and let live* provision for water use in the basins while the ACT/ACF comprehensive study and negotiations were conducted. That provision memorialized the parties' understanding that existing water users could continue to make withdrawals for water supply, including reasonable increases in withdrawal amounts, for the period necessary to negotiate a solution to the water issues. The MOA also specified that USACE would operate the USACE reservoirs in the ACT and ACF basins within its statutory and contractual obligations to maximize water resource benefits to the basins as a whole, while taking into account the needs of existing water users and the need to maintain the historical flow regime in the rivers in the basins. Subsequent supplemental MOAs extended the term of the agreements and continued to extend the *live and let live provision*.

It was envisioned that the comprehensive study would recommend, among other things, a conceptual plan for management of water resources in the ACT and ACF basins, including the following elements:

- Management of the USACE and nonfederal reservoirs in the basins
- An assessment of existing and future water resource needs
- The extent of water resources available in the basins to serve such needs
- An appropriate mechanism to implement management of the basins

Prior to the completion of the comprehensive study, however, the state partners recommended river basin compacts between the states as the mechanism for negotiating water allocation formulas and managing the basins. The live and let live provision was incorporated into the Interstate River Basin Compact for each basin and signed into law by President Bill Clinton in November 1997; the MOAs were allowed to expire in September 1998. The Interstate River Basin Compact created an interstate administrative agency, the ACF Commission, composed of the governors of Alabama, Florida, and Georgia (state commissioners) and a federal commissioner appointed by the President of the United States. The comprehensive study was never completed, although useful data on water resource needs and availability were generated and assessment and modeling tools were developed to assist in resource assessment and basin management.

Interstate River Basin Compact negotiations began in early 1998, with a December 31, 1998, deadline for reaching agreement on the water allocation formulas. In anticipation of the states agreeing on a water allocation formula, USACE issued the *Water Allocation for the Apalachicola–Chattahoochee–Flint (ACF) River Basin, Alabama, Florida, and Georgia, Draft Environmental Impact Statement* in September

1998 (USACE 1998). Article VII of the ACF Interstate River Basin Compact required the federal commissioner to concur with the water allocation formula developed by the state commissioners for it to be implemented. The 1998 draft EIS was prepared to provide a basis for the federal commissioner's concurrence. By mutual agreement and in accordance with the provisions of the compacts, the states extended the deadline numerous times. Nevertheless, the state commissioners were unable to reach an agreement on an equitable apportionment of the waters in either basin, and the compacts were allowed to expire in August 2003 (ACF Basin) and July 2004 (ACT Basin); the 1998 draft EIS was never finalized. Upon expiration of the ACT and ACF compacts, Alabama and Florida reactivated their previous litigation and filed new litigation. The states asserted in that litigation that water control operations in the ACF Basin were not being conducted in accordance with approved water control plans, USACE regulations, and federal law.

Court-ordered mediation between the parties was initiated in March 2006 for both the ACT and ACF litigation. The mediation expired in March 2007 (ACF Basin) and September 2007 (ACT Basin). In March 2007, the ACF claims were consolidated as Multiple District Litigation to be heard by one judge, with the proceedings to be held in the federal district court for the Middle District of Florida. On November 1, 2007, the governors of Alabama, Florida, and Georgia met with executive branch leaders (Secretary of the Department of the Interior, Chairman of the Council on Environmental Quality [CEQ], and Chief of Engineers) to discuss strategies for developing solutions to the decades-long dispute among the three states and associated litigation. The resulting discussions focused primarily on the ACF Basin and the need for the states to agree on a drought operations plan. The mutually agreed-upon deadline was March 1, 2008. The parties did not reach an agreement, and negotiations ended on the deadline.

Meanwhile, on January 30, 2008, Secretary of the Army Pete Geren directed USACE to proceed with updating the water control plans for the ACF Basin. On February 22, 2008, the Mobile District published in the *Federal Register* the notice of intent (NOI) to prepare an EIS for the Master Manual update.

3.5.2 Litigation

As indicated above, Alabama filed a lawsuit in June 1990 to halt proposed reallocations of storage in USACE reservoirs for M&I water supply. Between June 1990 and January 2013, several cases related to the ACF Basin were heard in federal court. The following paragraphs summarize the issues involved in those cases.

3.5.2.1 The Alabama Case

In 1990, Alabama and Florida filed suit (the Alabama case) against USACE to stop the larger withdrawals it had approved for Georgia, based in part on the effect they would have on downstream users and a failure to comply with NEPA (42 U.S.C. 4321–4347). The suit alleged that USACE had exceeded its authority under the WSA of 1958 by reallocating storage in the ACF reservoirs. Under the act, a modification to reservoir projects, "which would seriously affect the purposes for which the project was authorized...or which would involve major structural or operational changes shall be made only upon the approval of Congress." The authorized purposes of Lake Lanier were disputed among the parties and became a recurring issue in each of the lawsuits filed. Generally, each of the parties except Georgia and USACE recognized three authorized uses—flood risk management, hydroelectric power generation, and navigation. Georgia and USACE, however, have maintained that M&I use was also authorized. USACE and Georgia, however, disagreed over the amount of M&I water supply that was authorized and the source of the water supply authority. The parties suspended the proceeding in 1992 with the signing of an MOA as described in section 3.5.1.

3.5.2.2 The District of Columbia Case

While the action was suspended in the Alabama case pending negotiations, another case was brought in the Federal District Court for the District of Columbia (District of Columbia District Court) in December 2000 by Southeastern Federal Power Customers, Inc. (SeFPC), a nonprofit corporate consortium of rural electric cooperatives and municipal electric systems. SeFPC alleged that the USACE contracts that provided for increased withdrawals from Lake Lanier, without appropriate compensation to hydroelectric power customers, exceeded USACE's authority under the WSA of 1958. The increased withdrawals, it argued, consequently diminished the flow-through by which hydroelectric power is generated. SeFPC claimed that its members were paying for Buford Dam hydroelectric power generation at prices disproportionate to the residual share of the water stored in Lake Lanier that was allocated to power generation. The proceedings of the Alabama and District of Columbia cases were interrelated. In the Alabama case, Alabama and Florida sued to prevent withdrawals of water from Lake Lanier made to the detriment of downstream users.

In January 2003, the parties in the District of Columbia case, including Georgia and USACE, reached a settlement agreement and requested the court's approval. The settlement agreement included a proposal for USACE to enter into 10-year interim water storage contracts at Lake Lanier for several municipalities and local governments, along with the potential for the interim water storage contracts to roll over to permanent reallocation storage contracts in the future, subject to NEPA compliance. Because the parties in the District of Columbia case attempted to implement a settlement agreement that would affect the use of the water at issue in the Alabama case, Alabama and Florida revived the Alabama case to challenge the settlement agreement. Alabama and Florida also intervened in the District of Columbia case to oppose the approval of the agreement as a violation of the suspension of proceedings in the Alabama case. In October 2003, the federal district court in the Alabama case granted Alabama and Florida's motion for a preliminary injunction, enjoining USACE and Georgia from implementing the agreement in the District of Columbia case. In February 2004, the federal district court in the District of Columbia case approved the settlement agreement but required that the injunction entered in the Alabama case be dissolved before the agreement could be implemented. In 2005, the 11th Circuit Court of Appeals vacated the Alabama District Court's injunction order, finding that Alabama and Florida did not establish an imminent threat of irreparable harm or a substantial likelihood of prevailing on the merits of the case. On December 21, 2005, the SeFPC filed a motion with the District of Columbia District Court to stay proceedings in the case pending completion of the NEPA process contemplated by the settlement agreement.

In January 2006, the District of Columbia District Court issued an order granting the stay and specifically stating that USACE would not be released from its existing legal obligation to implement the settlement agreement as expeditiously as practicable. On June 16, 2006, the Mobile District published in the *Federal Register* an NOI to prepare an EIS to address the proposed interim storage contracts. Public scoping meetings were held in November 2006, and a final scoping report was published in February 2007. Alabama and Florida appealed the District of Columbia District Court decision to the District of Columbia Circuit Court of Appeals, and arguments were heard in November 2007. In February 2008, the Court of Appeals for the District of Columbia Circuit reversed the federal district court's approval of the settlement agreement reached by the parties in the District of Columbia case. The court's opinion addressed only one of the statutory issues raised by the appeal—the WSA of 1958. The court determined the settlement agreement involved a reallocation of 22 percent of the conservation storage in Lake Lanier and held that "the Agreement's reallocation of Lake Lanier's storage space constitutes a major operational change on its face" and therefore, under the act, required prior congressional approval. Because Congress did not authorize the change, the court ruled that the agreement could not be enforced. Florida and Alabama also claimed that the agreement violated the Flood Control Act and NEPA, but the court did not address those issues. Georgia filed a petition for a writ of certiorari with the U.S. Supreme Court. The U.S. Supreme Court denied the petition on January 12, 2009.

3.5.2.3 The Georgia I Case

In 2000, the Governor of Georgia made a written request for a water supply reallocation study asking USACE to commit to making increased releases of water from the Buford Dam until the year 2030 to ensure a reliable M&I water supply to Metro Atlanta. In 2001, after 9 months without a reply, Georgia sued USACE to increase its water supply. While the Alabama and District of Columbia cases were being litigated, Florida and SeFPC filed motions to intervene in the Georgia I case, but the federal district court denied the motions. After that denial, USACE denied Georgia's request, claiming that it lacked the "legal authority to grant Georgia's request without additional legislative authority, because the request would involve substantial effects on project purposes and major operational changes." On appeal, the Court of Appeals for the 11th Circuit overturned the federal district court's decision. The court permitted Florida and SeFPC to intervene and returned the case to the district court for further adjudication. The federal district court, noting the similarity of the parties and the subject matter, found the case to be parallel to the Alabama case. The court suspended the proceedings in the Georgia I case pending resolution of the Alabama case.

3.5.2.4 The Georgia II Case

In 2006, USACE issued an Interim Operations Plan (IOP) for Jim Woodruff Lock and Dam for the purpose of protecting federally protected species in the Apalachicola River. Georgia sued USACE to challenge the IOP, claiming that it constituted a change from the only approved water control plan (which had been adopted in the late 1950s). Georgia argued that, by releasing more water from reservoir storage to meet the in-stream requirements in the IOP for the Apalachicola River, USACE was jeopardizing the state's future water supply. The releases allegedly did not account for dry-weather conditions and did not reserve enough water to supplement the dry summer conditions in northern Georgia. The suit also alleged that water supply was a contemplated purpose of USACE's water project.

3.5.2.5 The Florida Case

In September 2006, USFWS issued a Biological Opinion (BO) regarding the impact of the IOP for Jim Woodruff Lock and Dam on protected species downstream. Florida filed a lawsuit to review the BO, which was issued pursuant to the Endangered Species Act (ESA). The BO concluded that USACE's operations under the IOP were not likely to jeopardize the species or their habitat. Florida sought review of the BO and the NEPA supporting the IOP. The BO, according to Florida, violated rational decision-making standards. Furthermore, Florida alleged that the M&I water uses for which Georgia sought water were not authorized purposes.

3.5.2.6 The City of Columbus Case

In 2007, Columbus, Georgia, sued USACE, challenging the validity of the IOP. Columbus asserted that USACE had failed to adopt a formally finalized water control plan for the ACF Basin and that USACE's operation under the IOP violated its legal authority. USACE was operating under a third revision of the IOP (each IOP had changed the flow levels in the rivers) at the time Columbus filed the lawsuit. Columbus claimed that the lack of reliable flow from the Chattahoochee River impaired its ability to discharge water that it used to provide services to the city in compliance with regulatory requirements. The city alleged that the IOP improperly revised the water control plan because it was published in final form without public comment and was put into effect for an indefinite period. According to Columbus, the IOP resulted in over-releases of water from the ACF reservoirs to the city's detriment.

3.5.2.7 The City of Apalachicola Case

In 2008, Apalachicola, Florida, sued USACE, challenging its management and operation of the ACF facilities. The lawsuit arose from the city's interest in maintaining the Apalachicola Bay ecosystem, which the city claims as a basis for its economy and livelihood. Apalachicola alleged that USACE had not completed an adequate NEPA review when it issued the original IOP, the modified IOP, or the Exceptional Drought Operations modification to the modified IOP. The city also claimed that USACE had not complied with the EAs required under the Coastal Zone Management Act. Apalachicola also alleged that various contracts entered into by USACE, which provide for withdrawals for purposes other than those authorized by law, and USACE's application of the draft water control plan violate the WSA of 1958, the Flood Control Act, and NEPA.

3.5.2.8 Consolidated Cases

In March 2007, the Alabama, Florida, Georgia I, and Georgia II cases were consolidated and transferred to the federal district court for the Middle District of Florida "to serve the convenience of the parties and witnesses and promote the just and efficient conduct of the litigation." The Columbus and Apalachicola cases were also included in the consolidated litigation. The District of Columbia case was excluded from the consolidation of proceedings because it had already reached the appellate court, whereas the cases that were consolidated remained in various federal district courts.

3.5.2.8.1 Federal District Court for the Middle District of Florida

After the cases were consolidated, the parties agreed that the court should consider the claims in two phases to address separate distinct legal issues.

- Phase I addressed USACE's authority to operate Lake Lanier for water supply and reallocate storage under the WSA of 1958, as well as claims raised under NEPA and other statutes.
- Phase II consisted of environmental claims concerning USACE compliance with the ESA, as well as claims raised under NEPA.

In general, Alabama, Alabama Power Company, Florida, and SeFPC contended that USACE was obligated to seek congressional approval for actions it had taken with respect to water supply in Lake Lanier because those actions significantly affect the purposes for which the Buford Dam project was authorized or constitute major structural or operational changes. The Georgia parties contended that USACE has authority to allocate storage to accommodate increased levels of water supply, and improperly rejected Georgia's request in 2000 for additional water supply from Lake Lanier to meet anticipated future needs. USACE contended that, while it properly denied Georgia's 2000 request for future water supply storage, it has sufficient authority under the Buford project authorization and the WSA of 1958 to reallocate storage to accommodate present water supply withdrawals from Lake Lanier and the Chattahoochee River downstream.

The phase I summary judgment hearing was held on May 11, 2009. On July 17, 2009, the U.S. District Court for the Middle District of Florida issued an order in *In re Tri-State Water Rights Litigation* (Case No. 3.07-md-01) (J. Magnuson), which addresses the fundamental question of whether, by taking or failing to take the actions complained of in the various lawsuits, USACE had violated section 301 of the WSA of 1958. That act provides that:

> Modifications of a reservoir project heretofore authorized, surveyed, planned, or constructed to include storage [for water supply] which would seriously affect the purposes for which the project was authorized, surveyed, planned, or constructed, or which would involve major structural or operational changes shall be made only upon the approval of Congress. 43 U.S.C. 390b(d). (Emphasis added.)

The federal district court reviewed the legislative history and USACE's own statements to determine whether water supply was an authorized purpose of the project. After lengthy review of a large number of historical sources (e.g., congressional testimony, the 1958 Master WCM), the court concluded that water supply is not an authorized purpose for Lake Lanier.

The court then took up the question of whether water supply reallocation might be permissible under the WSA of 1958. For minor reallocations of a reservoir to water supply, USACE may act unilaterally. Approval of Congress would be required, however, if the reallocation "would seriously affect the purposes for which the project was authorized … or … involve major structural or operational changes." The court looked at the factual information concerning the amounts committed to interim contracts (now hold-over contracts because of their expiration) for withdrawal of water from the reservoir, the amounts taken from the Chattahoochee River near Atlanta, and the capacity of the reservoir's conservation pool. The court concluded that USACE actions would seriously affect hydroelectric power generation and constitute major operational changes.

On the basis of those analyses, the court concluded that USACE must seek congressional approval before it reallocates storage in Lake Lanier for water supply and issued its rulings accordingly on the various motions for summary judgment. Noting the draconian nature of a decision to potentially reduce Atlanta's water supply so much, the court gave the parties 3 years to obtain the necessary congressional approval. However, without congressional authorization, the district court's order required that withdrawals from Lake Lanier (apart from relocation agreements) must cease and off-peak releases for water supply must be limited to 600 cfs by three years of the date of the court's order or July 17, 2012.

The phase II summary judgment hearing was held on June 8, 2010. On July 21, 2010, the U.S. District Court for the Middle District of Florida issued a second phase order in *In re Tri-State Water Rights Litigation* determining that USACE and USFWS had complied with the ESA, but that USACE had not properly complied with NEPA requirements. The appropriate remedy would be for USACE to prepare new NEPA documentation on the Master WCM; however, because USACE had already agreed to develop an EIS as part of the WCM update, the court determined Florida's claims were moot. Florida appealed the phase II ruling to the 11th Circuit. After the appeal was filed, new information on endangered species caused USFWS to request USACE to reinitiate consultation. All parties agreed to stay the appeal while USACE and USFWS conducted additional studies.

3.5.2.8.2 U.S. Court of Appeals for the 11th Circuit

On May 3, 2010, the Solicitor General authorized appeal of the phase I ruling. On June 28, 2011, the U.S. Court of Appeals for the 11th Circuit issued an opinion that the authorizing documents for the Buford Dam project should include water supply as an authorized purpose. The opinion reversed the judgment of the District Court on the phase I ruling, vacated its findings and conclusions of law, and remanded the case *In re Tri-State Water Rights Litigation* to the district court with instructions to remand to USACE for further proceedings "not inconsistent with this order." As to the merits, the court held that the majority of plaintiffs' claims in the ACF were not final agency actions and, therefore, not subject to judicial review.

This decision set aside the Army's 2002 decision to deny Georgia's 2000 request and ordered a remand to USACE to reconsider whether it has the legal authority to operate the Buford project to accommodate Georgia's request, in light of the legal authority conferred by Congress in the River and Harbor Act (RHA) of 1946; Public Law (P.L.) No. 84-841 (July 30, 1956) (1956 Act); and the WSA of 1958. The court of appeals also directed USACE to consider a number of other issues related to the legal authority to accommodate Georgia's request, including how to measure the impacts of Georgia's projected withdrawals and return flows on authorized purposes and whether compensation to hydropower users was appropriate.

An appeal by Alabama, Florida, and the SeFPC for the case to be heard by the full panel of the U.S. Court of Appeals for the 11th Circuit was denied on September 16, 2011. On October 5, 2011, the district court remanded the matter to USACE in accordance with the appeals court's instructions. Limited jurisdiction was retained by the 11th Circuit pending the submittal by USACE of its position regarding authority to grant Georgia's 2000 request. USACE submitted its legal opinion, discussed below, on June 25, 2012. On July 10, 2012, the appeals court remanded any remaining jurisdiction in the cases to the district court. A subsequent appeal by Alabama, Florida, and the SeFPC to the U.S. Supreme Court on the phase I ruling was denied on June 25, 2012.

On January 24, 2013, the district court vacated its phase II ruling on the grounds that USACE and USFWS reinitiated consultation while the appeal was pending, thus rendering the appeal moot and making it proper to vacate the underlying order. Accordingly, there currently is no active litigation regarding USACE operation of the ACF Basin.

3.5.2.8.3 USACE 2012 Legal Opinion

USACE's legal opinion (Stockdale 2012) submitted to the 11th Circuit Court of Appeals on June 25, 2012, sets forth USACE's view that:

- It has the legal authority under the 1946 RHA to release water from Buford Dam sufficient to accommodate Georgia's requested downstream withdrawals of 408 mgd;
- Withdrawals of 20 mgd from Lake Lanier are authorized under relocation agreements and the 1956 Act; and
- It has discretion under the WSA of 1958 to accommodate additional net withdrawals of 170 mgd from Lake Lanier (including withdrawals of 277 mgd and returns of 107 mgd to the reservoir), because accommodating those withdrawals and returns would not fundamentally depart from congressional intent for the Buford project and the ACF system.

USACE could accommodate the downstream withdrawals without reallocating or charging for storage in Lake Lanier, because Congress expected that the downstream water supply needs of Metro Atlanta would be accommodated by the use of the existing multipurpose storage pool authorized under the 1946 RHA, and did not expect or provide for repayment of storage costs associated with the downstream water supply purpose. Withdrawals from Lake Lanier beyond the 20 mgd already authorized under relocation agreements would require contracts with the State of Georgia or other entities for storage pursuant to the 1956 Act and the WSA of 1958.[5] Any operational decisions to accommodate Georgia's request, and any determinations of how much storage to reallocate for the additional Lake Lanier withdrawals, are questions outside the purview of the legal opinion; however, because operations to accommodate Georgia's projected water supply withdrawals and return flows to Lake Lanier would not significantly depart from congressional intent for the ACF system, the legal opinion concluded that USACE has the legal authority under the relevant statutes to accommodate Georgia's request (Stockdale 2012).

[5] Presently, Gainesville withdraws 18 mgd and returns 10 mgd, resulting in a net withdrawal of 8 mgd. The total gross withdrawal under relocation contracts is 20 mgd.

3.5.2.9 Florida v. Georgia U.S. Supreme Court Case

On October 1, 2014, the State of Florida filed an original motion with the U.S. Supreme Court for leave to file a bill of complaint against the State of Georgia seeking an equitable apportionment of the waters of the ACF Basin and appropriate injunctive relief against Georgia to sustain an adequate flow of fresh water into the Apalachicola Region. The Supreme Court on November 3, 2014, gave Florida permission to sue Georgia. The Supreme Court on November 19, 2014, named a special master to review and propose a ruling to the court. On Oct. 31, 2016, the Special Master began the trial between Florida and Georgia on the issue of equitable apportionment of the waters of the ACF Basin. At this point it is unclear how long the trial will take and when the Special Master will issue his recommendation. At this time, it is unclear whether the outcome of this litigation will affect the USACE proposed operations that are the subject of this final EIS. USACE is following the litigation closely, and any potential outcome will be reviewed and analyzed by USACE and the Department of Justice. Following that review, the USACE will take appropriate action.

3.6 Other Relevant Statutes and Executive Orders

A decision on whether to proceed with the proposed action rests on numerous factors such as mission requirements, schedule, funding availability, and environmental considerations. In addressing environmental considerations, the Army is guided by relevant statutes (and their implementing regulations) and EOs that established standards and provide guidance on environmental and natural resources management and planning. Table 3.6-1 provides a brief list of applicable laws and EOs that are addressed in various sections throughout this EIS when relevant to environmental resources and conditions. The full text of the laws, regulations, and EOs is available on the Defense Environmental Network and Information Exchange Web site at www.denix.osd.mil.

Table 3.6-1.
Applicable Laws and Executive Orders

Anadromous Fish Conservation Act of 1965, as amended (16 U.S.C. 757 et seq.)	Noise Control Act of 1972 (P.L. 92-574)
Antiquities Act of 1906, as amended (16 U.S.C. 431)	North American Wetlands Conservation Act (16 U.S.C. 4401 et seq.)
Archeological and Historical Preservation Act (16 U.S.C. 469)	Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6901–6992k)
Archeological Resources Protection Act (16 U.S.C. 470aa–470ll)	River and Harbor Act of 1888 (33 U.S.C. 608); of 1899 (33 U.S.C. 401–413); as amended and supplemented
Clean Air Act (42 U.S.C. 7401)	Safe Drinking Water Act (P.L. 93-523; 42 U.S.C. 300f–j-10)
Clean Water Act (33 U.S.C. 1344 et seq); also known as the Federal Water Pollution Control Act of 1972, as amended	Toxic Substances Control Act (15 U.S.C. 2601–2692)
Coastal Zone Management Act (P.L. 92-583, 16 U.S.C. 1451–1456)	Water Pollution Control Act Amendments of 1961 (P.L. 87-88)
Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. 9601–9675)	Water Resources Development Act of 1986 (P.L. 99-662; 33 U.S.C. 2201–2330), as amended 1988, 1990, 1992, 1996, 1999, 2000, and 2007
Emergency Wetlands Resources Act of 1986 (16 U.S.C. 3901–3932)	Watershed Protection and Flood Prevention Act (16 U.S.C. 1001)
Endangered Species Act (16 U.S.C. 1531)	EO 11514 (Protection and Enhancement of Environmental Quality)
Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701–1784)	EO 11988 (Floodplain Management)
Federal Water Project Recreation Act of 1965, as amended (P.L 89-72, 79 Stat. 213; 16 U.S.C. 4601–12 et seq.)	EO 11990 (Protection of Wetlands)
Fish and Wildlife Conservation Act (16 U.S.C. 2901)	EO 12088 (Federal Compliance with Pollution Control Standards)
Fish and Wildlife Coordination Act (16 U.S.C. 661)	EO 12580 (Superfund Implementation)
Flood Control Act of 1944, as amended (16 U.S.C. 460)	EO 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations)
Food Security Act of 1985 (16 U.S.C. 3811 et seq.)	EO 13045 (Protection of Children from Environmental Health Risks and Safety Risks)
Historic Sites Act of 1935 (16 U.S.C. 461)	EO 13061 (American Heritage Rivers)
Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (P.L. 104–267; 16 U.S.C. 1801)	EO 13101 (Greening the Government through Waste Prevention, Recycling, and Federal Acquisition)
Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1401–1445, 16 U.S.C. 1431 et seq. and 33 U.S.C. 1271)	EO 13123 (Greening the Government through Efficient Energy Management)
Migratory Bird Treaty Act (16 U.S.C. 701–719c)	EO 13148 (Greening the Government through Leadership in Environmental Management)
National Environmental Policy Act (P.L. 91-190)	EO 13175 (Consultation and Coordination with Indian Tribal Governments)
National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 et seq.) and amendments of 1980 (16 U.S.C. 469a)	EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds)
Native American Graves Protection and Repatriation Act (25 U.S.C. 3001)	EO 13547 (Stewardship of the Ocean, Our Coasts, and the Great Lakes)

4 Development and Descriptions of ACF Water Management Alternative and Proposed Water Management Alternative

As previously indicated, the purpose of this EIS is to:

- Update the Master WCM for the ACF Basin as directed by Secretary of the Army Pete Geren on January 30, 2008, and
- Consider, along with operations for all authorized purposes, an expanded range of water supply options associated with the Buford Dam/Lake Lanier project, including current levels of water supply withdrawals and additional amounts from Lake Lanier and downstream at Atlanta that Georgia requested in 2015.

The updated Master Manual has been developed in compliance with Engineer Regulation (ER) 1110-2-240 and other USACE regulations and policies. To respond to Georgia's 2015 request, a WSSA was prepared following guidance in ER 1105-2-100 and *The Water Supply Handbook* (revised IWR Report 96-PS-4) for reports on reallocation of reservoir storage (appendix B).

USACE is taking the opportunity to make revisions to the water management procedures to improve overall performance of the ACF Basin and to implement the June 2011 ruling of the 11th Circuit Court of Appeals. In updating the Master Manual and considering Georgia's 2015 water supply request within the context of the purpose and need statement (section 1.2), USACE used a 6-step planning process described in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources* and in ER 1105-2-100. This process is a structured approach to problem solving that provides a rational framework for sound decision making. Although specifically required for planning studies, this process was well suited for this Master Manual update and is consistent with the Council on Environmental Quality's (CEQ)'s Regulations for Implementing NEPA (Title 40 *Code of Federal Regulations* [CFR] parts 1500–1508). Following are the six steps in the planning process:

- Step 1—Identify problems (challenges) and define objectives (includes scoping as required by 40 CFR 1501.7).
- Step 2—Inventory and forecast critical resources (i.e., physical, environmental, economic, and demographic) and develop the No Action Alternative (NAA).
- Step 3—Formulate alternatives.
- Step 4—Evaluate alternatives.
- Step 5—Compare alternatives.
- Step 6—Select a plan.

The steps of the planning process are presented and discussed in sequence for ease-of-understanding; however, they usually occur iteratively and sometimes concurrently. The steps were repeated as necessary to formulate efficient, effective, complete, and acceptable alternatives.

Problems associated with the current water management practices were identified (step 1 of the planning process) based on experiences gained in managing the reservoir system and from scoping input. Step 2 of the planning process was accomplished using input from the scoping process together with collection of available data and information. For step 3, alternatives considered in this EIS were formulated in two phases. The focus of Phase 1 was to consider revisions and updates to current water management practices for the five USACE reservoirs in the ACF Basin, with specific consideration given to methods of more effectively operating the projects as a system. A variety of water management measures were

identified, screened, and subsequently combined into several different sets of measures to form distinct water management alternatives. The water management alternatives were analyzed and evaluated (step 4) and then compared to current water management practices (step 5) to determine which one of them would most effectively meet authorized project purposes, as well as the objectives and environmental considerations defined for the WCM update process (step 6). The result of Phase 1 of the formulation process was identification of the proposed water management alternative.

In Phase 2 of the alternative formulation process, measures for addressing the State of Georgia's 2015 request for water supply from Lake Lanier and for downstream withdrawers were identified and screened to develop the set of water supply options to be considered (step 4). Phase 2 of the alternative formulation process is presented in section 5. In the draft EIS, USACE considered future water supply needs for Metro Atlanta as requested in the Governor of Georgia's January 11, 2013, letter to the Assistant Secretary of the Army for Civil Works. During public coordination of the draft EIS for the Master WCM update, the State of Georgia submitted a revised water supply request on December 4, 2015, based upon revised future population projections and water demands for Metro Atlanta. A copy of this request in contained in appendix C. The state's revised water supply request (reflecting reduced quantities from the 2013 request) were incorporated into the alternatives considered in the final EIS.

For Phase 2 of alternative formulation, the water management alternative reflecting current practices and the proposed water management alternative derived from the Phase 1 of the formulation process were combined with various water supply options for reallocation of conservation storage in Lake Lanier to establish combined alternatives that were evaluated and compared. The result of Phase 2 of alternative formulation and evaluation was the identification of a Proposed Action Alternative (PAA) addressing both revisions to USACE water management in the ACF Basin and reallocation of storage in Lake Lanier for water supply.

The Water Supply Act (WSA) of 1958 stipulates that congressional authorization is required for any reallocation of storage in completed reservoirs that would seriously affect the purposes for which the project was authorized or that would involve major structural or operational changes. The two-phased alternative formulation approach enables the identification of a proposed water management alternative to serve as a baseline for evaluating the effects on other project purposes when considering reallocation of storage in Lake Lanier for water supply. Based on the outcome of the Phase 2 of the alternative formulation and evaluation process, a determination can be made regarding whether any proposed reallocation would seriously affect the purposes for which the project was authorized or that would involve major structural or operational changes.

The two-phased alternative formulation process is illustrated in Figure 4.1-1. This section describes Phase 1 and section 5 describes Phase 2 of the alternative formulation process and the associated results and recommendations.

4.1 Water Management Alternative Formulation (Phase 1)

Problems and challenges associated with water management were identified by the scoping process (stakeholder comments). Additionally, USACE water management staff performed a review based on experience gained from operating under the draft 1989 Master Manual. The following water management challenges were identified as a result of these efforts:

- Making operational decisions on the basis of the 1989 action zones affected reservoir levels disproportionately. Explaining the basis for the action zones in the draft 1989 Master Manual was not easy. The zones were based on experience gained in the 1980s in responding to droughts and attempting to support navigation in the system. Additional experience gained in operating in

drought conditions, to conserve threatened and endangered species, and to support navigation in the system is considerably different than in the 1980s.

- Current USACE water control plans do not have a basinwide drought operations plan.
- When operating under the May 2012 Revised Interim Operations Plan (RIOP), there remains a need to suspend ramping rates during prolonged low flows.
- Sustained hydroelectric power operations during drought have an adverse effect on USACE's ability to continually operate for conservation of federally listed threatened and endangered species.
- Historic operations at Lake Lanier, West Point Lake, and Walter F. George Lake have seldom maintained a full pool during the May–October period.
- Navigation on the Apalachicola River is undependable.

USACE developed several objectives for the Master WCM update and the WSSA to address the water management issues. In the context of this EIS, an *objective* is a statement of what the updated Master WCM should try to achieve. Accordingly, the following objectives have been developed:

- To define action zones on a scientific basis that eliminate a disproportionate impact on reservoirs and address current system needs.
- To develop and implement a basinwide USACE reservoir drought operations plan.
- To reduce or eliminate the chance of prematurely returning to drought operations and reducing flows downstream from Jim Woodruff Lock and Dam below 5,000 cfs.
- To reduce or eliminate the adverse effect of system operations on federally listed threatened and endangered species.
- To improve system performance to achieve congressionally authorized project purposes.
- To increase the reliability of navigation on the ACF system.

USACE used an iterative process to identify the various water management measures that would be further developed, analyzed, and refined toward the goal of developing an updated Master WCM (see Figure 4.1-2). The Phase 1 alternative formulation and evaluation process involved the following:

- On the basis of the operational challenges and problems identified above, extensive stakeholder input during three rounds of scoping, and accounting for the 11th Circuit Court of Appeals ruling, USACE identified numerous water management measures for possible consideration in the updated Master WCM.
- USACE considered each water management measure individually and determined whether it passed the eight screening criteria listed in section 1.4.4.
- Measures failing to pass the criteria in the first screening were not carried forward for further evaluation (i.e., they were eliminated from further consideration).
- Measures carried forward for further evaluation were refined, if required, and then further evaluated and screened a second time to determine their feasibility.
- The water management measures passing the second screening were combined to form basinwide water management alternatives that address one or more of the objectives identified above.
- HEC-ResSim was used to model the effects of the water management alternatives providing data outputs (e.g., hydroelectric power generation, reservoir levels, and river flows and stages) across the entire hydrologic period of record (1939–2011). The modeling results were not expected to replicate exactly the actual daily operations or streamflows from 1939–2011 for several reasons.

Pre-dam conditions existed during the period before 1954 and actual flow data for that period would not reflect a regulated system. Further, actual flow data from before 2008 do not include protected species operations. The modeling rules are very rigid and did not capture the within-day flexibility that actually exists nor did the modeling reflect emergency operations or other approved deviations in reservoir operations that have occurred during the period of record. For these reasons, calibration of the ResSim model to actual flow data was not appropriate. Limited comparisons to observed periods, particularly the years 2000–2011, however, allowed for verification of HEC-ResSim's accurate replication of project operations.

- To assist in identifying the water management alternative that most effectively satisfies the objectives for the Master WCM update, USACE developed a process for ranking the performance of the alternatives based on the HEC-ResSim modeling results. Performance measures defined for the various project purposes are described in the following sections. Based on the values of the performance measures resulting from HEC-ResSim modeling, the alternatives were ranked from 1 (best performance) to 7 (worst performance). The water management alternative that best balances the authorized project purposes was identified as the proposed water management alternative.

For the draft EIS, the two-phase formulation process relied extensively on modeling using what was then the latest software application, HEC-ResSim Version 3.2, Build 3.2.1.19. The USACE Hydrologic Engineering Center (HEC) developed that decision support tool to meet the needs of modelers performing reservoir project studies as well as of reservoir regulators during real-time events. HEC-ResSim is now the standard for USACE reservoir operations modeling. HEC-ResSim Version 3.3, Build 3.3.1.42 became available in 2015 and is used for analysis of alternatives in this final EIS. Although this newer version of ResSim has not yet been officially released, it offers important advantages over ResSim 3.2, including new features, enhancements, bug fixes, and improved algorithms.

In 2006, the Mobile District began working with HEC to create HEC-ResSim watershed models of its established HEC-5 models simulating 1977, 1995, and 2006 physical and operational conditions. The three HEC-5 models hold significance as the tools of record for analyses concerning the 1998 draft EIS, the comprehensive study, the 2006 Interim Operations Plan (IOP), the 2008 RIOP, and the 2012 RIOP. After ensuring that the corresponding HEC-ResSim models could effectively reproduce the HEC-5 results, Mobile District and HEC created another HEC-ResSim model that captured the most significant operations as of 2008, including the RIOP rules and head limits constraints. That model was presented to stakeholders in October 2008 and generally accepted as a promising improvement to ACF Basin reservoir system modeling.

As the HEC-ResSim model for the ACF Basin was further refined and initial baseline model runs were conducted, USACE conducted a second stakeholder workshop in May 2011. Participants in the workshops included representatives of the states of Alabama and Georgia, U.S. Geological Survey (USGS), Alabama Power Company, local water utilities in the basin, and several consultants. The Mobile District and HEC have continued to refine the HEC-ResSim model, using it to evaluate alternatives in support of the 2012 legal opinion and this EIS. HEC-ResSim modeling conducted for this EIS for the period of January 1939–December 2011 is documented in appendix E. Additionally, HEC-ResSim's Firm Yield subroutine was used in the *Federal Storage Reservoir Critical Yield Analyses* (USACE Mobile District 2014) (appendix F).

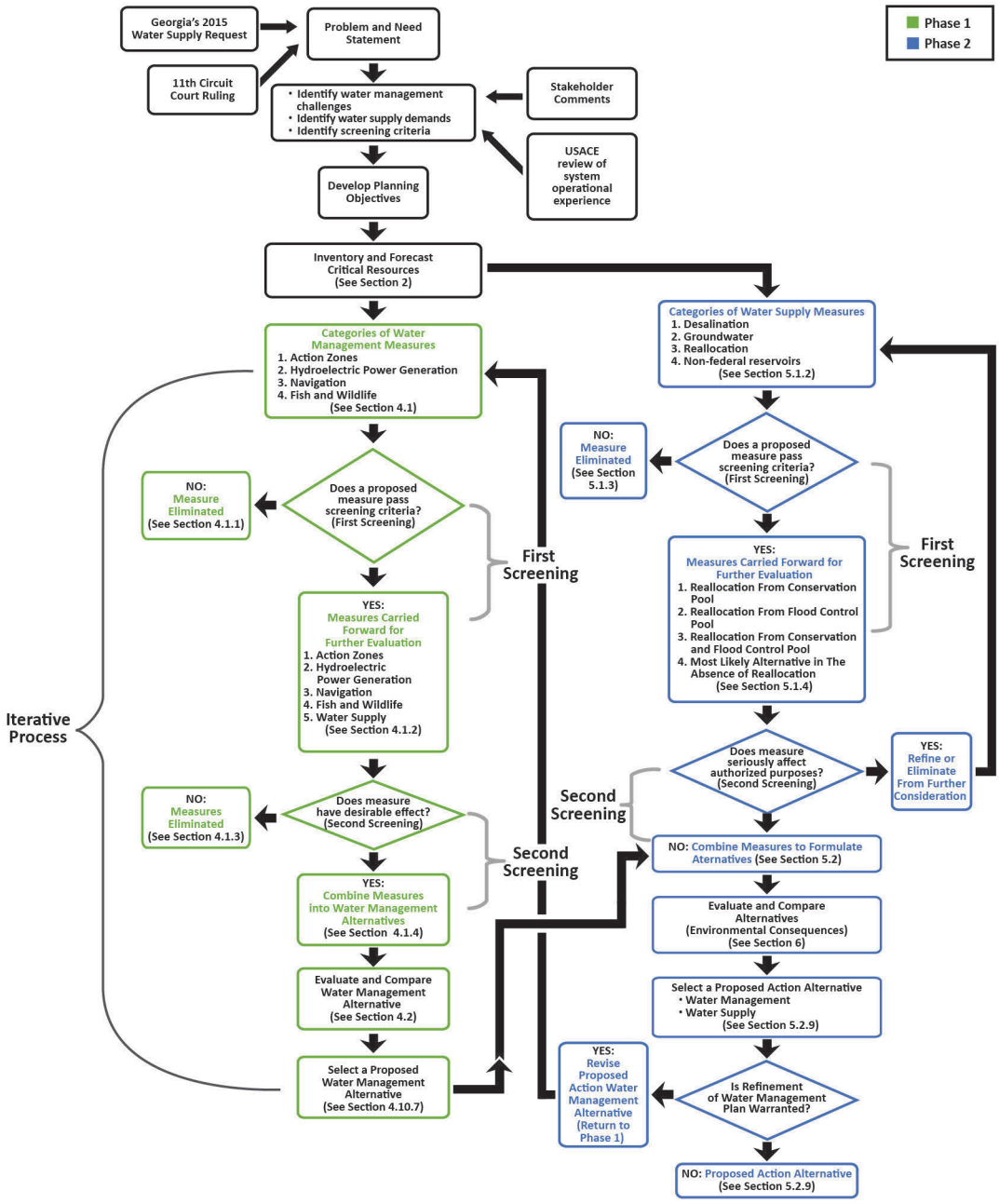


Figure 4.1-1. Water Management Planning Process.

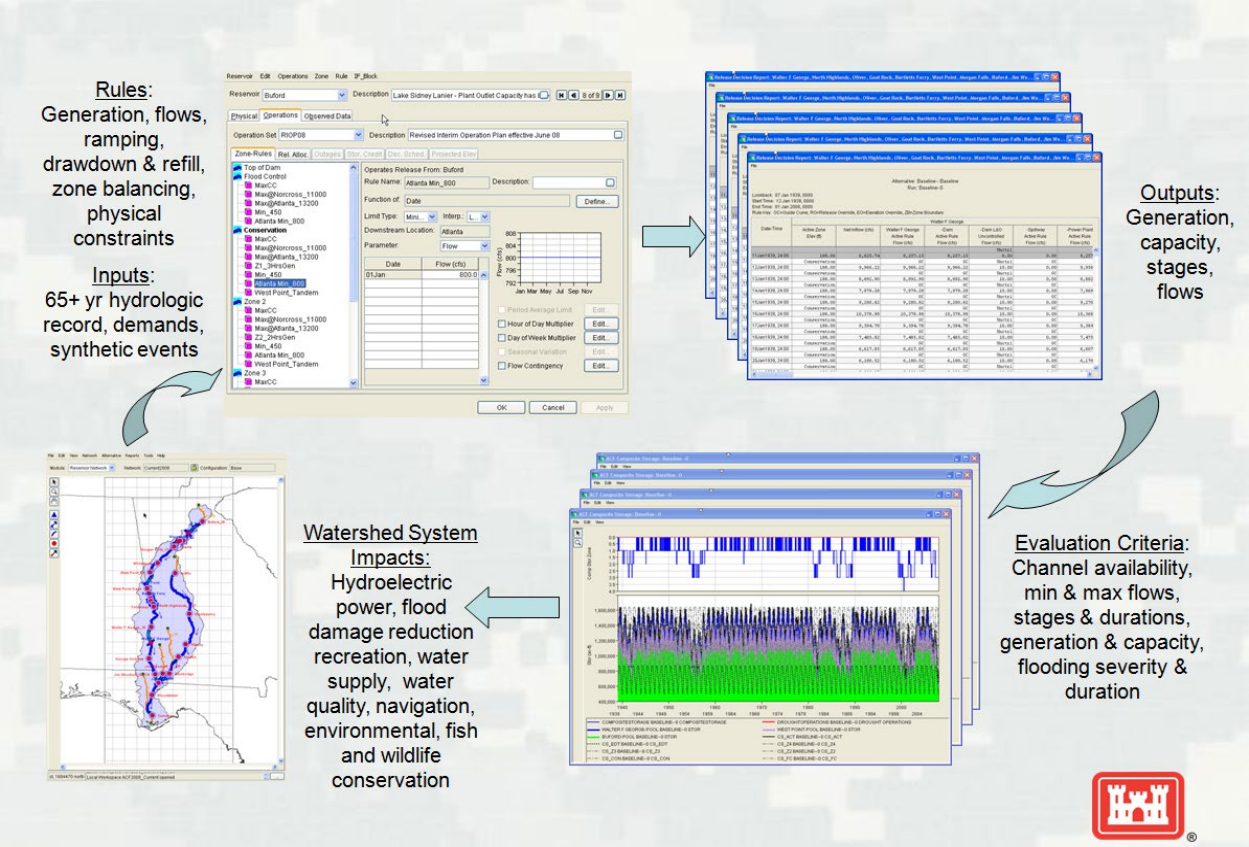


Figure 4.1-2. Process of Refining Current Operations.

USACE selected HEC-ResSim as the tool most capable of faithfully representing district water management practices at the culmination of a 3-year model development and verification process. In accordance with Engineering and Construction Bulletin 2007-6, *Model Certification Issues for Engineering Software in Planning Studies*, issued April 10, 2007, HEC-ResSim falls under the category of engineering models used in planning studies, leaving certification to the Science & Engineering Technology initiative associated with the USACE's Technical Excellence Network. As of January 2010, network guidance listed HEC-ResSim as *"Community of Practice Preferred"* for the purpose of reservoir system analysis.

HEC-ResSim models reservoir operations at one or more reservoirs for a variety of operational goals and constraints. The software simulates reservoir operations for flood risk management, low-flow augmentation and water supply for planning studies, detailed reservoir regulation plan investigations, and real-time decision support. HEC-ResSim can represent both large- and small-scale reservoirs and reservoir systems through a network of elements that the user builds (i.e., junctions, routing reaches, diversions, and reservoirs). The software can simulate single events or a full period of record using available time-steps. Familiar data entry features make model development relatively easy, and localized *mini plots* graph the data entered in most tables so that errors can be quickly identified and corrected. A variety of default plots and reports, along with tools to create customized plots and reports, facilitate output analysis. HEC-ResSim provides a realistic view of the physical river/reservoir system using a map-based schematic. The program's user interface allows the user to draw the network schematic as a stick figure or as an overlay on one or more geo-referenced maps of the watershed. HEC-ResSim represents a system of reservoirs as a network composed of four types of physical elements: junctions, routing reaches, diversions, and reservoirs. By combining those elements, the HEC-ResSim modeler is able to

build a network capable of representing anything from a single reservoir on a single stream to a highly developed and interconnected system like the ACF Basin. A reservoir is the most complex element of the reservoir network and is composed of a pool and a dam. HEC-ResSim assumes that the pool is level (i.e., it has no routing behavior), and its hydraulic behavior is completely defined by an elevation-storage-area table. The real complexity of HEC-ResSim's reservoir network begins with the dam.

The USACE reservoirs in the ACF Basin are constructed and operated for one or more of the following purposes: flood risk management, hydropower generation, navigation, recreation, water supply, water quality, and fish and wildlife conservation. Those purposes typically define the goals and constraints that describe the reservoir's release objectives. Other factors that might influence the objectives include time of year, hydrologic conditions, water temperature, current pool elevation (or action zone), and simultaneous operations by other reservoirs in a system. HEC-ResSim uses an original rule-based description of the operational goals and constraints that reservoir operators must consider when making release decisions.

To evaluate the alternatives considered in the Phase 1 and Phase 2 formulation processes, USACE determined that the 73-year hydrologic period of record (1939–2011) would provide a reasonable range of future hydrologic conditions by which to assess and compare the effects of alternatives to current project operations. The HEC-ResSim model for the ACF Basin included the following basic assumptions that apply to the simulations:

- The software incorporates characteristics of the basin and individual reservoirs, including physical constraints (e.g., spillway capacities, area-discharge curves, and flows associated with hydroelectric power generation) and operational procedures (e.g., action zones, balancing, and the like). All the current USACE and nonfederal reservoir projects were in place and operational over the entire period of record. Simulated project operations for water management alternatives followed current operations practices or occurred as prescribed for each different water management alternative.
- Net diversions for municipal and industrial (M&I) water supply (withdrawals minus returns of treated wastewater) and for agricultural use throughout the ACF Basin were simulated using 2007 levels over the entire hydrologic period of record to represent the baseline condition for diversions. Net diversion values in the ACF Basin in 2007 represent the greatest annual amount of net water diversion in the basin during the 73-year period of simulation and, consequently, the year of greatest stress on the system from water withdrawals for human use. Starting with average monthly values for each diversion, average daily values were calculated for each month (by dividing by the number of days), resulting in a year of daily values. The simulation applied these values to hydrologic conditions for each year in the period of record. For Phase 2 formulation and evaluation, various assumed increases in M&I water supply diversions from Lake Lanier and from the Chattahoochee River between Buford Dam and Peachtree Creek were considered in the HEC-ResSim simulation. See section 5 of the EIS for additional details.
- For consistency in comparing the water management alternatives, the Phase 1 analysis assumed that (1) the water supply withdrawals from Lake Lanier would be limited to the 20 mgd currently authorized to be withdrawn by the cities of Buford and Gainesville under existing relocation contracts and (2) releases from Buford Dam would be made in accordance with the *Chattahoochee River Management System* (CRMS) to support water supply withdrawals from the Chattahoochee River in Metro Atlanta limited to the amounts withdrawn in 2007 (i.e., 277 mgd). Return flows to Lake Lanier and to the Chattahoochee River downstream of Buford Dam from wastewater treatment facilities also were taken into account. These assumptions facilitated the comparison of the performance of the water management alternatives using a consistent baseline condition relatively independent of the influence of the water supply withdrawals from Lake Lanier under the expired contracts.

- The model included operations for five Georgia Power Company (GPC) dams in the ACF Basin—Morgan Falls, Bartletts Ferry, Goat Rock, Oliver, and North Highlands.
- The HEC-ResSim model utilized for Phase 1 and 2 formulation and analysis in the draft EIS included assumed operations for the proposed Glades Water Supply Reservoir (Hall County, Georgia) and Bear Creek Water Supply Reservoir (south Fulton County, Georgia). For the final EIS, modeling in support of phases 1 and 2 alternative formulation and analysis was adjusted as follows:
  - an updated version of HEC-ResSim was used;
  - Georgia's revised and reduced 2015 water supply request was modeled;
  - Glades and Bear Creek reservoirs were deleted from the model network in response to public comments and new information; and
  - an updated elevation-storage-area relationship for Buford reservoir which reflects the most recent survey of the reservoir pool was used.

Details of the HEC-ResSim modeling for the WCM update process are presented in the HEC-ResSim modeling report and modeling report addendum in appendix E. The development of the unimpaired flow dataset used as input to the HEC-ResSim model is described in appendix O.

The following sections outline operational revisions considered in updating WCMs for the ACF Basin.

4.1.1 Water Management Measures Eliminated from Further Consideration (First Screening)

The purpose of the federal action is to update the water control plans and manuals for the USACE system of improvements in the ACF Basin to operate for congressionally authorized purposes, taking into account changed conditions since the last approved Master Manual and public comments. USACE solicited public comments on the proposed scope of the Master Manual update effort. After reviewing public comments, and in light of the overall purpose, USACE developed screening criteria, as discussed in section 1.4.4, to guide the scope of the federal action. Measures eliminated from further consideration did not pass the screening criteria. Further, in the scoping comments received, a number of specific measures (or alternatives) were identified that were found to be outside the scope of this EIS. Appendix D details 228 specific measures (or alternatives) identified in scoping some of which were eliminated from further evaluation. This section briefly discusses some examples of the eliminated measures.

As explained in section 2.1.1.2, USACE strives to operate the reservoirs of the ACF Basin in a balanced manner to meet all of the project purposes. The relative importance (priority) of project purposes varies from project to project depending on water level and storage conditions in each reservoir. All project purposes, regardless of whether they are identified in the original congressional authorization or by subsequent general legislation, are considered equally when making water management decisions. Therefore, any measure proposed during public scoping that recommended prioritization of project purposes (e.g., WQ16, WS2 and WS6, or HP1) was not carried forward for further consideration.[6]

Because navigation is one of the congressionally authorized purposes in the ACF Basin, it must be considered in making any operational decisions. Accordingly, any recommendations to eliminate navigation as a project purpose (e.g., NV4) were not considered. Eliminating a project purpose would not meet the purpose and need of the federal action (screening criterion 1), which is to determine how the

[6] See section 1.4.4 and Table 1.4-2 for an explanation of the identifiers for scoping comments/suggestions detailed in appendix D.

USACE projects in the ACF Basin should be operated for their authorized purposes in light of current conditions and applicable law.

Measures that suggest use of reservoir flood storage for other purposes (e.g., WM52 and FRM5) were not considered because they would not maintain at least the current level of flood risk management (screening criterion 3). Thus the measure to raise Lake Lanier 2 ft to a conservation pool elevation of 1,073 ft was eliminated from further consideration. As described in appendix D, USACE's authority to consider raising the pool at Lake Lanier would reduce the available flood storage and require a reallocation of that storage to some other purpose. USACE is not exercising that discretionary authority as part of this Master Manual update. The update is being conducted to determine how the USACE projects in the ACF Basin should be operated for their authorized purposes in light of current conditions and applicable law.

Flood risk management at West Point Lake is an authorized purpose. Some stakeholders suggested managing the reservoir for recreation rather than flood risk management or maintaining a constant pool level of 632.5 ft year-round (e.g., FRM2 and FRM4). That suggestion is not consistent with the screening criteria that any alternative considered by USACE should maintain at least the current level of flood risk management (screening criterion 3). Additionally, managing West Point Lake for recreation or maintaining a constant pool level would essentially ignore a congressionally authorized purpose. It is not the purpose of this EIS to investigate the feasibility of eliminating or reducing the level of flood protection afforded downstream communities by West Point Lake.

Measures suggesting studies to determine the allocation of water among Alabama, Florida, and Georgia (e.g., WM17 and DS15) were also not carried forward for further consideration. USACE acknowledges that the states are in longstanding disagreement regarding the allocation of waters in the ACF Basin. While USACE would, within the limits of applicable law and authority, seek to incorporate any tristate agreement into its operation of its projects in the ACF Basin, the allocation of waters among the states is not within USACE's authority. Meanwhile, USACE intends to implement updated water control plans and manuals for ACF Basin USACE projects in compliance with all applicable law.

USACE also did not carry forward measures that change minimum releases (for other than threatened and endangered species) or minimum flows to ensure that other entities meet their federal compliance requirements in the future (e.g., BR15; NEPA17; HP9; and WM15, WM16, WM18, WM19, WM59, and WM60). USACE recognizes existing minimum flow requirements of various entities within the ACF Basin, but authorized project purposes of its projects do not include operating to meet requirements for which other parties are responsible. The use of West Point Dam releases to ensure that the GPC complies with its Federal Energy Regulatory Commission license is an example of a recommendation that was not carried forward. Measures to ensure that discharges by municipalities and industries comply with the Water Pollution Control Act of 1972 as amended also are not within USACE authority. States have the regulatory authority to ensure that discharges to surface water meet permitted standards and that permitees comply with their National Pollutant Discharge Elimination System (NPDES) permits.

The difference in the water level behind a dam and in the tailrace of the dam is critical in water management. This difference is referred to as *head* in hydrologic modeling. Changes to the existing head at dams in the ACF Basin could increase the risk to the structural integrity of the projects (screening criterion 7). Therefore, measures that would potentially change the existing head limits for projects in the ACF Basin (e.g., WM52 and FRM5) were eliminated from further consideration.

Measures that suggest structural modifications to the ACF project or other USACE projects do not meet the purpose and need to determine how the existing USACE projects in the ACF Basin should be operated for their authorized purposes, in light of current conditions and applicable law (screening criterion 1). Accordingly, suggestions to repair and reverse channel degradation in the Apalachicola River (e.g., WM44); to halt or limit the current diversion of fresh water caused by the Chipola Cutoff (e.g., WM45); to build

another dam within Lake Lanier at or near Browns Bridge (e.g., WM57); to build a large lake on the Flint River (e.g., WM65); or to close or install a lock at Sikes Cut (e.g., WM66 and NEPA15) were not carried forward for further consideration. Separate authorities that might be pursued to address some of those issues include section 216 of the River and Harbor and Flood Control Act of 1970 (Review of Completed Projects); section 1135 of Water Resources Development Act (WRDA) 1986, as amended (Project Modifications for Improvement of the Environment); and section 206 of WRDA 1996, as amended (Small Aquatic Ecosystem Restoration Projects). The latter two authorities have specific limits on federal funds that can be expended on each project ($10 million). In addition, the USACE rehabilitation program for major components of existing infrastructure projects provides a separate and specific avenue for approval, budgeting, and funding of necessary project rehabilitation, including limited opportunities to incorporate features within the scope of the project that might provide environmental benefits.

4.1.2 Water Management Measures Considered for Further Evaluation (First Screening)

Only water management measures that passed the screening criteria presented in section 1.4.4 (first screening) were considered in updating the Master WCM. Each measure was considered individually and refined iteratively as described above. The following categories of measures are described in more detail in the subsections that follow:

- Guide Curves
- Action Zones
- Drought Plan Revisions
- Minimum Flows at Peachtree Creek
- Hydroelectric Power Generation
- Navigation
- Basin Inflow (BI)
- Fish and Wildlife Conservation
- Water Supply

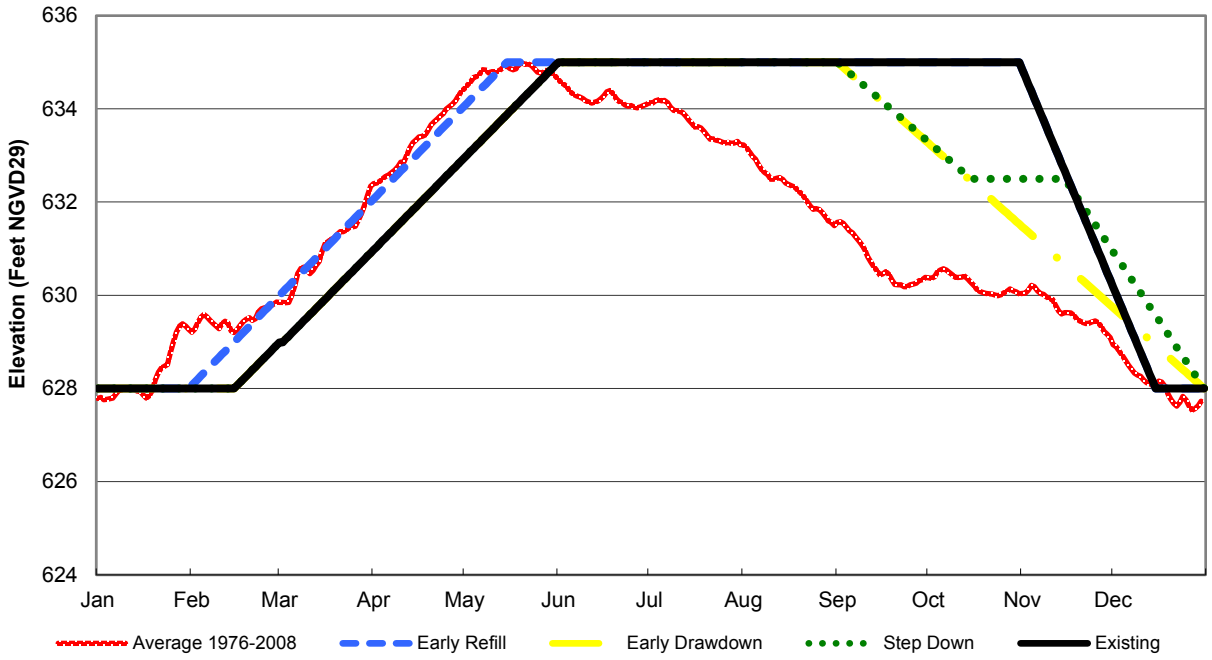
4.1.2.1 Guide Curves

USACE considered maintaining the existing guide curves as well as redefining guide curves at West Point Lake and Walter F. George Lake. Existing guide curves are shown in the WCMs for the Buford Dam (1991), West Point Dam (1984), and Walter F. George Lock and Dam (1993). The guide curves for Lanier, West Point, and Walter F. George lakes are shown in Figures 2.1-22, 2.1-28, and 2.1-33.

Measures to modify guide curves (which would modify the summer pool duration) at West Point Lake and Walter F. George Lake were considered in partial response to stakeholder comments. Consideration for this measure was given to adjusting the timing of refill and drawdown periods between winter and summer pool (guide curve shoulders). The initial variations considered to adjust shoulders at West Point Lake are shown in Figure 4.1-3.

At Walter F. George Lake, guide curve modifications also included lowering the summer pool level to minimize the static head limitations. There is a 2-foot (-ft) fluctuation between the winter level of 188 ft and summer pool of 190 ft which is equivalent to 82,400 acre-feet (ac-ft) of storage. Two factors play into the variability in pool elevation between the summer and winter level at Walter F. George Lake.

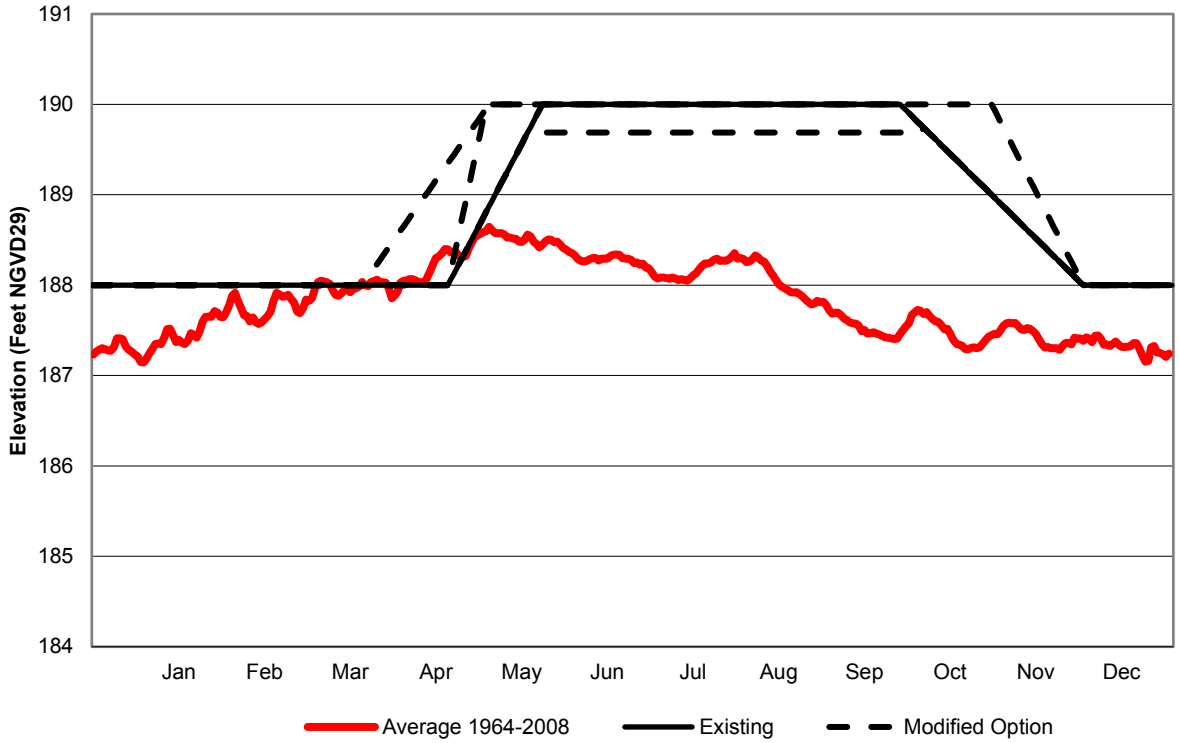
- Walter F. George Lake is the furthest downstream storage project and the first project to make releases in support of needs at Jim Woodruff Lock and Dam and the Apalachicola River.
- The limited flood storage requires rapid response to high flow conditions and results in abrupt changes in storage.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-3. West Point Lake Guide Curve Options.

Figure 4.1-4 displays the guide curve options considered for Walter F. George Lake, including the existing condition.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-4. Walter F. George Lake Guide Curve Options.

4.1.2.2 Action Zones

4.1.2.2.1 Maintain Existing Action Zones

The *1989 draft ACF Water Control Plan* (USACE, Mobile District 1989) defines action zones for each of the three major storage projects on the ACF Basin—Lake Lanier (Figure 2.1-22), West Point Lake (Figure 2.1-28), and Walter F. George Lake (Figure 2.1-33). Those zones are used to manage the reservoirs at the highest level possible while balancing the needs of all the authorized purposes. Zone 1, the highest in each reservoir, defines a reservoir condition where all authorized project purposes should be met. As lake levels decline, zones 2 through 4 define increasingly critical system water shortages and guide USACE in reducing flow releases resulting from drier-than-normal or drought conditions. The action zones also provide guidance on meeting minimum hydroelectric power generation needs at each project, and they determine the amount of storage available for downstream purposes such as flood risk management, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water quality, and water supply.

At the time of their development in 1989, action zones were derived on the basis of past project operations, which considered time of year, historical pool level/release relationships, operational limits for conservation, and recreational resource impact levels. The action zones have provided a key management tool for more than 20 years, providing the basic guidelines for operating the ACF system; however, other factors and activities might cause USACE to operate the reservoirs differently than the zones shown on the charts. Examples of those factors or activities could include exceptional flood risk management measures, fish spawn operations, maintenance and repair of turbines, emergency situations such as a drowning and chemical spills, drawdowns because of shoreline maintenance, and releases made to free grounded barges.

The storage projects are operated to maintain their lake level in the same zones concurrently. However, because of the hydrologic and physical characteristics of the ACF Basin and factors mentioned above, there might be periods when one reservoir is in a higher or lower zone than another. When that occurs, USACE makes an effort to bring the reservoirs back into balance with each other as soon as conditions allow. By doing so, effects on the ACF Basin are shared equitably among the projects. The following definitions apply to the action zones:

- Zone 1: Indicates that releases can be made in support of seasonal navigation (when the channel has been adequately maintained) and hydroelectric power releases. If all reservoirs are in Zone 1, USACE would operate the ACF system normally.
- Zone 2: Indicates that water to support seasonal navigation might be limited. Hydroelectric power generation is supported at a reduced level. Minimum flows are met.
- Zone 3: Indicates that water to support seasonal navigation might be significantly limited. Hydroelectric power generation is supported at a reduced level. Minimum flows are met.
- Zone 4: Indicates that navigation is not supported. Hydroelectric power demands will be met at minimum levels and might occur only for concurrent uses. Minimum flows are met.

4.1.2.2.2 Modified Action Zones at Lake Lanier, and West Point and Walter F. George Lakes

In modifying existing action zones, USACE reviewed changing summer and winter pool levels and the proportionality of fill and drawdown relative to each zone at storage projects—Lake Lanier, West Point Lake, and Walter F. George Lake.

- Summer levels—USACE considered the refill capability of each storage project. Because of their larger drainage areas, West Point and Walter F. George lakes are more likely to refill each year than Lake Lanier. Consequently, a greater percentage of Lake Lanier's conservation storage contributes to the lower composite conservation storage zones (e.g., Lake Lanier's zones 3 and 4 compose the bulk of composite conservation storage in zones 3 and 4).

- Winter levels—USACE considered tying action zones to recreation effects and hazard levels.
- Proportional fill and drawdown—Lower reservoirs in the basin have less storage volume; however, because of the basin hydrology, the lower reservoirs also have a larger drainage area and, therefore, refill more quickly than reservoirs located in the upper portion of the basin. USACE compared individual project conservation storage contributions to the composite conservation storage zones on the basis of a project's drainage area contribution. Reflecting hydrology, USACE relies on using storage first from the lower projects during normal and incipient drought conditions.

Table 2.1-3 presents the drainage areas at Lake Lanier, West Point Lake, and Walter F. George Lake and their respective conservation storage capacities.

Two modified action zone measures were considered in formulating water management alternatives as described below.

4.1.2.2.2.1 Watershed proportional action zones (Level 1)

In recognition of experience in operating the basin, USACE explored the feasibility of adjusting the size of the action zones at Lake Lanier, West Point Lake, and Walter F. George Lake. The changes in action zones were based on the proportion of reservoir storage to the relative size of the contributing watershed at each project (as depicted in Table 2.1-3). In refining the action zones, USACE reviewed the option of changing the timing of the following:

- Transitioning from summer to winter pool levels
- The proportionality of fill and drawdown relative to each zone during the summer period
- The refill capability of each storage project

The winter levels of the action zones are tied to recreation impact and hazard levels for all three reservoirs with a 0.5 ft buffer. In considering action zone summer period revisions, USACE took into account that West Point and Walter F. George lakes are more likely to refill each year than Lake Lanier because of reservoir inflow and precipitation. The contributing watershed area to West Point and Walter F. George lakes is greater than at Lake Lanier. Annual precipitation is also greater in more southerly portions of the ACF Basin. Consequently, because the conservation storage at Lake Lanier is greater, a greater percentage of Lake Lanier's conservation storage contributes to storage in West Point and Walter F. George lakes. That is especially true when basinwide storage is in the lower composite conservation zone (see Section 2.1.1.2.4.4).

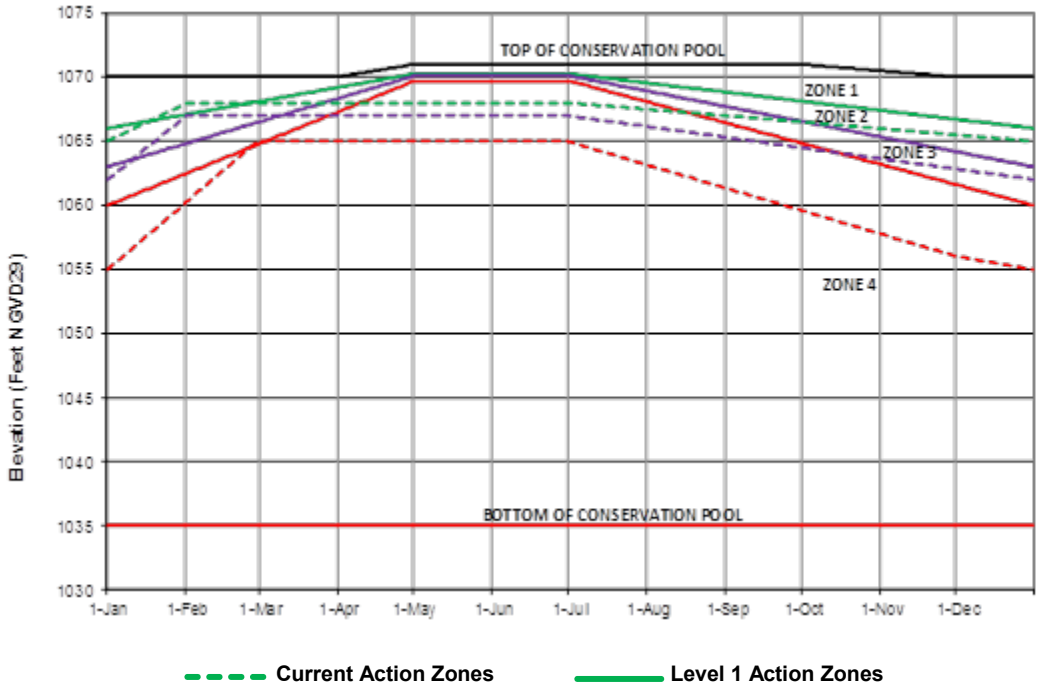
Proportional sizing of action zones 1 and 2 summer period at each project was based on the size of the project's contributing watershed. This works well for zones 1 and 2 and to a certain extent for Zone 3. In Composite Storage Zone 4, however, the system is under stress and Lake Lanier contributes 78 percent of the system storage to Composite Zone 4, reserving the bulk of the storage for drought operations support to the largest headwater project, which also has the smallest drainage area. The elevation range difference in zones 1 and 2 remained about the same for West Point and Walter F. George lakes, 2.5 ft and 0.5 ft, respectively (Table 4.1-1). However, this approach to sizing the action zones led to a narrowing of zones 1, 2, and 3 at Lake Lanier to 0.75, 0.15, and 0.4 ft per zone, respectively, for summer pools levels, compared to zone level increments of 3.0, 1.0, and 2.0, respectively, under current operations (Figure 4.1-5). Such a narrowing of the action zone intervals results from the disproportionately large storage volume in Lake Lanier compared to the relatively small contributing watershed above Buford Dam (Table 4.1-1). This set of potential action zones for the projects, proportionally sized based on contributing watershed size, are called Level 1 action zones for purposes of this analysis.

Table 4.1-1.
Level 1 Action Zones on June 1 (ft)

	Lake Lanier	West Point Lake	Walter F. George Lake
Top of Zone 1	1,071	635	190
Top of Zone 2	1,070.25	632.5	187.5
Top of Zone 3	1,070.1	632	187
Top of Zone 4	1,069.7	631	186.3

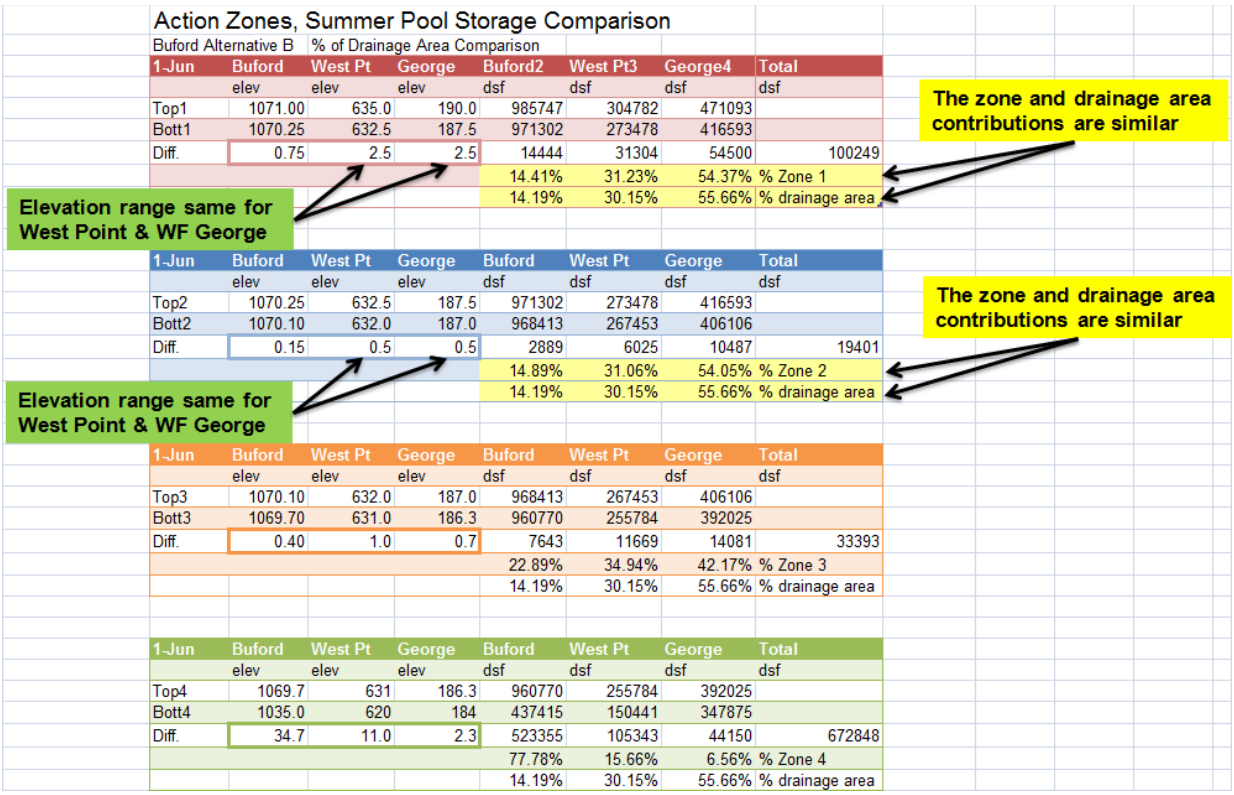
A linear foot-for-foot drawdown relationship was created between West Point Lake and Walter F. George Lake for the upper action zones. This concept supports using storage from the lower projects first, during normal and initial drought conditions. During severe droughts, Lake Lanier will support the majority of the system demands. The lower action zone elevations at West Point and Walter F. George lakes were not changed to reflect a linear drawdown relationship.

Figure 4.1-6 shows the Level 1 summer pool comparison of drainage area, storage contributions, and elevation ranges for Lake Lanier, and West Point and Walter F. George lakes for the four action zones.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-5. Lake Lanier Level 1 Action Zones.



1-Jun	Buford	West Pt	George	Buford2	West Pt3	George4	Total
	elev	elev	elev	dsf	dsf	dsf	dsf
Top1	1071.00	635.0	190.0	985747	304782	471093	
Bott1	1070.25	632.5	187.5	971302	273478	416593	
Diff.	0.75	2.5	2.5	14444	31304	54500	100249
				14.41%	31.23%	54.37%	% Zone 1
				14.19%	30.15%	55.66%	% drainage area

1-Jun	Buford	West Pt	George	Buford	West Pt	George	Total
	elev	elev	elev	dsf	dsf	dsf	dsf
Top2	1070.25	632.5	187.5	971302	273478	416593	
Bott2	1070.10	632.0	187.0	968413	267453	406106	
Diff.	0.15	0.5	0.5	2889	6025	10487	19401
				14.89%	31.06%	54.05%	% Zone 2
				14.19%	30.15%	55.66%	% drainage area

1-Jun	Buford	West Pt	George	Buford	West Pt	George	Total
	elev	elev	elev	dsf	dsf	dsf	dsf
Top3	1070.10	632.0	187.0	968413	267453	406106	
Bott3	1069.70	631.0	186.3	960770	255784	392025	
Diff.	0.40	1.0	0.7	7643	11669	14081	33393
				22.89%	34.94%	42.17%	% Zone 3
				14.19%	30.15%	55.66%	% drainage area

1-Jun	Buford	West Pt	George	Buford	West Pt	George	Total
	elev	elev	elev	dsf	dsf	dsf	dsf
Top4	1069.7	631	186.3	960770	255784	392025	
Bott4	1035.0	620	184	437415	150441	347875	
Diff.	34.7	11.0	2.3	523355	105343	44150	672848
				77.78%	15.66%	6.56%	% Zone 4
				14.19%	30.15%	55.66%	% drainage area

Notes: elev = elevation; dsf = day second feet.

Figure 4.1-6. Level 1 Action Zones for Buford, West Point, and Walter F. George Dams.

4.1.2.2.2.2 Revised Level 1 action zones

The Level 1 action zones were refined to better achieve the objective to define action zones on a scientific basis that eliminates disproportionate impact on reservoirs and addresses current system needs. At Lake Lanier, the summer period for zones 1, 2, and 3 was expanded to reflect proportionality of contributing watershed size and historic operations to meet system demands (Table 4.1-2). A comparison of the Lake Lanier summer zone elevations for current, Level 1, and Revised Level 1 options is shown in Table 4.1-3. The action zones reflected by Figure 4.1-7 achieve a more equitable balance between action zone sizing based on the project's watershed size and because they provide a proportionately balanced drawdown among the projects when operating in Zone 1. As the action zones were refined, generally they were revised upward in the winter months at Lake Lanier and at West Point Lake and downward in the summer months at Walter F. George Lake, as reflected in Figure 4.1-7, Figure 4.1-8, and Figure 4.1-9, respectively. The new zones fulfill the objectives of putting the greater burden of the system demands on the lower two reservoirs when in the upper action zones and on Lake Lanier when the system reaches drought operation.

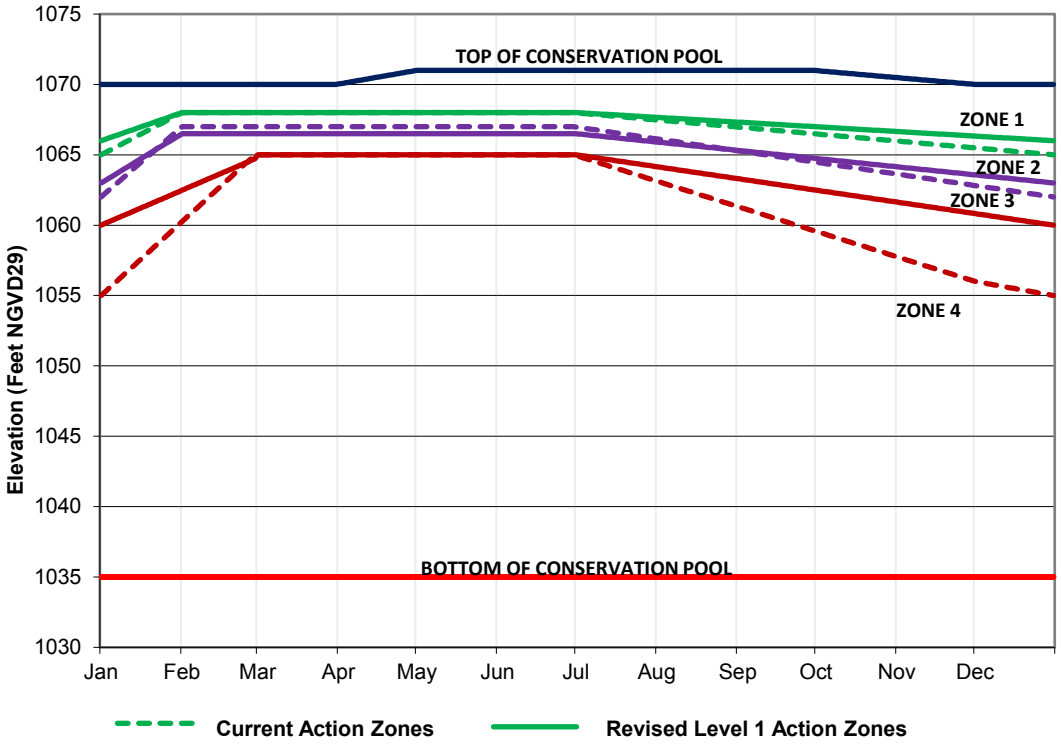
Figure 4.1-10 shows the Level 1 summer pool comparison of drainage area, storage contributions, and elevation ranges for Lake Lanier, and West Point and Walter F. George lakes for the four revised action zones.

Table 4.1-2.
Revised Level 1 Action Zones on June 1 (ft)

	Lake Lanier	West Point Lake	Walter F. George Lake
Top of Zone 1	1,071	635	190
Top of Zone 2	1,068	632.5	187.5
Top of Zone 3	1,066.5	632	187
Top of Zone 4	1,065	631	186.3

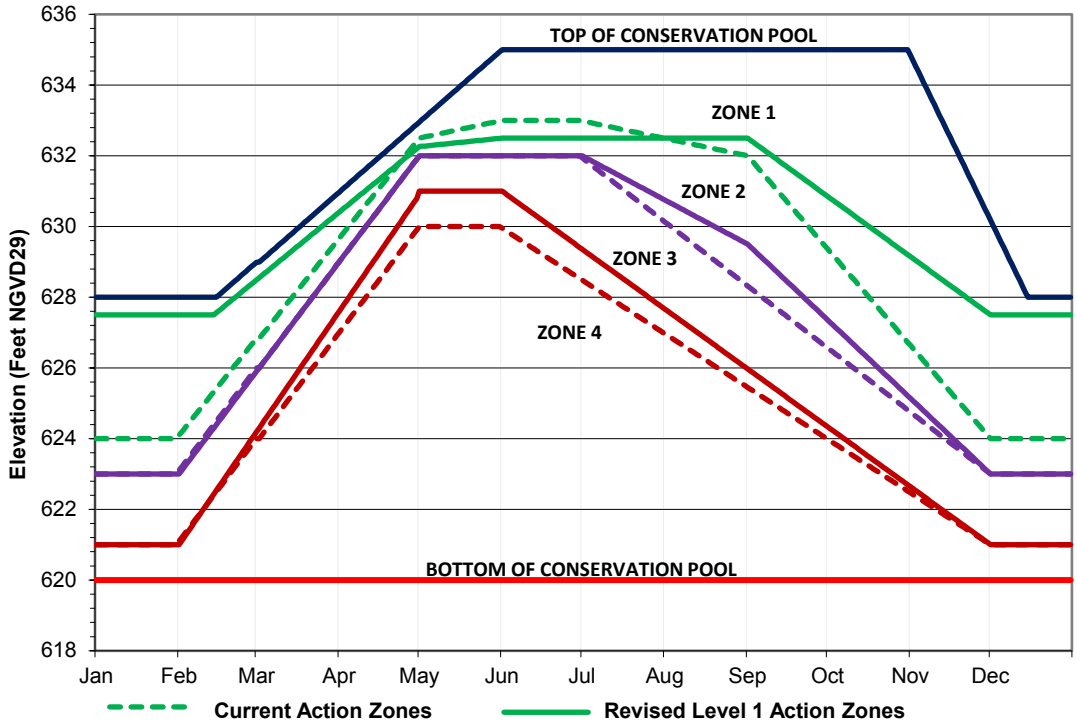
Table 4.1-3.
Lake Lanier Action Zone on June 1 (ft)

	Current	Level 1	Revised Level 1
Top of Zone 1	1,071	1071	1,071
Top of Zone 2	1,068	1070.25	1,068
Top of Zone 3	1,067	1070.1	1,066.5
Top of Zone 4	1,065	1069.7	1,065



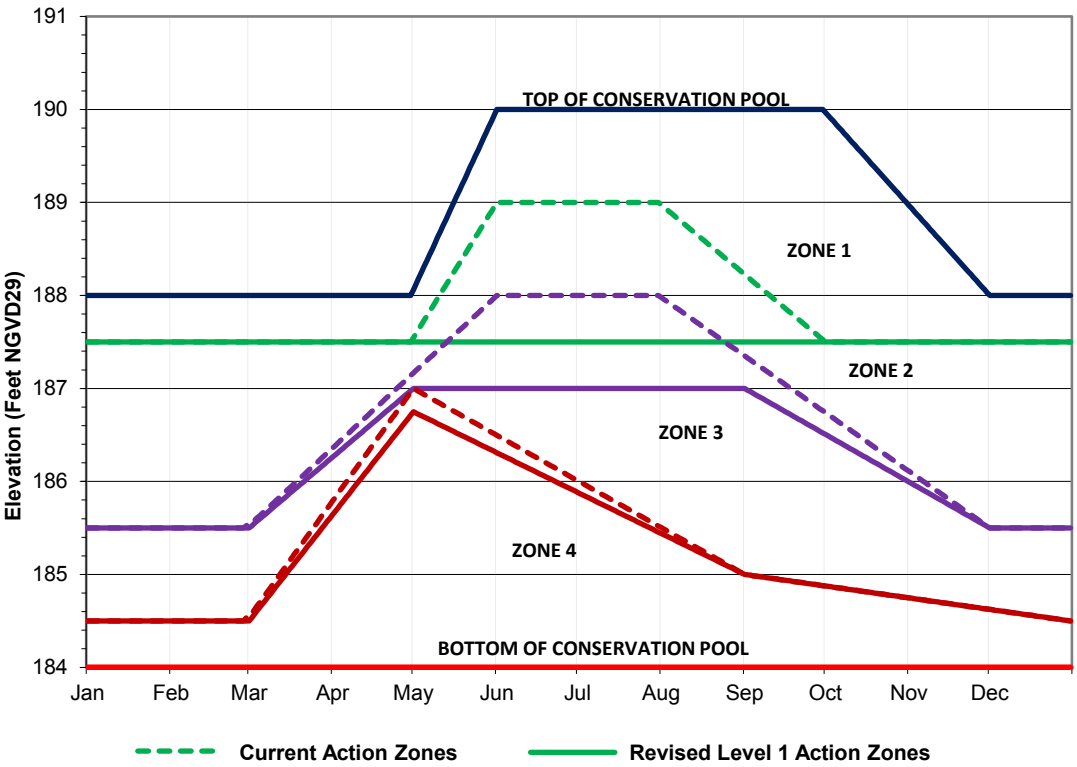
Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-7. Lake Lanier Water Control Action Zones.



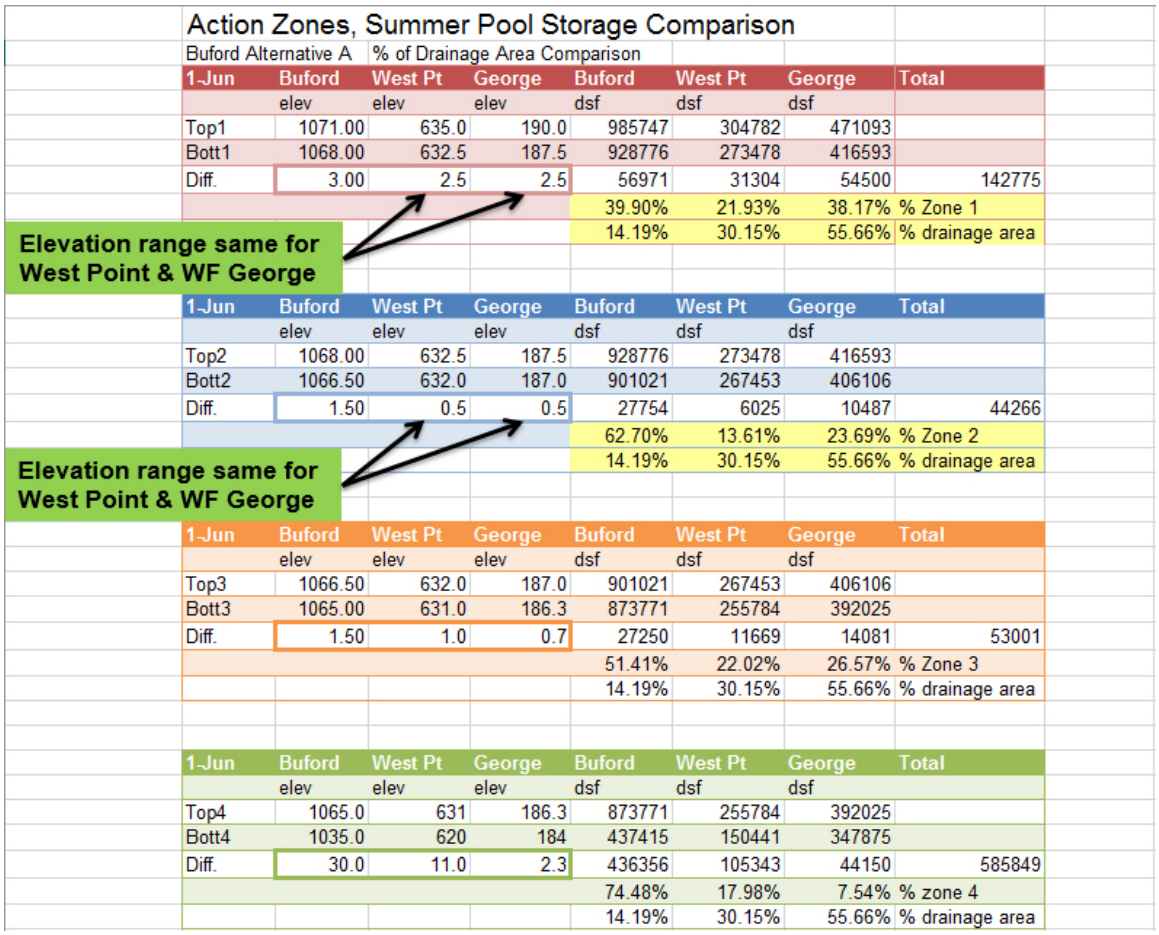
Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-8. West Point Lake Water Control Action Zones.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-9. Walter F. George Lake Water Control Action Zones.



Action Zones, Summer Pool Storage Comparison

Buford Alternative A | % of Drainage Area Comparison

1-Jun	Buford elev	West Pt elev	George elev	Buford dsf	West Pt dsf	George dsf	Total	
Top1	1071.00	635.0	190.0	985747	304782	471093		
Bott1	1068.00	632.5	187.5	928776	273478	416593		
Diff.	3.00	2.5	2.5	56971	31304	54500	142775	
				39.90%	21.93%	38.17%	% Zone 1	
				14.19%	30.15%	55.66%	% drainage area	

Elevation range same for West Point & WF George

1-Jun	Buford elev	West Pt elev	George elev	Buford dsf	West Pt dsf	George dsf	Total	
Top2	1068.00	632.5	187.5	928776	273478	416593		
Bott2	1066.50	632.0	187.0	901021	267453	406106		
Diff.	1.50	0.5	0.5	27754	6025	10487	44266	
				62.70%	13.61%	23.69%	% Zone 2	
				14.19%	30.15%	55.66%	% drainage area	

Elevation range same for West Point & WF George

1-Jun	Buford elev	West Pt elev	George elev	Buford dsf	West Pt dsf	George dsf	Total	
Top3	1066.50	632.0	187.0	901021	267453	406106		
Bott3	1065.00	631.0	186.3	873771	255784	392025		
Diff.	1.50	1.0	0.7	27250	11669	14081	53001	
				51.41%	22.02%	26.57%	% Zone 3	
				14.19%	30.15%	55.66%	% drainage area	

1-Jun	Buford elev	West Pt elev	George elev	Buford dsf	West Pt dsf	George dsf	Total	
Top4	1065.0	631	186.3	873771	255784	392025		
Bott4	1035.0	620	184	437415	150441	347875		
Diff.	30.0	11.0	2.3	436356	105343	44150	585849	
				74.48%	17.98%	7.54%	% zone 4	
				14.19%	30.15%	55.66%	% drainage area	

Figure 4.1-10. Revised Level 1 Action Zones for Buford, West Point, and Walter F. George Dams.

4.1.2.3 Drought Operations

4.1.2.3.1 Current Drought Operations

As lake levels decline, Action Zones 2 through 4 define increasingly critical system water shortages, and guide USACE in reducing flow releases as pool levels drop as a result of drier than normal or drought conditions. The Action Zones also provide a guide to USACE to help balance the remaining storage in each of the three major storage reservoirs. The current drought plan specifies a minimum release from Jim Woodruff Lock and Dam and temporarily suspends the other minimum release and maximum fall rate provisions of the May 2012 RIOP until composite conservation storage (see Figure 2.1-40) within the basin is replenished to a level that can support them. The definition of composite conservation storage and its role in the implementation of drought operations are provided in the more detailed discussion of the RIOP in section 2.1.1.2.4.4. Under the current drought plan, the minimum discharge is determined in relation to composite conservation storage. The drought plan is *triggered* when composite conservation storage falls below the bottom of Zone 3 into Zone 4. At that time, all the composite conservation storage zones 1–3 provisions (i.e., seasonal storage limitations, maximum fall rate schedule, and minimum flow thresholds) are suspended and management decisions are based on the provisions of the drought plan. The drought plan includes a temporary waiver from the existing Master WCM to allow temporary storage above the winter pool guide curve at the Walter F. George and West Point projects if the opportunity presents itself and/or to begin spring refill operations at an earlier date in order to provide additional

conservation storage for future needs. It also provides for minimum releases less than 5,000 cfs from Jim Woodruff Lock and Dam.

The current drought plan prescribes two minimum releases based on composite conservation storage in Zone 4 and an additional zone referred to as the *Drought Zone* (Figure 2.1-40). The Drought Zone delineates a volume of water roughly equivalent to the inactive storage in Lake Lanier, West Point Lake, and Walter F. George Lake plus Zone 4 storage in Lake Lanier. When the composite conservation storage is within Zone 4 and above the Drought Zone, the minimum release from Jim Woodruff Lock and Dam is 5,000 cfs and all BI above 5,000 cfs that is capable of being stored may be stored.

Once the composite conservation storage falls into the Drought Zone, the minimum release from Jim Woodruff Lock and Dam is 4,500 cfs and all BI above 4,500 cfs that is capable of being stored can be stored. When transitioning from a minimum release of 5,000 cfs to 4,500 cfs, maximum fall rates will be limited to a 0.25-feet-per-day (ft/day) drop. The 4,500 cfs minimum release is maintained until composite conservation storage returns to a level above the top of the Drought Zone, at which time the 5,000 cfs minimum release is reinstated. Under the current May 2012 RIOP, the drought plan provisions remain in place until conditions improve to the point at which the composite conservation storage reaches a level above the top of Zone 2 (i.e., within Zone 1). During the drought operations, a monthly monitoring plan that tracks composite conservation storage to determine water management operations, with the first day of each month representing a decision point, will be implemented to determine which operational triggers are to be applied. In addition, recent climatic and hydrological conditions experienced and meteorological forecasts will be used to determine the set of operations to be used in the upcoming month. There is a special provision for the month of March under drought operation: If recovery conditions are achieved in February (after February 1), drought plan provisions will not be suspended until April 1, unless the level of composite conservation storage reaches the top of Zone 1 (i.e., all federal reservoirs are full) before March 1. When recovery conditions are achieved, the temporary drought plan provisions will be suspended and all the other provisions will be reinstated.

Under the current drought plan, when the remaining composite conservation storage is about 10 percent of the composite conservation storage, additional emergency actions might be necessary. When conditions have worsened to that extent, use of the inactive storage must be considered. For example, such an occurrence could be contemplated in the second or third year of a drought. Inactive storage zones have been designated for the three USACE projects with significant storage. The operational concept established for the extreme drought impact level and to be implemented when instituting the use of inactive storage is based on the following actions:

- Inactive storage availability will be identified to meet specific critical water use needs within existing project authorizations.
- Emergency uses will be identified in accordance with emergency authorizations and through stakeholder coordination. Typical critical water use needs within the basin are associated with public health and safety.
- Weekly projections of the inactive storage water availability to meet the critical water uses from Buford Dam downstream to the Apalachicola River will be used when making water control decisions regarding withdrawals and water releases from USACE reservoirs.
- The inactive storage action zones described in the drought contingency plan in appendix A will be instituted as triggers to meet the identified priority water uses (releases will be restricted as storage decreases).
- Dam safety considerations will always remain the highest priority. The structural integrity of the dams due to static head limitations (i.e., Jim Woodruff at 38.5 ft; George W. Andrews at 26 ft; and Walter F. George at 88 ft) will be maintained.

4.1.2.3.2 Drought Plan Revisions

Two potential revisions to the drought plan were considered and are described in the following sections.

4.1.2.3.2.1 Revised drought operations trigger

This measure would revise the trigger for initiating the drought plan. As described above, the May 2012 RIOP provides that the drought plan is triggered when composite conservation storage falls below the bottom of Zone 3 into Zone 4. The *revised drought operations trigger* measure initiates the drought plan when composite conservation storage falls below the bottom of Zone 2 into Zone 3. This modification facilitates a more proactive approach to drought management to better ensure that storage is available to meet all project purposes throughout a prolonged drought period worse than has been realized to date.

4.1.2.3.2.2 Revised drought operations suspension trigger

As noted in section 4.1.2.3, the May 2012 RIOP provides that the drought plan provisions remain in place until conditions improve to the point at which the composite conservation storage reaches a level above the top of Zone 2 (i.e., within Zone 1). The *revised drought operations suspension trigger* measure keeps the drought plan provisions in place until conditions improve to the point at which the composite conservation storage reaches a level above the top of Zone 4 (i.e., within Zone 3). As with the current drought plan, a monthly monitoring plan that tracks composite conservation storage to determine water management operations, with the first day of each month representing a decision point, will be implemented to determine which operational triggers are applied. There is a special provision for the month of March under drought operation: If recovery conditions are not achieved in February, (after February 1), drought plan provisions will not be suspended until April 1, unless the level of composite conservation storage reaches the top of Zone 1 (i.e., all federal reservoirs are full) before March 1.

4.1.2.4 Minimum Flows at Peachtree Creek

Three measures have been considered regarding minimum flows at Peachtree Creek and are described in subsequent sections.

4.1.2.4.1 Current Minimum Flow (750 cfs at Peachtree Creek)

This measure involves continuing to make releases from Buford Dam in accordance with the CRMS as described in the *Apalachicola Basin Reservoir Regulation Manual*, appendix B, Buford Dam (Lake Sidney Lanier) Chattahoochee River, Georgia, February 1991, which calls for discharges from Buford Dam sufficient to allow for downstream water supply withdrawals and to ensure a continuous net minimum flow of 750 cfs at Peachtree Creek for water quality purposes. USACE currently makes releases from Buford Dam to provide sufficient flows for water quality at Peachtree Creek, accounting for water supply withdrawals between Buford Dam and Peachtree Creek, pursuant to the CRMS. In accordance with the CRMS, GAEPD and the water supply providers manage discharges and withdrawals downstream of Buford Dam to ensure that a minimum flow of 750 cfs at Peachtree Creek is maintained.

4.1.2.4.2 Revised Minimum Flow (750 cfs [May–October]/650 cfs [November–April] at Peachtree Creek)

GAEPD, which manages Clean Water Act (CWA) compliance for the State of Georgia, has on occasion requested that USACE consider seasonal varying flow. In 2008, USACE conducted environmental analyses that concluded that 650 cfs during November through April would not have significant adverse effects on water quality and is a reasonable flow during the cooler months, to which GAEPD agreed. This measure is similar to the current minimum flow measure, except that GAEPD and the water supply

providers would manage discharges and withdrawals downstream of Buford Dam to ensure that a minimum flow of 750 cfs at Peachtree Creek is maintained from May–October and 650 cfs November–April.

4.1.2.4.3 Varying Monthly Flow

This measure specifies a minimum flow at Peachtree Creek for each month of the year that varies depending on reservoir composite conservation storage zone. These minimum flows are shown in Table 4.1-4.

Table 4.1-4.
Minimum Flows for Chattahoochee River at Peachtree Creek

Month	Composite Conservation Storage Zone 1	Composite Conservation Storage Zone 2	Composite Conservation Storage Zone 3	Composite Conservation Storage Zone 4
January	1,910	750	650	650
February	2,270	1,170	650	650
March	2,470	1,390	750	650
April	2,400	1,470	750	650
May	2,130	750	750	650
June	1,610	750	750	650
July	1,330	750	750	650
August	1,220	750	750	650
September	1,010	750	650	650
October	1,020	750	650	650
November	1,200	750	650	650
December	1,410	750	650	650

4.1.2.5 Hydroelectric Power Generation

Four specific measures were considered for operations of hydroelectric power generation:

- Current schedule at Buford Dam
- Modified schedule at Buford Dam
- Hydroelectric power drought operations
- Modified schedule at Buford Dam with hydroelectric power drought operations

4.1.2.5.1 Current Schedule

The Buford, West Point, and Walter F. George projects are operated as *peaking* plants and provide electricity during the peak demand periods of each day and week. Typically, those projects provide a minimum of 2 hours of generation a day for 5 days a week at plant capacity throughout the year, as long as their respective lake levels are in the conservation pool. During dry periods, as the lake levels drop below Zone 1, hydroelectric power generation is reduced proportionally as pool levels decline to as low as 2 hours per day generation at each peaking plant project during extreme low flow conditions. Peak

generation could be eliminated or limited to conjunctive releases during severe drought conditions. The typical, but not required, hours of operation by action zone are presented in Table 4.1-5.

Table 4.1-5.
Typical Hours of Peaking Hydroelectric Power Generation by USACE Project

Project Action Zone	Buford Dam (hours of operation)	West Point Dam (hours of operation)	Walter F. George Lock and Dam (hours of operation)
Zone 1	3	4	4
Zone 2	2	2	2
Zone 3	2	2	2
Zone 4	0	0	0

In addition to hydroelectric power generation being governed by action zone, physical limitations also factor into the power generation decisions. The main hydroelectric power generation units and small house unit intakes at Buford Dam are at elevation 919 ft. However, severe cavitation occurs in the main hydroelectric power generation units when the water surface falls to 1,035 ft or below, at which time the units are taken out of service and generation ceases. The small house unit goes off-line when water elevations reach 1,020 ft or lower. With this measure, the current hydroelectric power generation schedule would be maintained.

4.1.2.5.2 Modified Schedule at Buford, West Point, and Walter F. George Dams

USACE considered varying the amount of generation it would plan to provide for each action zone at each project. For instance, rather than have a fixed generation schedule as shown in Table 4.1-5, USACE examined the viability of a variable schedule (e.g., 0 to 4 hours would be made available when in Zone 1).

4.1.2.5.3 Hydroelectric Power Drought Operations

Similarly, USACE considered reducing the amount of generation that would be made available when operating under drought protocols. Conservation storage at Lake Lanier is much more sensitive to hydroelectric power generation operations because of the small drainage area upstream of Buford Dam from which the reservoir is refilled, particularly under drought conditions. The modified generation schedule, especially at Lake Lanier, would provide greater operational flexibility to meet power demands in the system while conserving storage as variable climate conditions might dictate.

4.1.2.5.4 Modified Schedule with Hydroelectric Power Drought Operations

This measure combines the measures described in sections 4.1.2.5.2 and 4.1.2.5.3 by modifying the general hydroelectric power generation schedule for Buford, West Point, and Walter F. George Dams to call for a more flexible generation schedule in all action zones under nondrought conditions and a more constrained generation schedule under drier conditions. The proposed typical hours represent releases that normally meet water system demands and provide the capacity specified in power marketing arrangements. During dry periods, generation could be eliminated or limited to conjunctive releases. Table 4.1-6 depicts the proposed modifications to the typical, but not required, hours of operation by action zone.

Table 4.1-6.
Proposed Typical Hours of Peaking Hydroelectric Power Generation by USACE Project

Project Action Zone	Buford Dam (hrs of operation) Normal Ops/Drought Ops	West Point Dam (hrs of operation)	Walter F. George Lock and Dam (hrs of operation)
Zone 1	3/2	4	4
Zone 2	2/1	2	2
Zone 3	2/1	2	2
Zone 4[a]	0	0	0

Note:
[a.] While hydropower would still be generated in Zone 4, it could not be generated on a regular peaking schedule under severe drought conditions.

4.1.2.6 Navigation

The existing project authorizes a 9-ft-deep by 100-ft-wide waterway from Apalachicola, Florida, to Columbus, Georgia, on the Chattahoochee River, and to Bainbridge, Georgia, on the Flint River. Historically, it has been difficult for USACE to provide reliable navigation on the ACF system even with dredging. USACE has not dredged on the Apalachicola River since 2001 for a multitude of reasons (see section 2.1.1.2.4.3), including Florida's denial of water quality certification for dredging in 2005. Limited dredging occurred on the Chattahoochee River between Lake Seminole and Columbus, Georgia, in 2010. Anticipating that such conditions and restrictions will not change in the immediate future, USACE explored several options to provide the most reliable navigation season possible within the constraints of water availability and a lack of dredging. USACE used updated channel survey data, taken during 2009, for the Apalachicola River when developing measures for navigation.

The objective to increase the reliability of navigation on the ACF system by including operational measures to provide sufficient flows to support a defined, albeit limited, navigation season was intended to provide the opportunity for commercial navigation to occur, not to ensure that some sustainable level of commercial navigation would necessarily return to the system. The conditions conducive to the use of the navigation channel might be improved by the potential measures described below, but the individual shippers would be responsible for deciding to use the increased channel availability. Use of the waterway under any water management alternative that would include measures to improve navigation reliability would likely be shipment-specific and opportunistic, and not subject to traditional navigation benefit estimation techniques.

4.1.2.6.1 Current-No Navigation Operations

The lack of dredging and routine maintenance discussed in section 2.6.2. has led to inadequate depths in the Apalachicola River navigation channel, and commercial navigation is possible only seasonally when flows in the river are naturally high, with flow support for navigation suspended during drier times of the year. Specific navigation operations occur on a case-by-case basis, with limited releases for navigation being made for special shipments when a determination can be made that other project purposes will not be significantly affected and any fluctuations in reservoir levels or river stages will be minimal. Over a period of months, the navigation industry in the ACF Basin works closely with USACE to coordinate the special shipments. Under this measure, the current operations in support of navigation would remain in effect unchanged.

4.1.2.6.2 Periodic Navigation

Measures that explored navigation opportunities at several intervals and of various durations throughout the year—conceptually a minimum 2-week period—were developed on the basis of system composite conservation storage. In developing this option, USACE also considered the different number of opportunities that might be possible allowing sufficient flows if dredging did or did not occur at channel depths of 7 ft or 9 ft.

4.1.2.6.3 Defined Navigation Seasons

Another measure considered having definite navigation seasons. Three variations were considered: December–May, January–April, and January–May. In developing this measure, USACE balanced use of storage for navigation versus the use of storage for other authorized project purposes and considered the effects on other needs and requirements in the system (e.g., hydroelectric power generation, recreation). After multiple modeling iterations and analysis, it was determined that navigation operations are feasible only when composite conservation storage is in Zone 1 or 2. That was determined by assessing how often implementation of a navigation concept would trigger drought operations and by assessing the frequency of channel availability.

4.1.2.6.4 4-month /5-month Navigation Seasons (7-ft channel)

A variation of the defined navigation season measure specifies the navigation season as 4 months in duration or, under certain conditions, 5 months. When supported by ACF Basin hydrologic conditions, this measure would provide a reliable navigation season. In so doing, the goal of the water management is to ensure a predictable minimum navigable channel in the Apalachicola River for a continuous period that is sufficient for navigation use.

Assuming basin hydrologic conditions allow, a typical navigation season would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May). During the navigation season, the flows (16,200 cfs) at the Blountstown, Florida, USGS gage should be adequate to provide at least a 7-ft channel. The most recent channel survey and discharge-stage rating was used to determine the flow required to sustain a minimum navigation depth during the navigation season.

The ability to support a navigation season will depend on actual and projected systemwide conditions in the ACF Basin before and during January, February, March, April, and May. Those conditions include:

- A navigation season can be supported only when the ACF Basin composite conservation storage is in Zone 1 or Zone 2.
- A navigation season will not be supported when the ACF Basin composite conservation storage is in Zone 3 and below. Provided drought operations have not been triggered, navigation support will resume when basin composite conservation storage level recovers to Zone 1 and is forecast to remain above Zone 2 for a practicable, continuous period.
- A navigation season will not be supported when drought operations are in effect. Navigation will not be supported after drought operations have ceased until the ACF Basin composite conservation storage recovers to Zone 1.
- The determination to extend the navigation season beyond April will depend on ACF BIs, recent climatic and hydrological conditions, meteorological forecasts, and basinwide model forecasts. On the basis of an analysis of those factors, USACE will determine if the navigation season will continue through part or all of May.

- Down-ramping of flow releases (regardless of period in the navigation season) will adhere to the Jim Woodruff Lock and Dam fall rate schedule for federally listed threatened and endangered species.
- Releases that augment the flows to provide for the 7-ft navigation channel will also be dependent on navigation channel conditions that ensure safe navigation.

When it becomes apparent that, because of diminishing inflows, downstream flows and depths must be reduced, navigation bulletins will be issued to project users. The notices will be issued as expeditiously as possible to give barge owners and other waterway users sufficient time to make arrangements to light load or remove their vessels before action is taken at Jim Woodruff Lock and Dam to reduce releases.

Though special releases will not be standard practice, they can occur for a short duration to assist navigation during the navigation season. For instance, releases can be requested to achieve up to a 9-ft channel. Those will be evaluated case by case, subject to applicable laws and regulations and the conditions above.

4.1.2.6.5 Year-round Navigation

A fourth measure that USACE considered is year-round navigation. This measure, suggested by a stakeholder, would require flow augmentation (i.e., releases from upstream reservoirs to supplement flows in the Apalachicola River to provide navigable depths). Flow augmentations of 1,000–3,000 cfs were considered. Table 4.1-7 provides the rules used for making release decisions from Jim Woodruff Lock and Dam. The flow requirements to provide 7-, 8-, and 9-ft navigation depths are listed at the bottom of the table.

Table 4.1-7.
Navigation Rule from Jim Woodruff Lock and Dam

Months	Composite Conservation Storage Zone	Basin Inflow (cfs)	Release from Jim Woodruff Lock and Dam (cfs)
Mar–May	Zone 1	>=34,000	=25,000
		>=min(16,000;9-ft NavQ-9-ft Augmentation)	=max(16,000+50%BI>16,000;9-ft NavQ)
		>=8-ft NavQ-8-ft Augmentation	=8-ft NavQ
		>=7-ft NavQ-7-ft Augmentation	=7-ft NavQ
		>=5,000 and <7-ft NavQ- 7-ft Augmentation	=BI
		<5,000	=5,000
	Zone 2	>=34,000	=25,000
		>=min(16,000;9-ft NavQ-9-ft Augmentation)	=max(16,000+50%BI>16,000;9-ft NavQ+50%BI>9-ft NavQ)
		>=8-ft NavQ-8-ft Augmentation	=8-ft NavQ
		>=7-ft NavQ-7-ft Augmentation	=7-ft NavQ
		>=5,000 and <7-ft NavQ- 7-ft Augmentation	=BI
		<5,000	=5,000
	Zone 3	>=39,000	=25,000
		>=9-ft NavQ-9-ft Augmentation	= 9-ft NavQ+50%BI>9-ft NavQ
		>=8-ft NavQ-8-ft Augmentation	=8-ft NavQ
		>=7-ft NavQ-7-ft Augmentation	=7-ft NavQ
		>=5,000 and <7-ft NavQ- 7-ft Augmentation	=BI
		<5,000	=5,000
Jun–Nov	Zones 1, 2, and 3	>=22,000	=max(16,000;9-ft NavQ)
		>=9-ft NavQ-9-ft Augmentation	=9-ft NavQ
		>=8-ft NavQ-8-ft Augmentation	=8-ft NavQ
		>=7-ft NavQ-7-ft Augmentation	=7-ft NavQ
		>=10,000 and <7-ft NavQ- 7-ft Augmentation	=10,000 + 50% BI>10,000
		>=5,000 and <10,000	=BI
		<5,000	=5,000
Dec–Feb	Zones 1, 2, and 3	>=9-ft NavQ-9-ft Augmentation	=9-ft NavQ
		>=8-ft NavQ-8-ft Augmentation	=8-ft NavQ
		>=7-ft NavQ-7-ft Augmentation	=7-ft NavQ
		<7-ft NavQ-7-ft Augmentation	=5,000
At all times	Zone 4	NA	=5,000 (store all BI>5,000)
At all times	Drought Zone	NA	=4,500 (store all BI>4,500)[a]

Notes:
[a.] Once composite conservation storage falls below the top of the USACE Drought Zone ramp down:
9-ft NavQ = 18,800 cfs=BlountstownQ=20,600 cfs
8-ft NavQ = 17,400 cfs=BlountstownQ=18,300 cfs
7-ft NavQ = 16,100 cfs=BlountstownQ=16,200 cfs

4.1.2.7 Basin Inflow

BI is a parameter used in making decisions regarding releases from Jim Woodruff Lock and Dam under various circumstances. The following BI measures were considered:

- Current BI Computational Methodology
- Revised BI Method 1
- Revised BI Method 2

4.1.2.7.1 Current Basin Inflow Computational Methodology

BI is currently defined as the amount of water that would flow by Jim Woodruff Lock and Dam during a given time period if all of the USACE reservoirs maintained a constant water surface elevation during that period. BI is not the natural, or *unimpaired*, flow of the basin at the site of Jim Woodruff Lock and Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses (e.g., M&I water supply and agricultural irrigation). As noted in section 1.4, some stakeholders have suggested that alternative methods for computing BI be considered. ACF BI is currently computed by adding the local flow into the four USACE projects: Lake Lanier (Buford Dam), West Point Lake (West Point Dam), Walter F. George Lake (Walter F. George Lock and Dam), and Lake Seminole (Jim Woodruff Lock and Dam):

> ACF BI = Buford Local Flow + West Point Local Flow + Walter F. George Local Flow + Jim Woodruff Local Flow

Where:

> Local Flow = Computed Inflow – Upstream Dam Discharge
> Computed Inflow = Dam Discharge + Change in Reservoir Storage
> Buford Local Flow *i* = Buford Computed Inflow *i*
> West Point Local Flow *i* = West Point Computed Inflow *i* – Buford Discharge *i*-3
> Walter F. George Local Flow *i* = Walter F. George Computed Inflow *i* – West Point Discharge *i*-2
> Jim Woodruff Local Flow *i* = Jim Woodruff Computed Inflow *i* – Walter F. George Discharge *i*-1
> Where *i* is the current daily time step.

4.1.2.7.2 Revised Basin Inflow Method 1

Revised basin inflow—or RBI—is an alternative method of calculating BI suggested by a stakeholder that adds depletions to BI as described in section 4.1.2.7.1. RBI is not true BI, but is intended to estimate inflow that would have resulted in the absence of reservoirs and withdrawals for M&I and agricultural water supply demands. According to the revised method:

> Real-time RBI = Real-time net-BI + typical* dry, normal, or wet year M&I demands, agricultural demands, and evaporation losses for the given month
>
> * Typical demands and evaporation losses would be based on the most current summary of demands, similar to Table 4.1-8.

For modeling purposes, each year in the 1939–2012 period of record has been characterized as dry, normal, or wet, as shown in Table 4.1-9, consistent with the methodology developed by the technical team representatives from USACE and the three states as part of the ACT/ACF Comprehensive Study.

Table 4.1-8.
Summary of Depletions (cfs) To Basin Inflow Upstream of Jim Woodruff Lock and Dam Used in Revised Basin Inflow—Method 1

	Municipal and Industrial				Agriculture				Reservoir Evaporation				Total			
	Dry	Normal	Wet	All Years	Dry	Normal	Wet	All Years	Dry	Normal	Wet	All Years	Dry	Normal	Wet	All Years
Jan	334	300	331	312	1	1	0	1	-183	-279	-415	-273	152	22	-85	40
Feb	302	263	295	276	23	3	0	7	-78	-159	-168	-141	246	107	127	142
Mar	345	254	257	276	94	41	31	53	153	-39	-197	-12	592	257	92	316
Apr	453	332	317	359	212	103	83	126	567	389	194	408	1231	825	594	883
May	615	457	340	480	586	344	292	395	672	573	338	569	1873	1374	970	1444
Jun	715	494	406	536	793	439	368	514	666	485	329	509	2173	1419	1104	1559
Jul	700	525	382	550	903	587	506	651	477	387	-61	356	2080	1499	827	1557
Aug	710	532	429	562	955	578	486	658	484	409	321	416	2149	1519	1236	1634
Sep	592	500	485	520	672	328	259	401	418	358	478	386	1682	1186	1222	1307
Oct	552	466	461	486	251	130	105	156	316	315	265	310	1119	912	831	951
Nov	435	378	388	392	192	90	70	112	33	-128	66	-67	660	339	525	437
Dec	399	337	358	354	168	79	62	98	-130	-186	-63	-158	437	230	356	293
Avg	514	404	371	426	406	228	180	266	284	179	91	193	1204	811	652	885

Source: USFWS Biological Opinion May 22, 2012—Table 3.2.1.A.

Table 4.1-9.
Types of Years for Purposes of Computing Revised Basin Inflow—Method 1

Year	Type[a]	Year	Type [a]	Year	Type [a]	Year	Type [a]
1939	N	1958	W	1977	N	1996	N
1940	N	1959	N	1978	N	1997	N
1941	D	1960	N	1979	N	1998	N
1942	N	1961	N	1980	N	1999	D
1943	N	1962	N	1981	D	2000	D
1944	W	1963	N	1982	N	2001	N
1945	N	1964	W	1983	N	2002	N
1946	W	1965	W	1984	N	2003	W
1947	W	1966	N	1985	N	2004	N
1948	W	1967	N	1986	D	2005	N
1949	W	1968	D	1987	N	2006	D
1950	N	1969	N	1988	D	2007	D
1951	D	1970	N	1989	N	2008	N
1952	N	1971	W	1990	D	2009	N
1953	W	1972	N	1991	W	2010	N
1954	D	1973	W	1992	N	2011	D
1955	D	1974	N	1993	N	2012	D
1956	D	1975	W	1994	W		
1957	N	1976	N	1995	N		

Notes: [a] W=wet year; N=normal year; D=dry year.

Using this methodology in practical applications would require that demand summaries be updated frequently (every 1–2 years) as water use demands change over time and as better information about demands and depletions becomes available. Dry, normal, and wet values should be selected based on an assessment of the current climatological data and drought outlook. Periodic adjustments would be required as more information about depletions becomes available.

4.1.2.7.3 Revised Basin Inflow Method 2

This method of computing BI would track observed flow in the Apalachicola River at Chattahoochee, Florida, and add considerations of storage change in Lake Lanier, West Point Lake, Walter F. George Lake, and Jim Woodruff Lock and Dam. Positive storage change represents a net increase in total composite conservation storage, and negative change represents a net decrease.

4.1.2.8 Fish and Wildlife Conservation

Measures considered for fish and wildlife conservation included current USACE operations and recommendations provided by USFWS in the following documents:

- Planning Aid Letter (PAL) dated April 2, 2010 and Addendum dated March 1, 2011
- Draft Fish and Wildlife Coordination Act Report (FWCAR) dated June 17, 2011
- Scoping letter date January 11, 2013
- PAL dated August 29, 2013
- Draft FWCAR dated July 31, 2015
- Final FWCAR dated September 14, 2016

Current fish and wildlife operations considered in developing alternatives for the updated Master Manual included the following:

- Lake and river fish spawn standard operating procedures (SOPs)
- Fish passage lockages at Jim Woodruff Lock and Dam
- May 2012 RIOP for federally listed threatened and endangered species

The USFWS Planning Aid Letter dated April 2, 2010 included recommendations for developing alternatives and mitigation, hydrologic modeling, and methods used to evaluate the effects of USACE alternatives (USFWS 2010). Measures considered by USACE from the USFWS letter included the following:

- Seasonally varying baseflow
- Small pulses or nonhydroelectric power peaking
- Fish passage at the George W. Andrews Lock and Dam and the Walter F. George Lock and Dam
- Manage Walter F. George Lake for the Eufaula National Wildlife Refuge (NWR)
- Revisions to operations for federally listed threatened and endangered species in the Apalachicola River

4.1.2.8.1 Continue Existing Reservoir and River Fish Spawn Standard Operating Procedures

This measure provides that USACE would continue to operate the federal reservoir system to support favorable conditions for annual fish spawning, both in the reservoirs and the Apalachicola River as reflected in South Atlantic Division Regulation (DR) PDS-O-1, *Project Operations, Lake Regulation and*

Coordination for Fish Management Purposes (May 31, 2010), and draft USACE, Mobile District SOP 1130-2-9, *Reservoir Regulation and Coordination for Fish Spawn Management Purposes* (February 2005). In most water years (i.e., October 1 to September 30), it is impossible to hold both lake levels and river stages at a steady or rising level for the entire spawning period, especially when upstream reservoirs or the Apalachicola River spawning periods overlap. During the fish spawning period for each water body (Table 4.1-10), USACE's goal is to operate for a generally stable or rising lake level and a generally stable or gradually declining river stage on the Apalachicola River for approximately 4 to 6 weeks during the designated spawning period. When climatic conditions preclude a favorable operation for fish spawn, USACE consults with the state fishery agencies and USFWS on balancing needs in the system and minimizing the effects of fluctuating lake or river levels.

Table 4.1-10.
Project-Specific Principal Fish Spawning Period

Project	Fish Spawn Period
Lake Lanier	April 1–June 1
West Point Lake	April 1–June 1
Walter F. George Lake	March 15–May 15
Lake Seminole	March 1–May 1
Apalachicola River	April 1–June 1

4.1.2.8.2 Continue Fish Passage Lockages at Jim Woodruff Lock and Dam

In most years since March–May 2005, USACE has operated the lock at Jim Woodruff Lock and Dam to facilitate downstream-to-upstream passage of Alabama shad and other anadromous fishes (i.e., those that return from the sea to the rivers where they were born to breed). There are slight differences in the locking technique each year. In general, however, two fish locking cycles are performed each day between 8 a.m. and 4 p.m.; one in the morning and one in the afternoon. The operation consists of opening the lower lock gates and getting fish into the lock in one of three ways—by transporting them into the lock by boat (2005), by using attraction flows to entice the fish into the lock (2006–2007 and 2010–2012), and by leaving the lower gate open for a period before a lockage and allowing the fish to move in without an attraction flow (2008). No lockages were done in 2009. Once the fish are in the lock (or assumed to be in the lock), the downstream doors are closed. The lock is filled to the reservoir elevation and the upper gates are opened. Studies are ongoing to determine the most appropriate technique and timing for the locks, but the number of lock cycles per day will not change. Under this measure, the current fish passage operation would remain in effect unchanged.

4.1.2.8.3 Continue Existing Endangered Species Operations (May 2012 RIOP)

This measure includes all of the provisions in the May 2012 RIOP, which is described in detail in section 2.1.1.2.4.4.

4.1.2.8.4 Seasonally Varying Baseflows

USACE evaluated the feasibility of providing a seasonally varying baseflow hydrograph that would more closely approximate predam conditions (e.g., more closely simulate run-of-the-river, before impoundment conditions).

4.1.2.8.5 Small Pulses or Nonhydroelectric Power Peaking

This measure would provide increased flows through the hydroelectric power units during off-peak hours of the day without generating hydroelectric power (nonhydroelectric power peaking windows) during critical reproductive and rearing periods in the Chattahoochee River below Buford and West Point dams. USFWS requested nonhydroelectric power peaking windows for a minimum of 4 weeks March–May. During that period, the projects would release a continuous flow mimicking a nondam flow regime. This measure also includes high flow pulses in the late winter and early spring to ensure seasonal high flows and river-floodplain connectivity with the timing, frequency, duration, magnitude, and rate of change necessary to sustain ecological functions and wildlife populations.

4.1.2.8.6 Fish Passage at George W. Andrews Lock and Dam and Walter F. George Lock and Dam

This measure would provide fish passage at George W. Andrews Lock and Dam and Walter F. George Lock and Dam similar to that which currently occurs in the spring of the year at Jim Woodruff Lock and Dam.

4.1.2.8.7 Manage Walter F. George Lake for the Eufaula National Wildlife Refuge

Under this measure, a request by USFWS would be considered to cycle the reservoir between the highest levels (190 ft) in late winter/early spring to the lowest levels (185 ft) in late summer to accommodate Eufaula NWR operations.

4.1.2.8.8 Revisions to Federally Listed Threatened and Endangered Species Operations

The current operations for federally listed threatened and endangered species downstream from Jim Woodruff Lock and Dam are the result of several rounds of formal consultation with USFWS, including the RIOP implemented in June 2008. USACE reinitiated consultation on the RIOP in September 2010 based on new information about the distribution and mortality of endangered fat threeridge mussels (*Amblema neislerii*) in the Apalachicola River. A revised amended biological assessment (BA) describing a proposed action and its effects on listed species was submitted to USFWS on February 14, 2012. During the reinitiated consultation, opportunities to further avoid and minimize impacts to the federally listed endangered fat threeridge, and federally listed threatened purple bankclimber (*Elliptoideus sloatianus*) and Chipola slabshell (*Eliptio chipolaensis*) mussels, and their designated critical habitat in the Apalachicola River were considered. USACE examined measures for operations for federally listed threatened and endangered species in tandem with measures for drought operations because low flow conditions are critical for threatened and endangered species. The resulting May 2012 RIOP incorporated a drought operation that specifies a minimum release from Jim Woodruff Lock and Dam and temporarily suspends the other minimum release and maximum fall rate provisions until composite conservation storage in the basin is replenished to a level that can support normal operations. Under drought operations, the minimum discharge from Jim Woodruff Lock and Dam is determined in relation to composite conservation storage and not average BI. See section 2.1.1.2.4.4 for a more detailed discussion of consultation under section 7 of the Endangered Species Act (ESA).

During development of the WCM updates and EIS, USACE continued to coordinate and consult with USFWS to comply with both the Fish and Wildlife Coordination Act (FWCA) and the ESA. Revisions proposed as part of the Master WCM update process have been the subject of informal consultation with USFWS as they were developed. The proposed WCM updates are intended to improve system operations, including those for listed threatened and endangered species downstream from Jim Woodruff Lock and Dam. Documentation of coordination with the USFWS under the FWCA and consultation with USFWS under the ESA is provided in appendix J. After public review of the draft EIS, USACE prepared a draft

Biological Assessment (BA) on the effects of the PAA on listed species. The BA is included in appendix J of the final EIS. Formal consultation under the ESA was completed, and the USFWS issued a Biological Opinion to USACE on September 14, 2016. The ESA consultation process is summarized in section 6.4.4; the consultation did not result in appreciable changes to endangered species operations for the ACF Basin. Reasonable and prudent measures in the USFWS Biological Opinion to avoid and minimize take of listed species are incorporated into the Master WCM update process.

In addition to the current provisions of the May 2012 RIOP, USACE considered revisions to operations for federally listed threatened and endangered species in the Apalachicola River, which are described in the following sections.

4.1.2.8.8.1 Revised ramping rate (maximum fall rate)

Table 2.1-6 shows the maximum fall rate for discharges from Jim Woodruff Lock and Dam specified in the May 2012 RIOP. Revising the maximum fall rate was considered under this measure, as shown in Table 4.1-11.

Table 4.1-11.
Revised Maximum Fall Rate by Release Range for Composite Conservation Storage Zones 1–4 and Drought Zone

Approximate Release Range (cfs)	Maximum Fall Rate (ft/day), Measured at Chattahoochee Gage
> 30,000	No ramping restriction
Exceeds Powerhouse Capacity (~ 16,000) and ≤ 30,000[a]	0.5
Within Powerhouse Capacity (16,000) and > 8,000 [a]	0.25 to 0.5
Within Powerhouse Capacity (16,000) and ≤ 8,000 [a]	0.25

Note:
[a.] Including implementation in Composite Conservation Storage Zone 4.

4.1.2.8.8.2 Revised percent of basin inflow stored

The May 2012 RIOP allows 50 percent of BI to be stored under certain conditions of BI and the composite conservation storage zone, as shown in Table 2.1-5. Under this measure, changing the percent of BI stored under those conditions to 60 percent or 70 percent was considered.

4.1.2.8.8.3 Suspend ramping during prolonged low flow

This measure proposed that if BI has been less than 7,000 cfs for 30 days, the use of the ramping rate would be suspended and resumed when BI was greater than 10,000 cfs for 30 days.

4.1.2.8.8.4 Revised seasonal flows

This measure would revise the seasonal minimum flow provisions of the May 2012 RIOP by establishing flow provisions at the Chattahoochee, Florida, USGS gage in the Apalachicola River for three seasons of the year, as shown in Table 4.1-12:

- Spring (March–May, or spawning season)
- Summer and fall (June–November, or nonspawning season)
- Winter (December–February, or refill season)

Table 4.1-12.
Revised Seasonal Flows

Months	Total Composite Conservation Storage in Reservoirs	Basin Inflow (cfs) or other Conditions	State Line Flow (SLF) (cfs)	Basin Inflow to be Stored (cfs)
March	Zones 1, 2, and 3	NA	>=6,500	Entire or partial BI above SLF, subject to available storage capacity
Apr 1–May 31	Zones 1, 2, and 3	Cumulative BI in February and March > 2.45 million ac-ft	Maintain Q=min(10,500, min(observed moving 30-day flow))	Entire or partial BI above SLF, subject to available storage capacity
		Otherwise if BI>=10,500 If BI<10,500 and >= 5,000 If BI <5,000	>= 10,500 >= BI >= 5,000	
In subperiod Apr 16–30		Lanier>1,066' West Point>632' Walter F George >187'	Maintain Q=min(22,500,max(10,500, min(observed March 17-April 15 daily flow)))	Entire or partial BI above SLF, subject to available storage capacity
Jun–Nov	Zones 1, 2, and 3	BI>= 10,476 & previous 7 days' Chattahoochee gage flow<5,100	>= High Pulse flow (June 14,850, July 15,500, August 14,400, September 11,200, October 10,100, November 10,500), No rise & fall rate limit	Entire or partial BI above SLF, subject to available storage capacity
		BI>= 7,181 and < 10,476 and previous 7 days' Chattahoochee gage flow<5,100	>= Small Pulse flow (June 11,600, July 11,500, August 11,100, September 8,620, October 7,420, November 7,980), No rise & fall rate limit	Entire or partial BI above SLF, subject to available storage capacity
		Other situation	>=5,000	Entire or partial BI above 5,000, subject to available storage capacity
Dec–Feb	Zones 1, 2, and 3	NA	>=5,000	Entire or partial BI above 5,000, subject to available storage capacity
At all times	Zone 4	NA	>=5,000	Entire or partial BI above 5,000, subject to available storage capacity
At all times	Drought Zone	NA	>=4,500	Entire or partial BI above 5,000, subject to available storage capacity

4.1.2.8.8.5 Pulse flows

During the period June 1 through November 30, this measure provides that when the 1-day BI for the period is above its 25th percentile (roughly 7,200 cfs) a 1-day pulse flow corresponding to the 25th percentile daily flow would be made. When BI rises above its median (roughly 10,500 cfs) levels for the season, a pulse flow lasting one day and corresponding to median daily flow would be made. There would be an interval of 7 days between any two consecutive pulses. Table 4.1-12 provides the details of the magnitude of pulses and when they would occur.

4.1.2.8.8.6 Monthly flows

This measure would establish monthly flow provisions and minimum releases from Jim Woodruff Lock and Dam. If the 7-day BI exceeds the month/composite conservation storage zone figure shown in Table 4.1-13, the specified flow would be released from Jim Woodruff Lock and Dam. All BI in excess of the specified flow could be stored. If the BI does not exceed the month/composite conservation storage zone figure in Table 4.1-13 minus the composite conservation storage zone augmentation limit shown in Table 4.1-14, the release from Jim Woodruff Lock and Dam would be the greater of the month/zone minimum (see Table 4.1-15) or BI plus the composite conservation storage zone augmentation limit.

Table 4.1-13.
Monthly Flows (cfs) for Apalachicola River at Jim Woodruff Lock and Dam

Month	Composite Conservation Storage Zone 1	Composite Conservation Storage Zone 2	Composite Conservation Storage Zone 3	Composite Conservation Storage Zone 4
Jan	19,000	17,000	10,000	5,000
Feb	21,000	19,000	10,000	5,000
Mar	21,000	19,000	14,000	5,000
Apr	21,000	19,000	14,000	5,000
May	19,000	17,000	10,000	5,000
Jun	14,000	14,000	10,000	5,000
Jul	12,000	10,000	10,000	5,000
Aug	12,000	10,000	10,000	5,000
Sep	10,000	10,000	10,000	5,000
Oct	10,000	10,000	10,000	5,000
Nov	10,000	10,000	10,000	5,000
Dec	10,000	10,000	10,000	5,000

Table 4.1-14.
Augmentation Limits (cfs) for Apalachicola River at Jim Woodruff Lock and Dam

Month	Composite Conservation Storage Zone 1	Composite Conservation Storage Zone 2	Composite Conservation Storage Zone 3	Composite Conservation Storage Zone 4
Jan	2,000	0	1,000	0
Feb	4,000	2,000	2,000	0
Mar	4,000	2,000	3,000	0
Apr	4,000	2,000	3,000	0
May	2,000	4,000	2,000	0
Jun	2,000	2,000	1,000	0
Jul	2,000	2,000	1,000	0
Aug	2,000	2,000	1,000	0
Sep	0	1,500	1,000	0
Oct	0	1,500	1,000	0
Nov	0	1,500	1,000	0
Dec	0	1,500	1,000	0

Table 4.1-15.
Minimum Flows (cfs) for Apalachicola River at Jim Woodruff Lock and Dam

Month	Composite Conservation Storage Zone 1	Composite Conservation Storage Zone 2	Composite Conservation Storage Zone 3	Composite Conservation Storage Zone 4
Jan	17,000	17,000	5,000	5,000
Feb	17,000	17,000	5,000	5,000
Mar	17,000	17,000	8,000	5,000
Apr	17,000	17,000	8,000	5,000
May	17,000	10,000	8,000	5,000
Jun	12,000	8,000	5,000	5,000
Jul	10,000	7,000	5,000	5,000
Aug	10,000	7,000	5,000	5,000
Sep	10,000	6,000	5,000	5,000
Oct	10,000	5,000	5,000	5,000
Nov	10,000	6,000	5,000	5,000
Dec	10,000	8,000	5,000	5,000

4.1.2.8.8.7 Daily flows

This measure, used together with Revised BI Method 1 (described above), would establish a full suite of minimum flows based on historic exceedance values that vary with seasons, reservoir storage zones, and general inflow conditions (dry or normal/wet), as shown in Table 4.1-16.

Table 4.1-16.
Computation Methodology for Daily Flows

If composite conservation storage-P7 is:	And if RBI-P7 is in:	The average flow release-U7 is:	
		Minimum Flow	Plus Additional Flow
Zone 1 or 2	Mid-to-high range	80% exceedance-U7	50% of any RBI-P7 that exceeds minimum flow
	Low range	85% exceedance-U7	50% of any RBI-P7 that exceeds minimum flow
Zone 3 or 4	Mid-to-high range	90% exceedance-U7 with a minimum of 6,000 cfs	50% of any RBI-P7 that exceeds minimum flow
	Low range	95% exceedance-U7 with a minimum of 5,000 cfs	Mar-Nov: 50% of any RBI-P7 that exceeds minimum flow Dec-Feb: No additional release required
Drought Zone	All conditions	99% exceedance-U7 with a minimum of 5,000 cfs	No additional release required except 50% of storm pulses under certain conditions[a]

Notes:
[a.] Conditions when 50% of storm pulses are released are under review and will be included at a later time.
P7=for the last 7 days; RBI=revised basin inflow; U7=for the upcoming 7 days.
Mid-to-high range=>75% exceedance of 7-day rolling average unimpaired flow (1939–2008); low. range=<75% exceedance of 7-day rolling average unimpaired flow (1939–2008).

4.1.2.9 Water Supply

Based on the June 2011 ruling of the 11th Circuit Court of Appeals and the USACE legal opinion of June 25, 2012, USACE has concluded that it has sufficient authority under the original Buford Dam project authorization and the WSA of 1958 to accommodate both the current level of releases from Buford Dam and direct withdrawals from Lake Lanier for water supply. For the purpose of evaluating the performance of the water management alternatives, as stated in section 4, water supply operations reflected current (2007) water supply use, basinwide and at USACE reservoirs, pursuant to existing relocation contracts. At Lake Lanier, for modeling purposes, it was assumed that no withdrawals would occur other than 20 mgd associated with the relocation contracts for the cities of Buford and Gainesville.

Water supply withdrawals vary on both an average daily and annual basis, but for modeling purposes, a fixed demand was identified to allow for effective comparison of alternatives. The highest levels of basinwide water supply withdrawals occurred in 2007, during the 2006-2008 drought. Although basinwide withdrawals since 2007 have been lower overall, 2007 was selected as representative of *current* demand because using the highest recent figure provides the most conservative estimate of the storage available for all purposes, assuming the greatest amount of reasonably forecasted water supply demand, including during times of drought. The withdrawal figures used do not necessarily reflect the maximum withdrawals that could be made at any given time, nor does the USACE analysis guarantee that the modeling withdrawals can actually be made at all times. The following current water supply withdrawals from and returns to Lake Lanier and releases from Buford Dam in accordance with the CRMS and returns to the Chattahoochee River were considered:

- 20 mgd water withdrawals relocation contracts (with the cities of Buford and Gainesville) with a 50 percent return rate.
- Releases from Buford Dam to support current withdrawals (277 mgd) by Metro Atlanta water providers with an 82 percent return rate.

Water supply withdrawals will also continue to occur at West Point Reservoir pursuant to the relocation contract with the City of LaGrange in the amount of 20.96 mgd. In 2007, the city withdrew an annual average of 9.74 mgd.

4.1.3 Water Management Measures Eliminated from Detailed Evaluation (Second Screening)

The measures that passed the first screening were considered for each of the USACE reservoirs in the ACF Basin and the basin as a whole, and a preliminary evaluation was performed. When deciding which measures to consider in a more detailed evaluation, USACE assessed the results of the preliminary analysis against the screening criteria described in section 1.4. The following measures were eliminated from detailed evaluation:

- Modified Guide Curve at West Point
- Modified Guide Curve at Walter F. George Lake
- Level 1 Action Zones
- Modified Hydropower Schedule at Buford, West Point, and Walter F. George Dams
- Hydroelectric Power Drought Operations
- Periodic Navigation
- December–May Navigation Season
- January–April Navigation Season
- Seasonally Varying Baseflows
- Revised Percent of BI Stored
- Small Pulses or Nonhydroelectric Power Peaking

- Fish Passage at George W. Andrews Lock and Dam and Walter F. George Lock and Dam
- Operations to Manage Walter F. George Lake for the Eufaula NWR

The results of the preliminary evaluation and screening process in eliminating measures are described in the following paragraphs.

4.1.3.1 Revised Guide Curves

4.1.3.1.1 Modified Guide Curve at West Point Lake

In considering adjustments to the guide curve at West Point Lake, USACE considered several variations for adjusting the refill and drawdown periods, as shown in Figure 4.1-3. An hourly model (e.g., flows routed on an hourly rather than a daily basis) was developed using hypothetical storm hydrographs to assess the possible effects of the changes to refill and drawdown periods on downstream flooding. Based on this analysis, the options for changing the guide curve for West Point Lake were eliminated from further consideration because they would likely increase the flood risk downstream of the project.

4.1.3.1.2 Modified Guide Curve at Walter F. George Lake

In considering adjustments to the guide curve at Walter F. George Lake, USACE considered several variations for adjusting the refill and drawdown periods (guide curves), as shown in Figure 4.1-4. Those modifications included extending the summer pool elevation by adjusting the timing of the summer refill and fall drawdown and lowering the summer pool level to minimize the static head limitations. There is a 2-ft fluctuation between the winter level of 188 ft and the summer pool of 190 ft, which is equivalent to 83,700 ac-ft. The Walter F. George project is not authorized for flood risk management, and induced surcharge operations are used to release water during flooding conditions. Historically, there is variability in pool elevation between the summer and winter levels at Walter F. George Lake, and two factors are responsible for this variability.

- The Walter F. George project is the furthest downstream storage project and called on first to make releases that support needs at Jim Woodruff Lock and Dam and the Apalachicola River.
- The limited flood storage requires rapid response to high flow conditions and results in abrupt changes in the 2-ft range of storage.

The technical team reviewed the guide curves options and concluded that the options provide no substantial benefit above the current guide curve. No change is anticipated in the pool variability between the summer and winter levels, and changing the timing of refill and/or drawdown would not alter that fact. Adjustments were made to the refill and drawdown portions of the guide curve to better meet conservation goals without adverse effect on flood protection, but the adjustments were eliminated from further consideration because of minimal gains.

4.1.3.2 Level 1 Action Zones

Level 1 action zone modifications represent an attempt to address the objective to *define action zones on a scientific basis that eliminate disproportionate impact on reservoirs and address current system needs*. However, when analyzed, this measure produced a more imbalanced use of conservation storage in the projects and generally would result in more disproportionate impact on the reservoirs than current operations. Level 1 action zones would not effectively *improve system performance to achieve congressionally authorized project purposes.* In addition, this measure would not effectively address the other objectives related to drought operations, further improved operations for federally listed threatened and endangered species, and navigation. Modeled results indicate that management of storage at Lake

Lanier, a major component of ACF basinwide water management operations, would be limited by this measure. Additional flexibility in drawdown at Lake Lanier is necessary to *improve system performance to achieve congressionally authorized project purposes* throughout the entire basin. Therefore, the Level 1 action zone modifications measure was not carried forward for detailed evaluation. Instead, the revised Level 1 action zones described in section 4.1.2.2.2.2 were carried forward.

4.1.3.3 Hydroelectric Power

4.1.3.3.1 Modified Schedule at Buford Dam

As noted in section 4.1.2.5.2, USACE considered varying the amount of generation it would plan to provide for each action zone at each project. For instance, rather than having a fixed generation schedule (e.g., when in Zone 1 at Lake Lanier, 4 hours of generation would be made available), USACE examined the viability of a variable schedule (e.g., 2 to 4 hours being made available when in Zone 1). USACE gave this measure no further consideration as a *stand-alone* measure.

4.1.3.3.2 Hydroelectric Power Drought Operations

Similarly, USACE considered reducing the amount of generation that would be made available when operating under drought protocols. Conservation storage at Lake Lanier is much more sensitive to hydroelectric power generation operations because of the small drainage area above Buford Dam from which to refill the reservoir, particularly under drought conditions. The modified generation schedule at Lake Lanier would provide greater operational flexibility to meet power demands in the system while conserving storage as variable climate conditions might dictate. These measures (Modified Schedule and Hydroelectric Power Drought Operations, section 4.1.2.5.4) were eliminated as stand-alone measures but were combined for further consideration.

4.1.3.4 Navigation

In developing a navigation operation, USACE explored several options to provide the most reliable navigation season possible within the constraints of water availability and limited dredging. In investigating navigation operations, USACE balanced use of storage for navigation versus the use of storage for other authorized project purposes.

4.1.3.4.1 Periodic Navigation

USACE considered scheduling navigation opportunities, as defined in section 4.1.2.6, where several intervals of 2-week periods of sufficient flow during the year would be identified on the basis of system composite conservation storage and varying channel depths (e.g., 7-ft and 9-ft channels). Table 4.1-17 presents the available navigation opportunities (two-week periods) during dry weather months in the summer and fall. USACE also considered the effect of dredging on navigation opportunities. Under this measure, the use of storage would be balanced with other uses so that other project purposes would not be adversely affected. In assessing this measure, USACE analyzed the water requirements necessary to support a 9-ft channel, but concluded that only a 7-ft channel is viable because of the amount of water storage it would require and the adverse effects on other project purposes.

Table 4.1-17.
Navigation Opportunities[a] During Dry-Weather Months

Composite Conservation Storage	May-Nov	Jun-Nov	Jul-Nov	Sep-Nov	Oct-Nov	Nov
Zone 1	6	5	4	2	2	1
Zone 2	2	2	2	1	1	1
Zone 3	Emergency only					
Zone 4	Emergency only					

Notes:
[a.]Navigation opportunities are two-week periods during which navigable depths exist.

Considering the requirements involved in implementing this measure, it is highly unlikely that USACE could obtain the necessary clearances from the Florida Department of Environmental Protection in the short-term to conduct limited channel dredging in the Apalachicola River to complement the limited use of storage under this measure. On the basis of the analysis, this measure could not produce a plan for navigation opportunities under those constraints that would be sufficiently reliable to meet navigation industry needs and would not effectively meet the objective to *increase the reliability of navigation on the ACF system.* Therefore, this measure was eliminated from further consideration.

4.1.3.4.2 December–May Navigation Season

This measure explored the viability of providing a 6-month navigation season (December–May) with a 7-ft channel depth made possible when supported by system composite conservation storage.

In assessing this measure, USACE balanced the use of storage for navigation versus the use of storage for other authorized project purposes and considered the impact on other needs and requirements in the system (e.g., hydroelectric power generation, recreation). Accordingly, this measure was analyzed to determine the extent to which additional releases to specifically support navigation would affect upstream conservation storage and trigger drought operations, and the degree to which a reliable commercial navigation channel would likely be available. USACE determined that the 6-month navigation season was not supportable because it would result in excessive depletion of conservation storage, detrimental effects on reservoir levels, and unacceptable effects on other project purposes throughout the ACF Basin. While this measure would *increase the reliability of navigation on the ACF system*, the adverse effects on other project purposes would be too significant. Therefore, this measure was eliminated from further consideration.

4.1.3.4.3 January–April Navigation Season

This measure explored whether a 4-month navigation season (January–April) would be possible when supported by system composite conservation storage. Figure 4.1-11 shows composite conservation storage requirements and the triggers that would suspend and reinstate operations for navigation support.

On the basis of modeling the system over the 73-year period of record, a reliable 4-month navigation season for a 7-ft channel could be provided in the Apalachicola River without an appreciable effect on other upstream water uses or project purposes. The viability of the navigation season was assessed by examining how additional releases to specifically support navigation would affect upstream conservation storage, how often the associated releases would trigger drought operations, and the degree to which a reliable commercial navigation channel would likely be available. Through the assessment, USACE determined that a 4-month navigation season was supportable, but only as long as composite conservation storage remains in Zone 1 or Zone 2.

A 4-month navigation season would be expected to improve system recovery after a drought, reduce the frequency of making releases below 5,000 cfs from Jim Woodruff Lock and Dam, and result in improved conservation of storage by reducing hydroelectric power generation during drought periods and by revising the ramping rate to match the 1-day BI fall rate when discharges are above the powerhouse capacity and below 30,000 cfs.

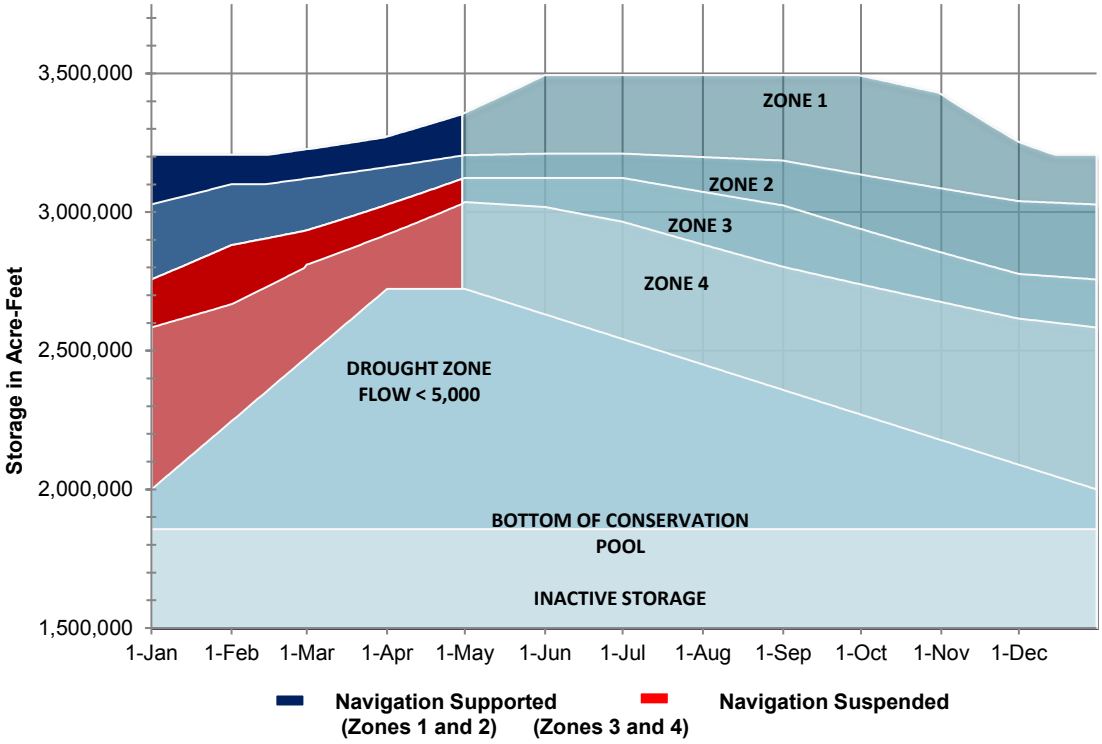


Figure 4.1-11. Composite Conservation Storage in a 4-Month Navigation Season.

As a result of the modeling and associated analysis of the alternatives, the 4-month navigation season appeared to be the most appropriate alternative to carry forward for detailed impact analysis. USFWS also recognized that releases to support navigation might also provide collateral benefits for aquatic species downstream of Jim Woodruff Lock and Dam and requested that USACE investigate the feasibility of another measure, essentially including the features of a 4-month navigation season with a 5-month navigation season (January–May). That measure proved to be feasible on the basis of modeling over the 73-year period of record and would be expected to effectively address the systemwide objectives for the Master WCM update. Therefore, the measure providing for only a 4-month (January–April) navigation season was eliminated from further consideration.

4.1.3.5 Fish and Wildlife Conservation

4.1.3.5.1 Seasonally Varying Baseflows

USACE evaluated the feasibility of providing a seasonally varying baseflow hydrograph that would more closely approximate predam conditions (e.g., more closely simulate run-of-the-river, before impoundment conditions). That analysis confirmed that the presence of the dams and their operations have altered the predam flow regime by generally providing a more stable flow pattern with higher base flows and lower

peak flows. The Buford and West Point projects were designed to provide flood risk management and altering seasonal variability, and reducing higher peak flows has been the result. Therefore, operating the projects to match the *natural* flow regime would adversely affect the congressionally authorized purpose of flood risk management.

4.1.3.5.2 Revised Percent of Basin Inflow Stored

As discussed in section 4.1.2.8.8.2, USACE evaluated the feasibility of changing the percent of BI stored under certain conditions of BI and the composite conservation storage zone to 60 percent or 70 percent (as shown in Table 2.1-5). That analysis established, however, that storing the additional volumes did not result in noticeable improvement in ability to manage the ACF system for endangered species.

4.1.3.5.3 Small Pulses

At the request of USFWS (USFWS 2010), USACE evaluated the effects of providing increased flows through the hydroelectric power units during off-peak hours of the day (i.e., nonhydroelectric power-peaking *windows*) during critical reproductive and rearing periods in the Chattahoochee River below Buford and West Point dams. USFWS requested small pulses for a minimum of 4 weeks March–May. During that period, the projects would release a continuous flow mimicking a nondam flow regime. USFWS also requested high flow pulses in the late winter or early spring to ensure seasonal high flows and river-floodplain connectivity with the timing, frequency, duration, magnitude, and rate of change necessary to sustain ecological functions and wildlife populations. Because the Buford and West Point projects were authorized and designed to operate as peaking hydroelectric power projects, USACE recognized it would have to forgo operating the large generators at both dams for 30 to 60 days to accomplish that option. Doing so would cause a significant loss in hydroelectric power production at the projects, which would be in violation of the existing project authorizations. Further, USACE determined that physical safety and logistical limitations would result from operating the projects to release the amount of flows USFWS requested for any amount of time. Leaving spillway gates open for extended periods would increase the possibility of debris getting lodged in the gate and damaging the equipment and produce increased maintenance costs because of additional wear and tear. That would be especially problematic because the West Point project is operated remotely from the Walter F. George project site. Finally, the option would inherently and adversely affected hydroelectric power generation through the cessation of peaking operations and affect hydroelectric power, flood risk management, and navigation through the use of potentially significant amounts of storage. For those reasons and the reasons documented in this section, nonhydroelectric power peaking was considered no further.

4.1.3.5.3.1 Lake Lanier and Buford Dam

USACE considered specifically at Lake Lanier the possibility of implementing nonhydroelectric power-peaking windows to provide 9 to 18 small pulses ranging from 3,658 cfs per day to 4,980 cfs per day (measured at the Norcross gage) for 2 to 3 days March–May each year to facilitate reproductive and rearing periods for riverine species downstream of the dam. In evaluating the feasibility of implementing the windows, USACE considered releases through the small 7-megawatt (MW) hydroelectric power unit (i.e., the house unit) and the jet valves installed in the sluice gates. That analysis revealed that a range of flows between 600 cfs (through just the small unit) and 1,200 cfs could be released. However, this range would be lower than the target range for an average or dry year. USACE determined that, although managing releases in that manner was potentially feasible from a purely mechanical standpoint, it would raise serious concerns regarding safety, storage, and hydroelectric power generation. The proposed operation inherently affects hydroelectric power generation both through the cessation of peaking operations and through the use of potentially significant amounts of storage. During dry springs with little to no local inflows, the target flow would require approximately 200 cfs more per day during the week

and 1,200 cfs more per day during the weekends than the peaking operation. That equates to approximately 30,000 ac-ft of water, equivalent to a roughly 1-ft drop in the reservoir water surface elevation. The issue is compounded by the fact that the operation takes place during the refill period for the project. In light of those factors, the power-peaking measure at Lake Lanier was eliminated from further consideration.

4.1.3.5.3.2 West Point Dam and Lake

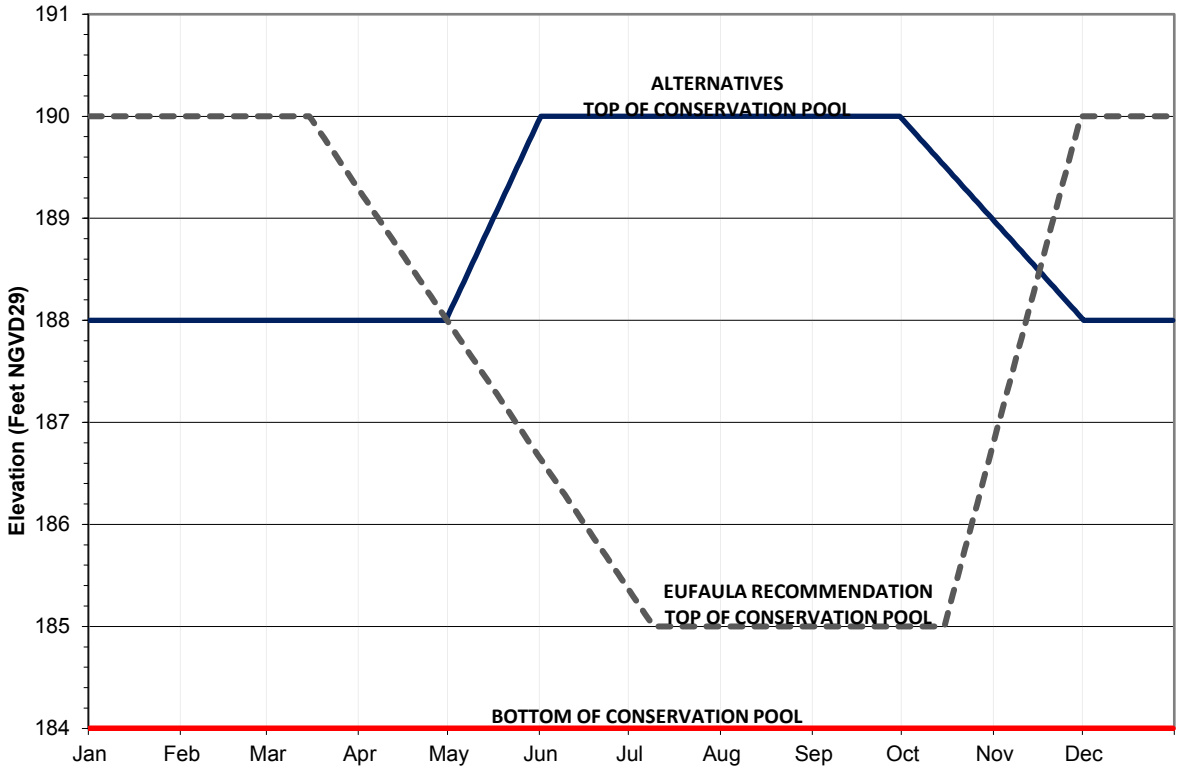
USACE also considered implementing nonhydroelectric power-peaking windows to provide 9 to 16 small pulses ranging from 8,853 cfs per day to 11,580 cfs per day for 3–4 days from March to May each year to facilitate reproductive and rearing periods for riverine species downstream of the dam. In evaluating the feasibility of the windows, USACE considered releases through one or both of the two main units (approximately 6,800–7,800 cfs capacity each), the small unit (approximately 675 cfs capacity), or the six spillway gates (capacity of the spillway gates is based on head differential, but generally is about 800 cfs for pool levels during that time of year). Given that design, the main units could not be used to meet the target flow. Therefore, operations for a 5,000-cfs flow were also considered. While it was determined that a combination of the small unit and five to six of the spillway gates could yield the target flow of approximately 5,000 cfs, that option was rejected because of serious concerns regarding safety, downstream recreation, and storage for hydroelectric power generation and navigation.

4.1.3.5.4 Fish Passage at George W. Andrews Lock and Dam and Walter F. George Lock and Dam

In considering fish passage at projects upstream of Jim Woodruff Lock and Dam, USACE looked at existing data to identify suitable habitat for shad and other riverine species. Unfortunately, little information was available to justify the need for fish passage. Furthermore, recent otolith analysis of juvenile Alabama shad from the Apalachicola River indicated that 97 percent of the juvenile Alabama shad were spawned in the Flint River (Schaffler 2012). Therefore, fish passage at George W. Andrews Lock and Dam and Walter F. George Lock and Dam is not warranted at this time.

4.1.3.5.5 Operations to Manage Walter F. George Lake for the Eufaula National Wildlife Refuge

USACE also considered a request by USFWS to cycle Walter F. George Lake between the highest levels (190 ft) in late winter/early spring to the lowest levels (185 ft) in late summer to accommodate Eufaula NWR operations (see Figure 4.1-12). As proposed, the option would require operation of the reservoir at its highest pool levels during winter-spring, when flood releases are typically the greatest. That would reduce the ability of the project to attenuate approximately 87,000 ac-ft of potential downstream flooding. By holding the reservoir higher during the winter wet season, induced surcharge and damaging downstream flows are increased, resulting in bank erosion and channel modifications below the project. Similarly, to operate the project at its lowest levels during the summer is contrary to what is required to meet the highest demands for recreation, hydroelectric power, and flow augmentation. Essentially, the option would remove Walter F. George Lock and Dam from the system approach to operations across the basin and eliminate approximately 100,000 ac-ft of conservation storage that could be used to meet authorized project purposes in the summer. Given the demands of the system, including the minimum flow provisions for listed species in the Apalachicola River, the proposed operation would have significant adverse effects on the authorized project purposes and the structural stability and safety of the dam. Operations to manage Walter F. George Lake to benefit the Eufaula NWR operations were considered no further.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 4.1-12. USFWS Proposed Operations at Walter F. George Lake.

4.1.4 ACF Stakeholders' Alternative (Sustainable Water Management Plan)

Incorporated as a 501(c)3 nonprofit organization in September 2009, the ACFS is a diverse group of cities, counties, industries, businesses, fishermen, farmers, historic/cultural, environmental, conservation, and recreation groups from Alabama, Florida, and Georgia working together to achieve a common goal. Their stated mission is to foster equitable water-sharing solutions among stakeholders in the ACF Basin that balance economic, ecological, and social values, while ensuring sustainability for current and future generations.

The ACFS established an organizational infrastructure and strategic planning process to address overarching water resource issues in the ACF Basin. The ACFS mission statement and goals were carried out by a volunteer-driven executive committee and working groups. The working groups endeavored to build consensus in the areas of financial, charter, stakeholder outreach, and work plan issues, culminating in the development of a sustainable water management plan (ACFS SWMP) for the ACF Basin that was published and released to the public in May 2015. The ACFS SWMP describes the modeling and the planning process used to develop a solution that considers the water resource needs of all interests in the ACF Basin. When commenting on the draft EIS, ACFS provided a copy of the ACFS SWMP for consideration. More information about the ACFS and the ACFS SWMP is available at http://acfstakeholders.org.

At the time the ACFS SWMP was published, many of the technical details and assumptions associated with the modeling in support of the ACFS SWMP were embargoed as a result of nondisclosure agreements for each of the ACFS members. ACFS comments on the draft EIS did not provide any of those details. Therefore, USACE gleaned all available technical information from the 2015 ACFS SWMP report. The following is a summary of the recommendations in the ACFS SWMP:

- Raise the winter guide curve at West Point Lake from 628 ft to 632.5 ft.
- Define new zones to coincide with the USACE reservoir recreational impact zones and then release water from an upstream reservoir only when the downstream reservoir is in a lower zone.
- Adjust hydropower requirements to achieve more flexibility.
- Provide two pulsed water releases to achieve 9,000 cfs at Chattahoochee, Florida, for 2 weeks each—one in May and one in July.
- Study and implement, if feasible, an increase in the guide curve at Lake Lanier by 2 ft.
- Use predictive drought indicators in the revised Master WCM.
- Study and implement, if feasible, modifying the calculation of BI to account for consumptive use, taking overall system operations into account.
- Add a flow control node at Columbus (contingent on accepting the main suite of recommendations; not a stand-alone recommendation).
- Work with USFWS (and others) to consider the Apalachicola River, floodplain, and Bay freshwater flow needs.
- Update the Master WCM on a regular basis.
- Develop special operations to address extended drought (multiyear) conditions in the basin, based on proactive, predictive triggers and responses.
- Perform field and design studies to confirm water flows needed and to define improvements required to provide a reliable navigation channel with and without dredging, including time and conditions when full 9-ft commercial channel might not be available and the degree to which those improvements can be made while preserving or enhancing aquatic habitat.
- Perform necessary channel maintenance to maximize channel availability both in high flow without dredging for full 9-ft channel depths and for suboptimal channel depths (e.g., a 7-ft channel). Studies outlined above should consider channel modifications that will enhance channel availability during lower flow periods.

As evaluated by USACE, the ACFS SWMP would violate several of the screening criteria for the Master WCM update process. Additionally, due to the lack of technical details and assumptions associated with the modeling in support of the ACFS SWMP, it is impossible to determine if the ACFS SWMP would meet the purpose and need of this EIS, the degree to which authorized project purposes would be met, or whether the USACE responsibilities under the ESA would be met. Raising the winter pool at West Point Lake is not consistent with the screening criteria that any alternative considered by USACE should not increase flood risk above the current level. For these reasons, the ACFS SWMP was not considered any further.

4.1.5 Water Management Measures Combined into Water Management Alternatives (Second Screening)

The measures remaining for consideration following the preliminary evaluation and screening process are listed below. These measures were combined into alternatives as described in section 4.2.

- Guide curves
  - Maintain existing guide curves
- Action Zones
  - Maintain existing action zones
  - Revised Level 1 action zones
- Drought Operations
  - Revised drought operations trigger
  - Drought zone operations, including measures for management of usable inactive storage in Lake Lanier, West Point Lake, and Walter F. George Lake in the event that the composite conservation storage in these reservoirs becomes fully depleted during an extreme drought event in the future.
  - Revised drought operations suspension trigger
- Minimum Flows at Peachtree Creek
  - Current (750 cfs at Peachtree Creek)
  - Seasonal (750 cfs [May–Oct]/650 cfs [Nov–Apr] at Peachtree Creek)
  - Varying monthly flow
- Hydroelectric Power Generation
  - Current schedule
  - Modified schedule at Buford Dam with hydroelectric power drought operations
- Navigation
  - Current-no navigation operations
  - 4 month /5 month (7-ft channel)
  - Year-round navigation
- Basin Inflow
  - Current BI Computational Methodology
  - Revised Method 1
  - Revised Method 2
- Fish and Wildlife Conservation
  - Lake and river fish spawn SOPs
  - Fish passage lockages at Jim Woodruff Lock and Dam
- Federally Listed Threatened and Endangered Species Operations
  - May 2012 RIOP for federally listed threatened and endangered species
  - Revised ramping rate
  - Suspend ramping during prolonged low flow
  - Suspend ramping during drought
  - Revised seasonal flows
  - Monthly flows

  - Daily flows
  - Pulse flows
- Current Water Supply Operations
  - 20 mgd water withdrawals from Lake Lanier relocation contracts (50 percent return rate)
  - Releases from Buford Dam to support current withdrawals (277 mgd) (82 percent return rate)

4.2 Water Management Proposed Action and Alternatives

Water management measures defined in section 4.1 were combined to form water management alternatives to achieve objectives developed for water management of the ACF Basin. Water management alternatives were not formulated based on every conceivable combination of measures. Instead, the measures selected for inclusion in a water management alternative were those USACE considered potential refinements based on experience with current operations or those recommended by one or more stakeholders during the scoping process. As defined in section 4.1, the objectives for the Master WCM update and the WSSA to address the water management issues include the following:

- Defining action zones on a scientific basis that eliminate a disproportionate impact on reservoirs and address current system needs.
- Reducing or eliminating the chance of prematurely returning to drought operations and reducing flows below Jim Woodruff Lock and Dam below 5,000 cfs.
- Reducing or eliminating the adverse effects of system operations on federally listed threatened and endangered species.
- Developing and implementing a basinwide USACE reservoir drought operations plan.
- Improving system performance to achieve congressionally authorized project purposes.
- Increasing the reliability of navigation on the ACF system.

Table 4.2-1 presents the seven basinwide water management alternatives developed to address the objectives and ensure that flood operations would not be compromised. During evaluation of the water management alternatives, HEC-ResSim modeling was conducted to determine if each alternative met the objectives, as described in section 4.1. The following sections further detail each alternative and describe a ranking process used to identify the Water Management PAA. For each alternative, information is presented regarding the alternative's performance as well as a comparison to Water Management Alternative 1. It should be noted that the ability to make special releases as described in section 2.1.1.2.4.7 would be a part of any water management alternative. Such releases, however, are not subject to HEC-ResSim modeling because of their unpredictable nature and duration; therefore, they are not discussed in the comparison of water management alternatives.

Table 4.2-1.
Summary of Water Management Alternatives

Water Management Measures			Water Management Alternatives						
			1	2	3	4	5	6	7
Guide Curves	Maintain existing guide curve		X	X	X	X	X	X	X
Action Zones	Maintain existing action zones		X						
	Revised Level 1 action zones			X	X	X	X	X	X
Drought Operations	Drought operations trigger[a]		Zone 4	Zone 4	Zone 4		Zone 4	Zone 4	Zone 3
	Drought zone operations		X	X	X	X	X		X
	Drought operations suspension trigger[a]		Zone 1	Zone 1	Zone 1		Zone 1	Zone 3	Zone 1
Peachtree Creek Minimum Flows	Current (750 cfs)		X						
	Seasonal flow 750 cfs/650 cfs			X	X	X	X		X
	Monthly (USFWS) determination by zone							X	
Hydropower Generation	Current generation schedule		X					X	
	Modified generation schedule with drought operations			X	X	X	X		X
Navigation	Current-no navigation operations		X						
	4/5 Month			X		X	X	X	X
	Year-round				X				
Basin Inflow	Current computational method		X	X	X			X	X
	Revised Method 1					X			
	Revised Method 2						X		
Fish and Wildlife	Current fish spawn and passage		X	X	X	X	X	X	X
Listed Species Management	RIOP May 2012		X						
	Ramping Rate	Current rate[b]	X	X	X		X	X	X
		Revised rate				X			
		Suspend during prolonged low flow		X	X		X	X	X
		Suspend in drought[a]	X	X	X			X	X
	Minimum Flow Provision	Current (seasonal) [b]	X	X	X				X
		Revised seasonal flow					X		
		Monthly flow						X	
		Daily flow (historic exceedance)				X			
	Pulse flow						X		

Water Management Measures		Water Management Alternatives						
		1	2	3	4	5	6	7
Water Supply	Water supply operations: 20 mgd for relocation contracts and 277 mgd downstream withdrawal by Metro Atlanta[c]	X	X	X	X	X	X	X

Notes:
[a]. Based upon composite conservation storage zones (cumulative conservation storage [by zone] for USACE ACF reservoirs [Lanier, West Point, and Walter F. George]).
[b.] Component of the May 2012 RIOP.
[c.] For the purpose of comparing alternatives, currently authorized water supply withdrawals from Lake Lanier and downstream at Atlanta were factored into each water management alternative. Those authorized, currently occurring annual average amounts are 20 mgd from Lake Lanier and 277 mgd at Atlanta.

4.2.1 Water Management Alternative 1

4.2.1.1 Description of Water Management Alternative 1

Water Management Alternative 1 consists of the following measures:

- Current guide curves
- Current action zones
- Current drought operations
  - Drought operations trigger-Zone 4
  - Drought operations suspension-Zone 1
  - Drought zone operations
- Current minimum flows of 750 cfs at Peachtree Creek
- Current hydropower generation schedule
- Current no-navigation operations
- Current BI computational method
- Current fish spawning and fish passage operations
- Current May 2012 RIOP provisions
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta

The operational practices on the ACF Basin under this alternative are summarized in section 2.1.1.2.

Water Management Alternative 1 represents no change from the current management direction or level of management intensity. This alternative would represent continuation of the current water control operations at each of the USACE projects in the ACF Basin. Basinwide management of all seven project purposes (i.e., flood risk management, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water quality, and water supply) is also considered in the alternative.

The CEQ regulations require detailed analysis of a NAA (40 CFR 1502.14); therefore, Water Management Alternative 1 was carried forward for further evaluation to serve as a basis of comparing performance among water management alternatives.

4.2.1.2 Performance Relative to Authorized Purposes

4.2.1.2.1 Flood Risk Management

Under Water Management Alternative 1, flood risk management operations would remain unchanged from those currently employed and would be achieved by storing damaging flood water, thus reducing downstream river levels below those that would occur without the dams in place. Of the five USACE reservoirs, only the Buford (Lake Lanier) and West Point projects were designed with space to store flood water. In addition to providing space above the conservation pool to hold flood water throughout the year, the Buford project is drawn down 1 additional ft, and the West Point project is drawn down at least 7 additional ft beginning in the fall season, through winter and into the early spring season to provide additional capacity to protect life and property within the basin. The George W. Andrews and Jim Woodruff lock and dams operate to pass inflows, while the Walter F. George Lock and Dam project operates according to specified flood control schedules. During the principal flood season, December–April, the current regulation plan at Walter F. George Lock and Dam provides for lower lake levels to ensure lower reduced peak stages in the reservoir during major floods. During a flood event, excess water above the guide curve should be evacuated through the use of the turbines and spillways in a manner consistent with other project needs as soon as downstream flows have receded sufficiently so that releases from the reservoirs do not cause flows to exceed the bankfull discharges. This timely evacuation is necessary so that consecutive flood events will not cause flood waters to exceed allocated flood storage capacities and endanger the integrity of the dam.

4.2.1.2.2 Hydroelectric Power Generation

Under this alternative, the current hydroelectric power generation schedule shown in Table 4.1-5 would be maintained. Under Water Management Alternative 1, system annual hydropower generation is 1.049,022 megawatt-hours (MWh) and system annual weekday hydropower generation is 777,455 MWh. System hydropower is the sum of generation at the four USACE power projects: Buford, West Point, Walter F. George, and Jim Woodruff. Hydropower generation that occurs at the three storage projects is shown in Table 4.2-2. Generation at Jim Woodruff Lock and Dam is primarily a byproduct of the RIOP release requirement. Peaking operation occurs only when conditions allow, perhaps 1–2 hours a day, when releases are above 6,700 cfs. The project generates power 7 days a week except when flow falls below 6,700 cfs. For these reasons, together with the fact that all water management alternatives include protected species provisions, the power generation at Jim Woodruff Lock and Dam was not considered relevant to the comparison of water management alternatives.

Table 4.2-2.
Hydropower Generation at ACF Projects for Water Management Alternative 1

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	139,035	112,659	1.51
West Point	181,153	137,691	1.37
Walter F. George	473,474	345,228	1.11

4.2.1.2.3 Navigation

Water Management Alternative 1 would continue the existing water management practices which do not include any specific measures to address the specific objective to *increase the reliability of navigation on*

the ACF system. Without specific operations for navigation, this water management alternative would provide a 9-ft navigation channel (Blountstown flow >/= 20,600 cfs) 35 percent of the time and a 7-ft navigation channel (Blountstown flow >/= 16,200 cfs) 50 percent of the time. Since this alternative has no specific operations for navigation, the reliability of adequate navigation flows is low. For comparison with other alternatives, note that under Water Management Alternative 1 the 7-ft channel would be fully available 20.5 percent of the time January–May (15 navigation seasons) and the 9-ft channel would be fully available 5.5 percent of the time, January–May (4 navigation seasons).

4.2.1.2.4 Fish and Wildlife Conservation

For Water Management Alternative 1, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005) as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum of growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,039 acres (ac); the median fall rate is 0.12 ft/day; and the maximum fall rate is 2.07 ft/day. Other performance measures associated with this water management alternative are shown in Table 4.2-3.

Table 4.2-3.
Listed Species Performance Measures for Water Management Alternative 1

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	1.4	0	0
< 6,000	30.1	0	0
< 7,000	45.2	0	0
< 8,000	60.3	6	5
< 9,000	79.5	36	12
< 10,000	93.2	60	28

No additional water control measures are included in this alternative for reservoirs in the ACF Basin to conserve storage in a manner that would reduce or eliminate the likelihood of flows from Jim Woodruff Lock and Dam below 5,000 cfs under extreme drought conditions. Therefore, Water Management Alternative 1 would not address objectives related to *flows below Jim Woodruff Lock and Dam under drought conditions, reducing the effect of operations on federally listed threatened and endangered species,* and *improving overall system performance to achieve authorized purposes.*

4.2.1.2.5 Recreation

For Water Management Alternative 1, Table 4.2-4 shows the number of weeks that lake levels would be below various impact levels for the recreation season during 1939–2011 period of record as well as the percent of time below the various impact levels.

Table 4.2-4.
Recreation Water Levels for Water Management Alternative 1

	Project		
	Buford (May-Sep)	**West Point (May-Sep)**	**Walter F. George (May-Sep)**
Number of weeks below initial impact level (IIL) during period of record	275	300	28
Number of weeks below recreation impact level (RIL) during period of record	77	45	0
Number of days below water access limited level (WAL) during period of record	9	111	0
Percent of time below IIL	18	20	2
Percent of time below RIL	5	3	0
Percent of time below WAL	0	1	0

4.2.1.2.6 Water Quality

Under Water Management Alternative 1, Buford Dam, West Point Dam, and Jim Woodruff Lock and Dam would continue to provide continuous minimum releases, in addition to meeting other project purposes and providing associated benefits. The releases would also benefit downstream water quality. At West Point Dam, a small generating unit provides a continuous release of approximately 675 cfs. In addition to these flows, Buford Dam is operated in conjunction with the downstream GPC Morgan Falls Dam to ensure a minimum in-stream flow of 750 cfs on the Chattahoochee River at Peachtree Creek to meet state water quality commitments.

4.2.1.2.7 Water Supply

Under the Water Management Alternative 1, withdrawals would be limited to 20 mgd from Lake Lanier (Buford and Gainesville relocation contracts) with a 50 percent return rate and to current withdrawals (277 mgd) downstream of Buford Dam by Metro Atlanta water providers with an 82-percent return rate, as described in section 4.1.2.9. The withdrawal value for Lake Lanier does not reflect current withdrawals, only those that are currently authorized and do not require a storage agreement. Nonetheless, these values, applied across all the water management alternatives, enable a consistent evaluation and comparison of the extent to which they would meet the other authorized project purposes and their associated environmental effects.

4.2.2 Water Management Alternative 2

4.2.2.1 Description of Water Management Alternative 2

Water Management Alternative 2 consists of the following measures:

- Current guide curves (same as Water Management Alternative 1)
- Revised Level 1 action zones
- Drought operations (same as Water Management Alternative 1)
- Seasonal flow at Peachtree Creek (750 cfs [May–Oct] and 650 cfs [Nov–Apr])
- Modified generation schedule with drought operations
- 4/5 month navigation (7-ft)

- Current BI computational method (same as Water Management Alternative 1)
- Current fish spawn procedures (same as Water Management Alternative 1)
- Current fish passage procedures (same as Water Management Alternative 1)
- Listed species management
  - Current ramping rates (same as Water Management Alternative 1)
  - Suspension of ramping rates in drought (same as Water Management Alternative 1)
  - Suspension of ramping rates during prolonged low flow
  - Current minimum flow provisions at the Chattahoochee, Florida, USGS gage on the Apalachicola River (same as Water Management Alternative 1)
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta (same as Water Management Alternative 1)

In developing this alternative, USACE balanced use of storage for navigation versus the use of storage for other authorized project purposes and considered effects on other needs and requirements in the system (e.g., hydroelectric power generation, recreation). The 4-month navigation season concept includes a navigation season January–April and water releases to support a 7-ft navigation channel in the Apalachicola River, assumes no dredging of the Apalachicola River, and releases for navigation occurring during normal operation when basin composite conservation storage is above Zone 3 (within Zone 1 or 2).

This alternative was developed to specifically address the objective of *defining action zones on a scientific basis that eliminate disproportionate impact on reservoirs and address current system needs* and *increasing the reliability of navigation on the ACF system.* That objective is consistent with input received from stakeholders during public scoping. The *action zones* are shown in Figure 4.1-7, Figure 4.1-8, and Figure 4.1-9.

4.2.2.2 Performance Relative to Authorized Purposes

4.2.2.2.1 Flood Risk Management

The effects of Water Management Alternative 2 on flood risk management at Lake Lanier and West Point Lake would be expected to be the same as those for Water Management Alternative 1 (section 4.2.1.2.1). This alternative would not be expected to have any impact on flood risk management in the ACF Basin because the project guide curves remain unchanged. Thus, flood storage and associated flood operations would not be affected as they would be under Alternative 1. Revisions to the action zones considered under Water Management Alternative 2 establish parameters for water management actions that would be taken to conserve storage when lake levels are below the guide curve.

4.2.2.2.2 Hydroelectric Power Generation

Under Water Management Alternative 2, the general hydroelectric power generation schedule would be modified for Buford Dam to be more flexible in all action zones under nondrought conditions and more constrained under drier conditions (see Table 4.2-5). Coupled with the revised Level 1 action zones, Water Management Alternative 2 would dictate more judicious use of conservation storage for hydroelectric power generation (particularly at Lake Lanier, but also at West Point Lake) under drier to drought conditions.

In a longer term and systemwide context, this management strategy would be beneficial for hydroelectric power generation, drought operations, and for other project purposes. With respect to the hydroelectric power generation project purpose, Water Management Alternative 2 would represent an overall improved condition. It supports the objectives to *define action zones on a scientific basis that eliminate disproportionate impact on reservoirs and address current system needs* and *to improve system performance to achieve congressionally authorized purposes*. Under Water Management Alternative 2 system, annual hydropower generation would be 864 MWh (0.1 percent) less than Water Management Alternative 1 and system annual weekday generation would be 1,749 MWh (0.2 percent) less.

Table 4.2-5.
Hydropower Generation at ACF Projects for Water Management Alternative 2

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	139,107	112,034	1.48
West Point	181,134	136,693	1.34
Walter F. George	472,714	345,179	1.12

4.2.2.2.3 Navigation

Assuming basin hydrologic conditions allow, Water Management Alternative 2 addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season would begin in January of each year and continue for 4 to 5 consecutive months (January–April or May), as described in section 4.1.2.6.4. On the basis of modeling of the system over the 73-year period of record, Water Management Alternative 2 would be expected to provide a reliable 4–5 month navigation season (January–April/May) for a 7-ft channel in the Apalachicola River without an appreciable impact on other upstream water uses or project purposes. A comparison of the navigation channel availability under Water Management Alternative 2 and that available under Water Management Alternative 1 is shown in Table 4.2-6. This alternative, which includes operations specifically for navigation, would provide a more dependable 7-ft navigation channel but a less dependable 9-ft channel.

Table 4.2-6.
Navigation Channel Availability under Water Management Alternative 2 Compared to Water Management Alternative 1

	WMA1	WMA2	Change from WMA1
9-ft channel Jan–Dec	34.7%	34.3%	-0.5%
9-ft channel Jan–May 100% reliability	5.5%	4.1%	-1.4%
9-ft channel Jan–May 90% reliability	19.2%	17.8%	-1.4%
7-ft channel Jan–Dec	50.2%	54.1%	3.9%
7-ft channel Jan—May 100% reliability	20.5%	43.8%	23.3%
7-ft channel Jan—May 90% reliability	49.3%	75.3%	26.0%

Note: WMA = water management alternative.

4.2.2.2.4 Fish and Wildlife Conservation

For Water Management Alternative 2, operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would generally continue as currently practiced. Compared to the Water Management Alternative 1, implementing this alternative would be expected to provide improved conditions for fish and wildlife by including measures to enhance ACF Basin operations (revised Level 1 action zones and the modified hydroelectric generation schedule at Buford Dam), and releases to support a 4/5-month (January–April or May) navigation season. As compared to Water Management Alternative 1, the annual maximum of growing season (April–October) floodplain connectivity to the main channel for 30 consecutive days would be 18,410 ac rather than 18,039 ac); the median fall rate would be 0.10 ft/day rather than 0.12; and the maximum fall rate would be 2.09 ft/day rather than 2.07. Other performance measures associated with this water management alternative are shown in Table 4.2-7.

Table 4.2-7.
Listed Species Performance Measures for Water Management Alternative 2

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	1.4	0	0
< 6,000	34.2	0	0
< 7,000	46.6	0	0
< 8,000	64.4	7	5
< 9,000	79.5	36	12
< 10,000	91.8	59	23

4.2.2.2.5 Recreation

Under Water Management Alternative 2, the pool levels at Lake Lanier during the recreation season would be below Initial Impact Level (IIL), Recreation Impact Level (RIL), and Water Access Limited Level (WAL) more often than under the Water Management Alternative 1 (Table 4.2-8). At West Point Lake, the lake levels during the recreation season would be below IIL and RIL more often than under the Water Management Alternative 1, but below WAL less often. At Walter F. George Lake, pool levels would be below IIL and RIL more often than under the Water Management Alternative 1.

Table 4.2-8.
Recreation Water Levels for Water Management Alternative 2

	Project		
	Buford (May-Sep)	West Point (May-Sep)	Walter F. George (May-Sep)
Number of weeks below IIL during period of record	346	378	132
Number of weeks below RIL during period of record	98	65	4
Number of days below WAL during period of record	68	104	0
Percent of time below IIL	22	25	9
Percent of time below RIL	6	4	0
Percent of time below WAL	1	1	0

4.2.2.2.6 Water Quality

Under Water Management Alternative 2, Buford Dam, West Point Dam, and Jim Woodruff Lock and Dam would continue to provide continuous minimum releases, in addition to meeting other project purposes and providing associated benefits. These releases would also benefit downstream water quality. At West Point Dam, a small generating unit provides a continuous release of approximately 675 cfs. In addition to these flows, Buford Dam is operated in conjunction with the downstream GPC Morgan Falls Dam to ensure a minimum in-stream flow of 650 cfs during November–April and 750 cfs during May–October on the Chattahoochee River at Peachtree Creek to meet state water quality commitments.

4.2.2.2.7 Water Supply

Water Management Alternative 2 would have similar implications for the water supply purpose for pertinent USACE projects in the ACF Basin as described for Water Management Alternative 1 in section 4.2.1.2.7. Water supply uses of the ACF Basin below Peachtree Creek (Chattahoochee RM 300.5) would not likely be appreciably affected by Water Management Alternative 2.

4.2.3 Water Management Alternative 3

4.2.3.1 Description of Water Management Alternative 3

Water Management Alternative 3 is the same as Water Management Alternative 2 except for the navigation feature. This alternative provides navigation flows, when available, 12 months a year rather than limiting navigation to January–April/May and consists of the following measures:

- Current guide curves (same as Water Management Alternative 1)
- Revised Level 1 action zones (same as Water Management Alternative 2)
- Drought operations (same as Water Management Alternative 1)
- Seasonal flow at Peachtree Creek (750 cfs [May–Oct] and 650 cfs [Nov–Apr]) (same as Water Management Alternative 2)
- Modified generation schedule with drought operations (same as Water Management Alternative 2)
- Year-round navigation
- Current BI Computational Method (same as Water Management Alternative 1)
- Current fish spawn procedures (same as Water Management Alternative 1)
- Current fish passage procedures (same as Water Management Alternative 1)
- Listed species management
  - Current ramping rates (same as Water Management Alternative 1)
  - Suspension of ramping rates in drought (same as Water Management Alternative 1)
  - Suspension of ramping rates during prolonged low flow (same as Water Management Alternative 2)
  - Current minimum flow provisions at Chattahoochee, Florida, USGS gage on the Apalachicola River (same as Water Management Alternative 1)
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta (same as Water Management Alternative 1)

This alternative was developed to address the objective *of increasing the reliability of navigation on the ACF system* with the intent of providing navigation on a year-round basis in the absence of dredging. It incorporates all the measures of Water Management Alternative 2 other than the 4/5-month navigation provision.

4.2.3.2 Performance Relative to Authorized Purposes

4.2.3.2.1 Flood Risk Management

The effects of Water Management Alternative 3 on flood risk management at Lake Lanier and West Point Lake would be expected to be essentially the same as for Water Management Alternative 1 (section 4.2.1.2.1). Since no guide curves are modified under this alternative, it would not likely have any impact on flood risk management in the ACF Basin.

4.2.3.2.2 Hydroelectric Power Generation

Under Water Management Alternative 3 (Table 4.2-9), the general hydroelectric power generation schedule would be the same as under Water Management Alternative 2. Under the Water Management Alternative 3 system, annual hydropower generation would be 2,579 MWh (0.2 percent) less than under Water Management Alternative 1 and system annual weekday generation would be 663 MWh (0.1 percent) less.

Table 4.2-9.
Hydropower Generation at ACF Projects for Water Management Alternative 3

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	138,431	111,033	1.46
West Point	180,855	136,447	1.30
Walter F. George	472,209	347,619	1.18

4.2.3.2.3 Navigation

Water Management Alternative 3 is intended to address the specific objective to *increase the reliability of navigation on the ACF system* by providing a reliable channel (7 ft or deeper) in the Apalachicola River on a year-round basis to the maximum extent practicable while continuing to meet the flow requirements in the Apalachicola River. A comparison of the navigation channel availability under Water Management Alternative 3 with that under Water Management Alternative 1 is shown in Table 4.2-10. On a year-round basis, this alternative would provide a more dependable 7-ft navigation channel and a less dependable 9-ft channel. During the January–May navigation season this alternative would provide a more dependable 7-ft navigation channel and a more dependable 9-ft channel.

Table 4.2-10.
Navigation Channel Availability under Water Management Alternative 3 Compared to Water Management Alternative 1

	WMA1	WMA3	Change from WMA1
9-ft channel Jan-Dec	34.7%	33.5%	-1.2%
9-ft channel Jan-May 100%reliability	5.5%	6.8%	1.4%
9-ft channel Jan-May 90%reliability	19.2%	19.2%	0.0%
7-ft channel Jan-Dec	50.2%	58.1%	7.9%
7-ft channel Jan-May 100%reliability	20.5%	39.7%	19.2%
7-ft channel Jan-May 90%reliability	49.3%	68.5%	19.2%

Note: WMA = water management alternative.

4.2.3.2.4 Fish and Wildlife Conservation

Under this alternative, operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced (see section 4.2.1.2.4).

Implementing Water Management Alternative 3 would result in more favorable conditions for fish and wildlife than Water Management Alternative 1. The annual maximum of growing season (April–October) floodplain connectivity to the main channel for 30 consecutive days would be 19,154 ac, 1,415 ac more than under Water Management Alternative 1; the median fall rate would be 0.07 ft/day rather than 0.12; and the maximum fall rate would be 2.40 ft/day rather than 2.07. Other performance measures associated with this water management alternative are shown in Table 4.2-11.

Table 4.2-11.
Listed Species Performance Measures for Water Management Alternative 3

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	2.7	0	0
< 6,000	38.4	0	0
< 7,000	57.5	6	5
< 8,000	69.9	20	11
< 9,000	91.8	48	24
< 10,000	93.2	74	34

4.2.3.2.5 Recreation

Under Water Management Alternative 3 (Table 4.2-12), the pool levels at Lake Lanier during the recreation season would be below the IIL, RIL, and WAL considerably more often than under Water Management Alternative 1. At West Point Lake, the lake levels during the recreation season would be below the IIL and the RIL considerably more often than under Water Management Alternative 1, but below the WAL less often. At Walter F. George Lake, pool levels would be below the IIL 147 weeks compared to 28 weeks under Water Management Alternative 1.

Table 4.2-12.
Recreation Water Levels for Water Management Alternative 3

	Project		
	Buford (May-Sep)	**West Point (May-Sep)**	**Walter F. George (May-Sep)**
Number of weeks below IIL during period of record	451	521	147
Number of weeks below RIL during period of record	116	81	5
Number of days below WAL during period of record	178	102	0
Percent of time below IIL	29	36	10
Percent of time below RIL	9	5	0
Percent of time below WAL	4	1	0

4.2.3.2.6 Water Quality

The implications of Water Management Alternative 3 relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.6.

4.2.3.2.7 Water Supply

The implications of Water Management Alternative 3 relative to water supply purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 1 in section 4.2.1.2.7.

4.2.4 Water Management Alternative 4

4.2.4.1 Description of Water Management Alternative 4

Water Management Alternative 4 was specifically developed to address the objectives of *reducing or eliminating the adverse effect of system operations on federally listed threatened and endangered species* and *reducing or eliminating the chances of prematurely returning to drought operations and reducing flows below Jim Woodruff Lock and Dam below 5,000 cfs*. It is similar to Water Management Alternative 2 except for several differences regarding drought operations, BI computation, and listed species management. This alternative consists of the following measures:

- Current guide curves (same as Water Management Alternative 1)
- Revised Level 1 action zones (same as Water Management Alternative 2)
- Drought operations
  - No drought operations trigger
  - No drought suspension trigger
  - Drought zone operations (same as Water Management Alternative 1)
- Seasonal flow at Peachtree Creek (750 cfs [May–Oct] and 650 cfs [Nov–Apr]) (same as Water Management Alternative 2)
- Modified generation schedule with drought operations (same as Water Management Alternative 2)
- 4/5 month navigation (7-ft) (same as Water Management Alternative 2)

- Revised BI Method 1
- Current fish spawn procedures (same as Water Management Alternative 1)
- Current fish passage procedures (same as Water Management Alternative 1)
- Listed species management
  - Revised ramping rates
  - Daily flow provisions at the Chattahoochee, Florida, USGS gage on the Apalachicola River
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta (same as Water Management Alternative 1)

4.2.4.2 Performance Relative to Authorized Purposes

4.2.4.2.1 Flood Risk Management

The effects of Water Management Alternative 4 on flood risk management at Lake Lanier and West Point Lake would be expected to be essentially the same as those described for Water Management Alternative 1 (section 4.2.1.2.1). Since no guide curves are modified under this alternative, it would not likely have any impact on flood risk management in the ACF Basin.

4.2.4.2.2 Hydroelectric Power Generation

Under Water Management Alternative 4 (Table 4.2-13), the general hydroelectric power generation schedule would be the same as under Water Management Alternative 2. System annual hydropower generation would be 2,370 MWh (0.2 percent) less than under Water Management Alternative 1 and system annual weekday generation would be 7,647 MWh (1.0 percent) less.

Table 4.2-13.
Hydropower Generation at ACF Projects for Water Management Alternative 4

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	138,952	110,575	1.42
West Point	180,853	135,188	1.26
Walter F. George	472,932	342,953	1.08

4.2.4.2.3 Navigation

Navigation operations for this alternative are the same as for Water Management Alternative 2, as described in section 4.1.2.6.4 and addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a 4/5 month navigation season. A comparison of the navigation channel availability under Water Management Alternative 4 with that under Water Management Alternative 1 is shown in Table 4.2-14. This alternative would provide a more dependable 7-ft navigation channel but a less dependable 9-ft channel during the January–May navigation season.

Table 4.2-14.
Navigation Channel Availability under Water Management Alternative 4 Compared to Water Management Alternative 1

	WMA1	WMA4	Change from WMA1
9-ft channel Jan-Dec	34.7%	35.1%	0.4%
9-ft channel Jan-May 100%reliability	5.5%	2.7%	-2.7%
9-ft channel Jan-May 90%reliability	19.2%	16.4%	-2.8%
7-ft channel Jan-Dec	50.2%	52.5%	2.3%
7-ft channel Jan-May 100%reliability	20.5%	39.7%	19.2%
7-ft channel Jan-May 90%reliability	49.3%	71.2	21.9%

Note: WMA = water management alternative.

4.2.4.2.4 Fish and Wildlife Conservation

Under this alternative, operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced (see section 4.2.1.2.4).

Implementing this alternative would provide somewhat more favorable conditions for fish and wildlife than Water Management Alternative 1. The annual maximum of growing season (April–October) floodplain connectivity to the main channel for 30 consecutive days would be 18,352 ac, 313 ac more than Water Management Alternative 1; the median fall rate would be 0.07 ft/day rather than 0.12; and the maximum fall rate would be 2.40 ft/day rather than 2.07. Other performance measures associated with this water management alternative are shown in Table 4.2-15.

Table 4.2-15.
Listed Species Performance Measures for Water Management Alternative 4

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	1.4	0	0
< 6,000	26.0	0	0
< 7,000	49.3	0	0
< 8,000	61.6	9	8
< 9,000	80.8	28	17
< 10,000	91.8	55	27

4.2.4.2.5 Recreation

Under Water Management Alternative 4 (Table 4.2-16), the pool levels at Lake Lanier during the recreation season would be below the IIL, and the RIL considerably more often and below the WAL much more often than under Water Management Alternative 1. At West Point Lake, pool levels would be below the IIL, RIL, and WAL considerably more often than under Water Management Alternative 1. At Walter F. George Lake, pool levels would be below the IIL 245 weeks compared to 28 weeks under Water Management Alternative 1 and below the RIL 12 weeks as compared to no weeks.

Table 4.2-16.
Recreation Water Levels for Water Management Alternative 4

	Project		
	Buford (May-Sep)	**West Point (May-Sep)**	**Walter F. George (May-Sep)**
Number of weeks below IIL during period of record	449	510	245
Number of weeks below RIL during period of record	133	106	12
Number of days below WAL during period of record	428	247	0
Percent of time below IIL	29	34	16
Percent of time below RIL	9	7	1
Percent of time below WAL	4	2	0

4.2.4.2.6 Water Quality

The implications of Water Management Alternative 4 relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.6.

4.2.4.2.7 Water Supply

The implications of Water Management Alternative 4 relative to water supply purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 1 in section 4.2.1.2.7.

4.2.5 Water Management Alternative 5

4.2.5.1 Description of Water Management Alternative 5

Water Management Alternative 5 was developed to address the objectives of *reducing or eliminating the adverse effect of system operations on federally listed threatened and endangered species* and *improving system performance to achieve congressionally authorized project purposes*. It is similar to Water Management Alternative 2 except for a revised BI computation method and revisions to listed species management measures. This alternative consists of the following measures:

- Current guide curves (same as Water Management Alternative 1)
- Revised Level 1 action zones (same as Water Management Alternative 2)
- Drought operations (same as Water Management Alternative 1)
- Seasonal flow at Peachtree Creek (750 cfs [May–Oct] and 650 cfs [Nov–Apr]) (same as Water Management Alternative 2)
- Modified generation schedule with drought operations (same as Water Management Alternative 2)
- 4/5 month navigation (7-ft) (same as Water Management Alternative 2)
- Revised BI Method 2
- Current fish spawn procedures (same as Water Management Alternative 1)
- Current fish passage procedures (same as Water Management Alternative 1)

- Listed species management
  - Current ramping rates (same as Water Management Alternative 1)
  - Suspension of ramping rates during prolonged low flow (same as Water Management Alternative 2)
  - Revised seasonal flow provisions at the Chattahoochee, Florida, USGS gage on the Apalachicola River
  - Pulse flow
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta (same as Water Management Alternative 1)

4.2.5.2 Performance Relative to Authorized Purposes

4.2.5.2.1 Flood Risk Management

The effects of Water Management Alternative 5 on flood risk management at Lake Lanier and West Point Lake would be expected to be essentially the same as for Water Management Alternative 1 (section 4.2.1.2.1). Since no guide curves are modified under this alternative, it would not likely have any impact on flood risk management in the ACF Basin.

4.2.5.2.2 Hydroelectric Power Generation

Under Water Management Alternative 5 (Table 4.2-17), the general hydroelectric power generation schedule would be the same as under Water Management Alternative 2. System annual hydropower generation would be 944 MWh (<0.1 percent) less than Water Management Alternative 1 and system annual weekday generation would be 1,339 MWh (0.02 percent) less.

Table 4.2-17.
Hydropower Generation at ACF Projects for Water Management Alternative 5

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	139,110	112,097	1.48
West Point	181,181	136,973	1.35
Walter F. George	472,757	345,526	1.13

4.2.5.2.3 Navigation

Navigation operations for this alternative would be the same as under Water Management Alternative 2, as described in section 4.1.2.6.4 and addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a 4/5 month navigation season.. A comparison of the navigation channel availability under Water Management Alternative 5 with that under Water Management Alternative 1 is shown in Table 4.2-18. This alternative would provide a more dependable 7-ft navigation channel but a less dependable 9-ft channel.

Table 4.2-18.
Navigation Channel Availability under Water Management Alternative 5 Compared to Water Management Alternative 1

	WMA1	WMA5	Change from WMA1
9-ft channel Jan-Dec	34.7%	34.6%	-0.1%
9-ft channel Jan-May 100%reliability	5.5%	2.7%	-2.8%
9-ft channel Jan-May 90%reliability	19.2%	17.8%	-1.4%
7-ft channel Jan-Dec	50.2%	54.2%	4.0%
7-ft channel Jan-May 100%reliability	20.5%	38.4%	17.9%
7-ft channel Jan-May 90%reliability	49.3%	75.3%	26.0%

Note: WMA = water management alternative.

4.2.5.2.4 Fish and Wildlife Conservation

Under this alternative, operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced (see section 4.2.2.2.4).

Implementing this alternative would provide somewhat more favorable conditions for fish and wildlife than under Water Management Alternative 1. The annual maximum of growing season (April–October) floodplain connectivity to the main channel for 30 consecutive days would be 19,166 ac—1,127 ac more than Water Management Alternative 1; the median fall rate would be 0.07 ft/day rather than 0.12; and the maximum fall rate would be 2.40 ft/day rather than 2.07. Other performance measures associated with this water management alternative are shown in Table 4.2-19.

Table 4.2-19.
Listed Species Performance Measures for Water Management Alternative 5

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	1.4	0	0
< 6,000	35.6	0	0
< 7,000	50.7	1	1
< 8,000	64.4	8	7
< 9,000	83.6	40	15
< 10,000	93.2	62	25

4.2.5.2.5 Recreation

Under Water Management Alternative 5 (Table 4.2-20), the pool levels at Lake Lanier during the recreation season would be below the IIL, RIL, and WAL somewhat more often than under Water Management Alternative 1. At West Point Lake, the lake levels during the recreation season would be below the IIL and the RIL somewhat more often, but below the WAL slightly less often. At Walter F. George Lake, pool levels would be below the IIL 119 weeks compared to 28 weeks under Water Management Alternative 1 and 5 weeks below the RIL as compared to no weeks.

Table 4.2-20.
Recreation Water Levels for Water Management Alternative 5

	Project		
	Buford (May-Sep)	**West Point (May-Sep)**	**Walter F. George (May-Sep)**
Number of weeks below IIL during period of record	344	340	119
Number of weeks below RIL during period of record	98	55	5
Number of days below WAL during period of record	78	109	0
Percent of time below IIL	22	23	8
Percent of time below RIL	6	4	0
Percent of time below WAL	1	1	0

4.2.5.2.6 Water Quality

The implications of Water Management Alternative 5 relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.6.

4.2.5.2.7 Water Supply

The implications of Water Management Alternative 5 relative to water supply purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.7.

4.2.6 Water Management Alternative 6

4.2.6.1 Description of Water Management Alternative 6

Water Management Alternative 6 represents another approach to addressing the objective of *reducing or eliminating the adverse effect of system operations on federally listed threatened and endangered species*. It is similar to Water Management Alternative 2 except for a change in the drought operation suspension trigger, specification of a varying monthly flow at Peachtree Creek, current hydropower generation schedule, and revisions to listed species management. This alternative consists of the following measures:

- Current guide curves (same as Water Management Alternative 1)
- Revised Level 1 action zones (same as Water Management Alternative 2)
- Drought operations
  - Drought operations trigger Zone 4 (same as Water Management Alternative 1)
  - Drought operations suspension trigger Zone 3
- Current hydropower generation schedule (same as Water Management Alternative 1)
- Monthly varying flow at Peachtree Creek depending on reservoir composite conservation storage zone
- 4/5 month navigation (7-ft) (same as Water Management Alternative 2)
- Current BI Computational Method (same as Water Management Alternative 1)
- Current fish spawn procedures (same as Water Management Alternative 1)
- Current fish passage procedures (same as Water Management Alternative 1)

- Listed species management
  - Current ramping rates (same as Water Management Alternative 1)
  - Suspension of ramping rates in drought (same as Water Management Alternative 1)
  - Suspension of ramping rates during prolonged low flow (same as Water Management Alternative 2)
  - Monthly flows
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta (same as Water Management Alternative 1)

4.2.6.2 Performance Relative to Authorized Purposes

4.2.6.2.1 Flood Risk Management

The effects of Water Management Alternative 6 on flood risk management at Lake Lanier and West Point Lake would be expected to be essentially the same as for Water Management Alternative 1 (section 4.2.1.2.1). Since no guide curves are modified under this alternative, it would not likely have any impact on flood risk management in the ACF Basin.

4.2.6.2.2 Hydroelectric Power Generation

Under Water Management Alternative 6 (Table 4.2-21), the general hydroelectric power generation schedule would be the same as Water Management under Alternative 1. System annual hydropower generation would be 1,048,845 MWh, essentially the same as for Alternative 1, but system annual weekday generation would be 10,137 MWh (1.3%) less.

Table 4.2-21.
Hydropower Generation at ACF Projects for Water Management Alternative 6

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	138,684	105,895	1.24
West Point	181,183	135,222	1.23
Walter F. George	473,075	343,606	1.08

4.2.6.2.3 Navigation

Navigation operations for this alternative would be the same as under Water Management Alternative 2, as described in section 4.1.2.6.4 and addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a 4/5 month navigation season.. A comparison of the navigation channel availability under Water Management Alternative 6 with that under Water Management Alternative 1 is shown in Table 4.2-22. This alternative would provide a more dependable 7-ft navigation channel but a less dependable 9-ft channel.

Table 4.2-22.
Navigation Channel Availability under Water Management Alternative 6 Compared to Water Management Alternative 1

	WMA1	WMA6	Change from WMA1
9-ft channel Jan-Dec	34.7%	34.8%	0.1%
9-ft channel Jan-May 100%reliability	5.5%	5.5%	0.0%
9-ft channel Jan-May 90%reliability	19.2%	20.5%	1.3%
7-ft channel Jan-Dec	50.2%	52.2%	2.0%
7-ft channel Jan-May 100%reliability	20.5%	42.5%	22.0%
7-ft channel Jan-May 90%reliability	49.3%	68.5%	19.2%

Note: WMA = water management alternative.

4.2.6.2.4 Fish and Wildlife Conservation

Under this alternative, operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced (see section 4.2.1.2.4).

Implementing this alternative would provide somewhat more favorable conditions for fish and wildlife. As compared with Water Management Alternative 1, the annual maximum of growing season (April–October) floodplain connectivity to the main channel for 30 consecutive days would be 19,860 ac, 1,821 ac more than Water Management Alternative 1; the median fall rate would be 0.12 ft/day (same as for Water Management Alternative 1); and the maximum fall rate would be 2.01 ft/day rather than 2.07. Other performance measures associated with this water management alternative are shown in Table 4.2-23.

Table 4.2-23.
Listed Species Performance Measures for Water Management Alternative 6

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	1.4	0	0
< 6,000	27.4	0	0
< 7,000	35.6	0	0
< 8,000	49.3	0	0
< 9,000	54.8	8	7
< 10,000	89.0	72	44

4.2.6.2.5 Recreation

Under Water Management Alternative 6 (Table 4.2-24), the pool levels at Lake Lanier during the recreation season would be below the IIL, RIL, and WAL much more often than under Water Management Alternative 1. At West Point Lake, lake levels during the recreation season would be below the IIL, RIL, and WAL considerably more often than under Water Management Alternative 1. At Walter F. George Lake, pool levels would be below the IIL 235 weeks compared to 28 weeks under Water Management Alternative 1 and below the RIL 8 weeks compared to no weeks.

Table 4.2-24.
Recreation Water Levels for Water Management Alternative 6

	Project		
	Buford (May-Sep)	**West Point (May-Sep)**	**Walter F. George (May-Sep)**
Number of weeks below IIL during period of record	518	534	235
Number of weeks below RIL during period of record	135	111	8
Number of days below WAL during period of record	261	230	0
Percent of time below IIL	33	36	16
Percent of time below RIL	9	7	1
Percent of time below WAL	2	2	0

4.2.6.2.6 Water Quality

The implications of Water Management Alternative 6 relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.6.

4.2.6.2.7 Water Supply

The implications of Water Management Alternative 6 relative to water supply purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.7.

4.2.7 Water Management Alternative 7

4.2.7.1 Description of Water Management Alternative 7

Water Management Alternative 7 is similar to Water Management Alternative 2 except the drought operations trigger is Zone 3 rather than Zone 4. It was developed to refine Alternative 2 and address the objective of *reducing or eliminating the chances of prematurely returning to drought operations and reducing flows below Jim Woodruff Lock and Dam below 5,000 cfs*. This alternative consists of the following measures:

- Current guide curves (same as Water Management Alternative 1)
- Revised Level 1 action zones (same as Water Management Alternative 2) (see section 4.1.2.2.2.2)
- Drought operations
  - Drought operations trigger-Zone 3 (see section 4.1.2.3.2.1)
  - Drought operations suspension trigger-Zone 1 (same as Water Management Alternative 1) (see section 4.1.2.3.2.2)
  - Drought zone operations (same as Water Management Alternative 1)
- Seasonal flow at Peachtree Creek (750 cfs [May–Oct] and 650 cfs [Nov–Apr]) (same as Water Management Alternative 2) (see section 4.1.2.4.2)
- Modified generation schedule with drought operations (same as Water Management Alternative 2) (see section 4.1.2.5.4)
- 4/5 month navigation (7-ft) (same as Water Management Alternative 2) (see section 4.1.2.6.4)

- Current BI Method (same as Water Management Alternative 1) (see section 4.1.2.7.1)
- Current fish spawn procedures (same as Water Management Alternative 1) (see section 4.1.2.8.1)
- Current fish passage procedures (same as Water Management Alternative 1) (see section 4.1.2.8.2)
- Listed species management
  - Current ramping rates (same as Water Management Alternative 1)
  - Suspension of ramping rates in drought (triggered when composite conservation storage falls into Zone 3)
  - Suspension of ramping rates during prolonged low flow (same as Water Management Alternative 2) (see section 4.1.2.8.8.3)
  - Current minimum flow provisions at the Chattahoochee, Florida, USGS gage on the Apalachicola River (same as Water Management Alternative 1)
- Water supply operations limited to 20 mgd for relocation contracts and 277 mgd for downstream withdrawal by Metro Atlanta (same as Water Management Alternative 1)
- Figure 4.2-1 shows the composite conservation storage associated with the revised level 1 action zones included in Water Management Alternative 7. Composite conservation storage is an important parameter used in making release decisions during drought operations and endangered species operations.

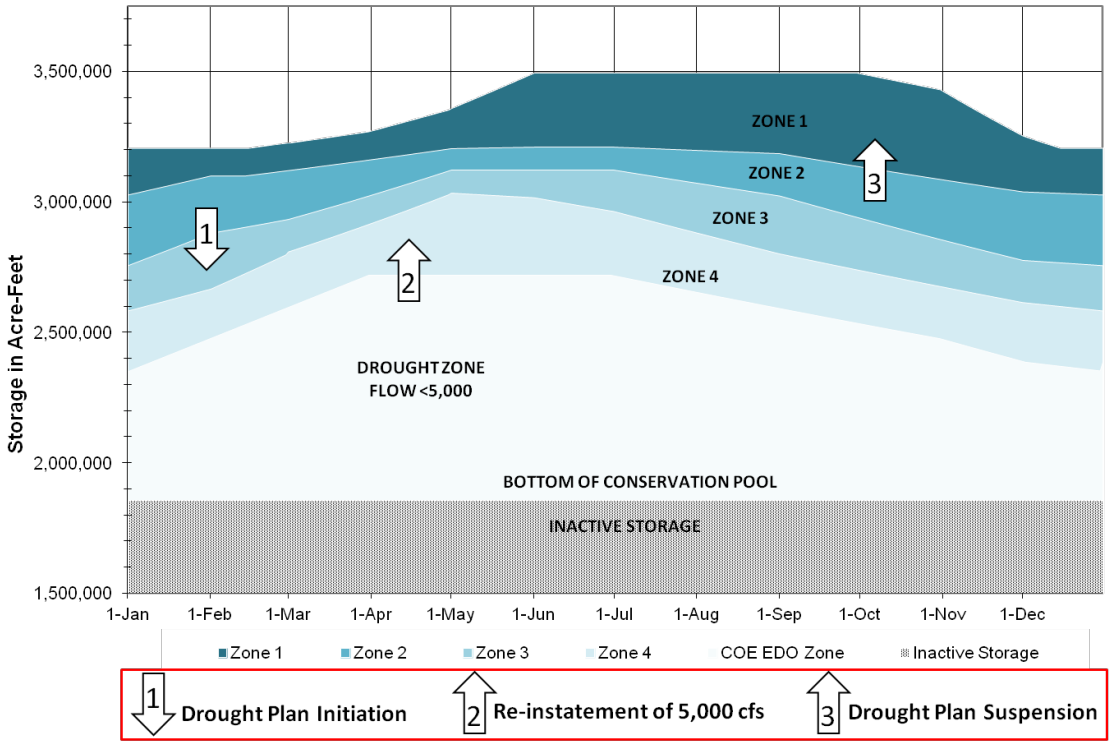


Figure 4.2-1. Composite Conservation Storage Zones and Drought Plan Triggers for Water Management Alternative 7.

4.2.7.2 Performance Relative to Authorized Purposes

4.2.7.2.1 Flood Risk Management

The effects of Water Management Alternative 7 on flood risk management at Lake Lanier and West Point Lake would be expected to be essentially the same as for Water Management Alternative 1 (section 4.2.1.2.1). Since no guide curves are modified under this alternative, it would not likely have any impact on flood risk management in the ACF Basin.

4.2.7.2.2 Hydroelectric Power Generation

Under Water Management Alternative 7 (Table 4.2-25), the general hydroelectric power generation schedule would be the same as under Water Management Alternative 2. System annual hydropower generation would be 977 MWh (0.1 percent) less than Water Management Alternative 1 and system annual weekday generation would be 887 MWh (0.1 percent) less.

Table 4.2-25.
Hydropower Generation at ACF Projects for Water Management Alternative 7

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	139,151	111,907	1.47
West Point	181,151	137,136	1.36
Walter F. George	472,702	346,000	1.14

4.2.7.2.3 Navigation

Navigation operations for this alternative would be the same as under Water Management Alternative 2, as described in section 4.1.2.6.4 and addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a 4/5 month navigation season. A comparison of the navigation channel availability under Water Management Alternative 7 with that under Water Management Alternative 1 is shown in Table 4.2-26. This alternative would provide a more dependable 7-ft navigation channel but a less dependable 9-ft channel.

Table 4.2-26.
Navigation Channel Availability under Water Management Alternative 7 Compared to Water Management Alternative 1

	WMA1	WMA7	Change from WMA1
9-ft channel Jan-Dec	34.7%	34.4%	-0.3%
9-ft channel Jan-May 100%reliability	5.5%	4.1%	-1.4%
9-ft channel Jan-May 90%reliability	19.2%	17.8%	-1.4%
7-ft channel Jan-Dec	50.2%	53.9%	3.7%
7-ft channel Jan-May 100%reliability	20.5%	43.8%	23.3%
7-ft channel Jan-May 90%reliability	49.3%	75.3	26.0%

Note: WMA = water management alternative.

4.2.7.2.4 Fish and Wildlife Conservation

Under this alternative, operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced (see section 4.2.1.2.4).

Implementing this alternative would provide somewhat more favorable conditions for fish and wildlife than Water Management Alternative 1. The annual maximum of growing season (April–October) floodplain connectivity to the main channel for 30 consecutive days would be 18,386 ac, 347 ac more than Water Management Alternative 1; the median fall rate would be 0.12 feet ft/day (same as for Water Management Alternative 1); and the maximum fall rate would be 2.08 feet ft/day rather than 2.07. Other performance measures associated with this water management alternative are shown in Table 4.2-27.

Table 4.2-27.
Listed Species Performance Measures for Water Management Alternative 7

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	1.4	0	0
< 6,000	34.2	0	0
< 7,000	47.9	0	0
< 8,000	63.0	6	5
< 9,000	79.5	36	12
< 10,000	91.8	58	26

4.2.7.2.5 Recreation

Under Water Management Alternative 7 (Table 4.2-28), the pool levels at Lake Lanier during the recreation season would be below the IIL, RIL, and WAL somewhat less often than under Water Management Alternative 1. At West Point Lake, lake levels during the recreation season would be below the IIL and RIL less often than under Water Management Alternative 1, but below the WAL somewhat more often. At Walter F. George Lake, pool levels would be below the IIL 89 weeks compared to 28 weeks under Water Management Alternative 1 and below the RIL 5 weeks compared to no weeks.

Table 4.2-28.
Recreation Water Levels for Water Management Alternative 7

	Project		
	Buford (May-Sep)	West Point (May-Sep)	Walter F. George (May-Sep)
Number of weeks below IIL during period of record	294	335	89
Number of weeks below RIL during period of record	80	46	5
Number of days below WAL during period of record	28	113	0
Percent of time below IIL	19	23	6
Percent of time below RIL	5	3	0
Percent of time below WAL	0	1	0

4.2.7.2.6 Water Quality

The implications of Water Management Alternative 7 relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 2 in section 4.2.2.2.6.

4.2.7.2.7 Water Supply

The implications of Water Management Alternative 7 relative to water supply purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Water Management Alternative 1 in section 4.2.1.2.7.

4.3 Identification of Proposed Water Management Alternative

To assist in identifying the water management alternative that best satisfies the objectives for the Master WCM update, USACE developed a process for ranking the performance of the alternatives based on HEC-ResSim modeling results. Performance measures defined for the various project purposes are described in the following sections. Based on the values of the performance measures resulting from HEC-ResSim modeling, the alternatives were ranked from 1 (best performance) to 7 (worst performance). It is noted that for some performance measures, a low numeric value is preferable to a higher value while for other performance measures a high value is preferable to a lower value. The ranking process took this into account and is described in subsequent sections.

4.3.1 Flood Risk Management

As stated in section 1.4.4, any proposed measure (or alternative) considered in the update process for the Master WCM should maintain at least the current level of flood risk management. None of the water management alternatives considered would change the level of flood risk management provided by the ACF projects. Therefore, water management alternatives were not ranked for this purpose.

4.3.2 Hydroelectric Power Generation

System performance of each water management alternative in achieving the hydropower purpose was ranked on annual hydropower generation and annual weekday hydropower generation. For Buford Dam, West Point Dam, and Walter F. George Lock and Dam, in addition to annual hydropower generation and annual weekday hydropower generation, lowest annual hydropower capacity (MW) also was considered. Generation at Jim Woodruff Lock and Dam was not considered because it is a run-of-the-river plant that operates on a continuous (24/7) basis, except during low flow conditions or special maintenance outages. Table 4.3-1 lists the system annual hydropower generation and the system annual weekday hydropower generation together with the rank of each water management alternative in achieving this output. As can be seen from the table, the Water Management Alternative 1 would provide the greatest system hydropower value as well as the highest system annual weekday generation value. Considering both annual hydropower generation and annual weekday hydropower generation, Water Management Alternative 1 would provide system hydropower to a greater extent than the other water management alternatives and was ranked first. It should be noted, however, that the difference in system generation between Water Management Alternative 1 and Water Management Alternative 4 (ranked number 7) is only 0.2 percent and the difference in system weekday generation is only 1.0 percent.

Rankings of hydropower performance for Buford, West Point, and Walter F. George dams are shown in Table 4.3-2, Table 4.3-3, and Table 4.3-4, respectively, and the overall ranking for the hydropower purpose is shown in Table 4.3-5. To derive the overall hydropower ranking, the system and individual project rankings were summed and then ranked based on the sum.

Table 4.3-1.
Ranking Water Management Alternatives for Hydropower System Performance

Water Management Alternative	Annual System Hydropower Generation		Annual Weekday System Hydropower Generation		Sum of Rankings	Composite System Hydropower Ranking
	MWh	Rank	MWh	Rank		
1	1,049,022	1	777,455	1	2	**1**
2	1,048,158	3	775,705	5	8	**2**
3	1,046,443	7	776,792	2	9	**5**
4	1,046,652	6	769,807	6	12	**7**
5	1,048,078	4	776,116	4	8	**2**
6	1,048,845	2	767,318	7	9	**5**
7	1,048,044	5	776,568	3	8	**2**

Table 4.3-2.
Ranking Water Management Alternatives for Hydropower Performance at Buford Dam

Water Management Alternative	Annual Hydropower Generation		Annual Weekday Hydropower Generation		Buford, Lowest Annual Hydropower Capacity (116.5 MW)		Sum of Rankings	Composite Hydropower Ranking
	MWh	Rank	MWh	Rank	MW	Rank		
1	139,035	4	112,659	1	110.15	1	6	**1**
2	139,107	3	112,034	3	109.80	3	9	**3**
3	138,431	7	111,033	5	109.52	4	16	**5**
4	138,952	5	110,575	6	101.10	7	18	**6**
5	139,110	2	112,097	2	109.52	5	9	**4**
6	138,684	6	105,895	7	108.33	6	19	**7**
7	139,115	1	111,907	4	110.00	2	7	**2**

Table 4.3-3.
Ranking Water Management Alternatives for Hydropower Performance at West Point Dam

Water Management Alternative	Annual Hydropower Generation		Annual Weekday Hydropower Generation		West Point, Lowest Annual Hydropower Capacity (85.5 MW)		Sum of Rankings	Composite Hydropower Ranking
	MWh	Rank	MWh	Rank	MW	Rank		
1	181,153	3	137,691	1	85.00	3	7	**1**
2	181,134	5	136,693	4	84.99	5	14	**6**
3	180,855	6	136,447	5	85.02	1	12	**5**
4	180,853	7	135,188	7	84.94	7	21	**7**
5	181,181	2	136,973	3	84.99	4	9	**2**
6	181,183	1	135,222	6	85.00	2	9	**2**
7	181,151	4	137,136	2	84.99	5	11	**4**

Table 4.3-4.
Ranking Water Management Alternatives for Hydropower Performance at Walter F. George Lock and Dam

Water Management Alternative	Annual Hydropower Generation		Annual Weekday Hydropower Generation		WFG, Lowest Annual Hydropower Capacity (167.6 MW)		Sum of Rankings	Composite Hydropower Ranking
	MWh	Rank	MWh	Rank	MW	Rank		
1	473,474	1	345,228	4	166.269	3	8	**1**
2	472,714	5	345,179	5	166.264	6	16	**7**
3	472,209	7	347,619	1	166.264	7	15	**6**
4	472,932	3	342,953	7	166.319	1	11	**3**
5	472,757	4	345,562	3	166.264	5	12	**4**
6	473,075	2	343,606	6	166.273	2	10	**2**
7	472,702	6	346,000	2	166.264	4	12	**4**

Note: WFG = Walter F. George Lock and Dam.

Table 4.3-5.
Ranking Water Management Alternatives for Hydropower Composite Performance

Water Management Alternative	Composite Rankings[a]				Sum of Rankings	Composite Hydropower Ranking
	Buford Dam	West Point Dam	Walter F. George Lock and Dam	System		
1	**1**	**1**	**1**	**1**	4	**1**
2	**3**	**6**	**7**	**2**	18	**5**
3	**5**	**5**	**6**	**5**	21	**6**
4	**6**	**7**	**3**	**7**	23	**7**
5	**3**	**2**	**4**	**2**	11	**2**
6	**7**	**2**	**2**	**5**	16	**4**
7	**2**	**4**	**4**	**2**	12	**3**

Note:
a. From Table 4.3-2, Table 4.3-3, and Table 4.3-4, respectively.

4.3.3 Navigation

System performance of each water management alternative in providing for navigation was ranked on two criteria:

- Percent of time a 9-ft navigation channel would be available (January–May) in the Apalachicola River based on exceeding a flow of 20,600 cfs at Blountstown
- Percent of time a 7-ft navigation channel would be available (January–May) in the Apalachicola River based on exceeding a flow of 16,200 cfs at Blountstown

The percent availability of the 9-ft and 7-ft channels is shown in Table 4.3-6 together with the rank of each water management alternative in achieving the specified channel depth. As can be seen from the table, Alt3 would provide a 9-ft channel 6.8 percent of the time, more often than any other alternative, and was ranked first. Water management alternatives 2 and 7, however, would each provide a 7-ft channel more often than other alternatives. Based on the availability of both the 9-ft and 7-ft channels, water management alternatives 2, 3, 6, and 7 would provide a navigable channel during January–May to a greater extent than the other water management alternatives.

Table 4.3-6.
Ranking Water Management Alternatives on Navigation Performance

Water Management Alternative	9-ft Channel		7-ft Channel		Sum of Ranking	Composite Navigation Ranking
	Percent	Rank	Percent	Rank		
1	5.5%	2	20.5%	7	9	**5**
2	4.1%	4	43.8%	1	5	**1**
3	6.8%	1	39.7%	4	5	**1**
4	2.7%	6	39.7%	4	10	**6**
5	2.7%	6	38.4%	6	12	**7**
6	5.5%	2	42.5%	3	5	**1**
7	4.1%	4	43.8%	1	5	**1**

4.3.4 Fish and Wildlife Conservation

The degree to which a water management alternative satisfied the fish and wildlife conservation project purpose was determined based on examination of the following six indicators:

- Percent of years with days < flow
- Median number of days per year < flow
- Median consecutive days per year < flow
- Annual maximum 30-day growing season floodplain connectivity (ac)
- Median fall rates
- Maximum fall rate

The fish and wildlife conservation performance indicators were identified by USFWS in a PAL during early coordination efforts for the Master WCM update. Some of the same indicators were previously used in BAs and Biological Opinions prepared during ESA section 7 consultation for ongoing ACF project operations. USFWS has not suggested or recommended that one or more of the indicators would be more important, or have more influence, than others. Further, the draft Fish and Wildlife Coordination Act Report in July 2015 did not offer specific guidance or recommendations on the relative importance of the individual indicators compared to each other. In the absence of any scientific reasons to give one parameter more weight than another, the evaluation process weighted each indicator equally in assessing effects of various water management alternatives.

The water management alternatives were ranked for each indicator. The first three indicators above can be expressed graphically. For example, Figure 4.3-1 displays the percent of years with flow less than various values for the seven water management alternatives. For these three graphed indicators, the area under the curve was determined for each alternative and ranked with the smallest area receiving the rank of 1 and the largest area receiving the rank of 7. For the floodplain connectivity indicator, the water management alternative with the largest acreage was ranked first and the smallest acreage was ranked last. For the median and maximum fall rates indicators, the water management alternative with the smallest fall rate was ranked first. Table 4.3-7 shows the fish and wildlife conservation performance rankings.

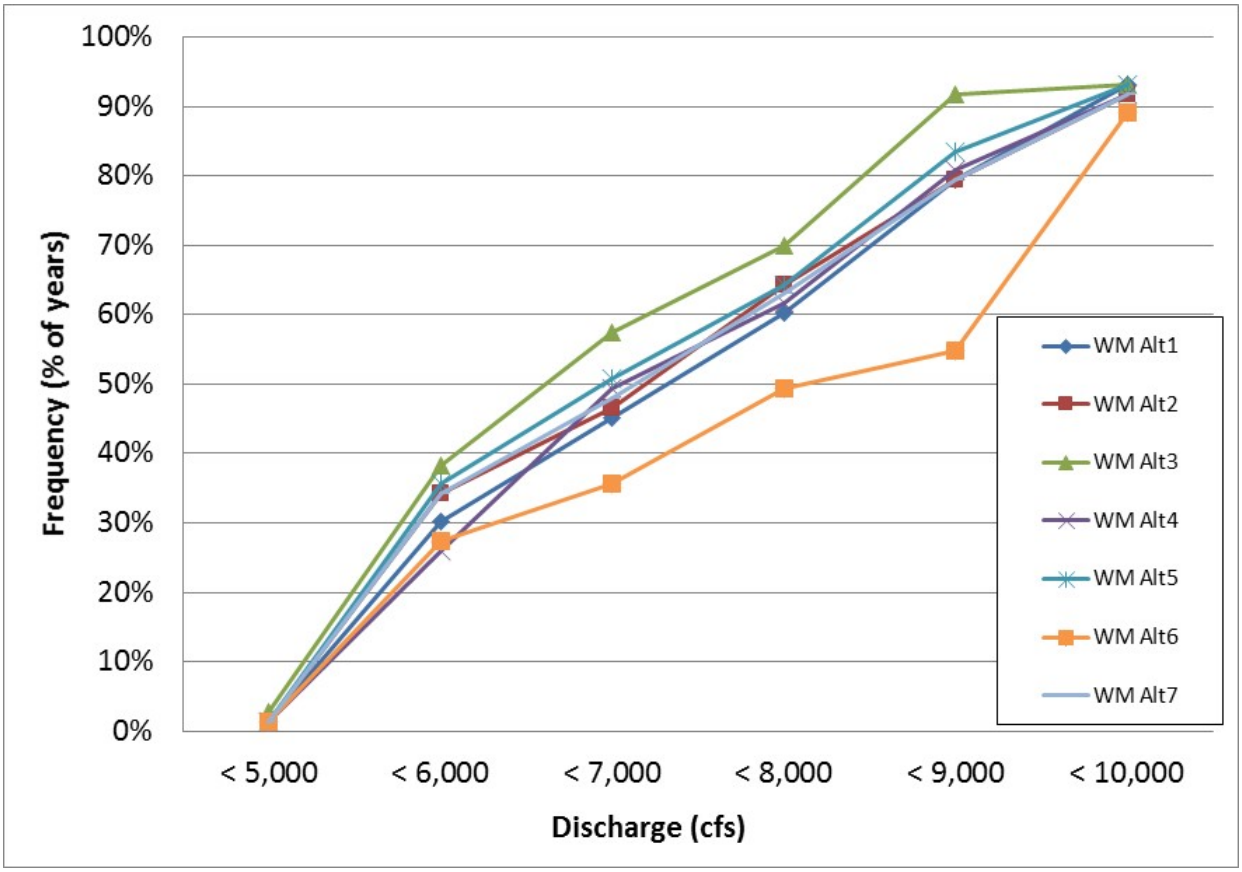


Figure 4.3-1. Percent of Years with Days of Less Than Flow.

Table 4.3-7.
Ranking Water Management Alternatives for Fish and Wildlife Conservation Performance

	WMA1	WMA2	WMA3	WMA4	WMA5	WMA6	WMA7
Percent of years with days < flow	2	4	7	3	6	1	4
Median # days/yr < flow	4	4	7	2	6	1	3
Median # consecutive days/yr < flow	3	1	7	6	4	5	2
Annual maximum 30-day growing season floodplain connectivity (ac)	7	4	2	6	3	1	5
Median fall rates	7	5	2	2	2	1	6
Maximum fall rates	2	4	5	5	5	1	3
Total	25	22	30	24	26	10	23
Ranking	**5**	**2**	**7**	**4**	**6**	**1**	**3**

Note: WMA = water management alternative.

4.3.5 Recreation

System performance of each water management alternative in achieving the recreation purpose was based on several measures at Lake Lanier, West Point Lake, and Walter F. George Lake as follows:

- Number of weeks below IIL during the recreation season during period of record
- Number of weeks below RIL during the recreation season during period of record
- Number of days below WAL during the recreation season during period of record
- Percent of time below IIL during the recreation season
- Percent of time below RIL during the recreation season
- Percent of time below WAL during the recreation season

Table 4.3-8 illustrates the ranking of alternatives in achieving the recreation purpose at Lake Lanier. As shown in the table, the water surface elevation under the Water Management Alternative 1 falls below the initial impact line (1,066 ft) for 119 days, less than any other water management alternative. The performance of Water Management Alternative 1 at Lake Lanier is also ranked better than the other alternatives for the other performance measures. Rankings of water management alternatives for West Point and Walter F. George lakes are shown in Table 4.3-9 and Table 4.3-10, respectively.

Table 4.3-8.
Ranking Water Management Alternatives for Recreation Performance at Lake Lanier

Water Management Alternative	Number of Weeks below IIL (1,066 ft)		Number of Weeks below RIL (1,063 ft)		Number of days below WAL (1,060 ft)		Percent of Time below IIL (1,066 ft)		Percent of Time below RIL (1,063 ft)		Percent of Time below WAL (1,060 ft)		Sum of Rankings	Composite Recreation Ranking for Lake Lanier
	Weeks	Rank	Weeks	Rank	Days	Rank	%	Rank	%	Rank	%	Rank		
1	275	1	77	1	9	1	17.6	1	5.0	1	0.1	1	6	**1**
2	346	4	98	3	68	3	22.0	3	6.3	3	0.6	3	19	**3**
3	451	6	116	5	178	5	28.8	6	7.6	5	1.6	5	32	**5**
4	449	5	133	6	428	7	28.6	5	8.5	6	3.8	7	36	**6**
5	344	3	98	3	78	4	22.3	4	6.4	4	0.7	4	22	**4**
6	518	7	135	7	261	6	33.1	7	8.6	7	2.3	6	40	**7**
7	294	2	80	2	28	2	18.9	2	5.1	2	0.3	2	12	**2**

Table 4.3-9.
Ranking Water Management Alternatives for Recreation Performance at West Point Lake

Water Management Alternative	Number of Weeks below IIL (632.5 ft)		Number of Weeks below RIL (629 ft)		Number of Days below WAL (627 ft)		Percent of Time below IIL (632.5 ft)		Percent of Time below RIL (629 ft)		Percent of Time below WAL (627 ft)		Sum of Rankings	Composite Recreation Ranking for West Point Lake
	Weeks	Rank	Weeks	Rank	Days	Rank	%	Rank	%	Rank	%	Rank		
1	300	1	45	1	111	4	20.2	1	3.0	1	1.0	4	12	**1**
2	378	4	65	4	104	2	25.1	4	4.3	4	0.9	2	20	**4**
3	521	6	81	5	102	1	36.1	7	5.4	5	0.9	1	25	**5**
4	510	5	106	6	247	7	33.8	5	7.1	6	2.2	7	36	**6**
5	340	3	55	3	109	3	23.1	3	3.7	3	1.0	3	18	**2**
6	534	7	111	7	230	6	35.8	6	7.5	7	2.1	6	39	**7**
7	335	2	46	2	113	5	22.8	2	3.2	2	1.0	5	18	**2**

Table 4.3-10.
Ranking Water Management Alternatives for Recreation Performance at Walter F. George Lake

Water Management Alternative	Number of Weeks below IIL (187 ft)		Number of Weeks below RIL (185 ft)		Number of Days below WAL (184 ft)		Percent of Time below IIL (187 ft)		Percent of Time below RIL (185 ft)		Percent of Time below WAL (184 ft)		Sum of Rankings	Composite Recreation Ranking for Walter F. George Lake
	Weeks	Rank	Weeks	Rank	Days	Rank	%	Rank	%	Rank	%	Rank		
1	28	1	0	1	0	1	1.9	1	0.0	1	0.0	1	6	**1**
2	132	4	4	2	0	1	8.8	4	0.3	2	0.0	1	14	**3**
3	147	5	5	3	0	1	10.1	5	0.4	4	0.0	1	19	**5**
4	245	7	12	7	0	1	16.4	7	1.0	7	0.0	1	30	**7**
5	119	3	5	3	0	1	8.2	3	0.4	5	0.0	1	16	**4**
6	235	6	8	6	0	1	15.6	6	0.6	6	0.0	1	26	**6**
7	89	2	5	3	0	1	6.0	2	0.3	3	0.0	1	12	**2**

Similar rankings for the recreation purpose were developed for West Point Lake and Walter F. George Lake and a systemwide ranking of alternatives for the recreation purpose was derived as shown in Table 4.3-11.

Table 4.3-11.
Ranking Water Management Alternatives for Recreation Composite Performance

Water Management Alternative	Lake Lanier Ranking	West Point Lake Ranking	Walter F. George Lake Ranking	Sum of Rankings	Composite Ranking
1	**1**	**1**	**1**	3	**1**
2	**3**	**4**	**3**	10	**3**
3	**5**	**5**	**5**	15	**5**
4	**6**	**6**	**7**	19	**6**
5	**4**	**2**	**4**	10	**3**
6	**7**	**7**	**6**	20	**7**
7	**2**	**2**	**2**	6	**2**

4.3.6 Water Supply

The ability of a water management alternative to satisfy the water supply purpose was based on examining six parameters reflecting the adequacy of the conservation storage of Lake Lanier to provide the 20 mgd the relocation contracts and 277 mgd downstream withdrawals as follows:

- Buford project minimum pool elevation (ft)
- Buford project percent time Storage >/= Zone 1 (%)
- Buford project years in or below Zone 3 by December 1
- Percent time refill from Zone 3 to Zone 1 by May 1 the next year
- Buford project percent time at full pool by May 1 (1,071 ft)
- Percent time Buford project pool elevation > 1,066 ft during period of record

In the HEC-ResSim modeling the water supply, demand of the each water management alternative was met; the remaining storage, however, would impact the ability to meet that same demand during more severe drought conditions. Although the water supply demand was not curtailed during the modeled drought periods, there was a use of storage to meet the water supply demand in conjunction with other authorized project purposes. The demands for the other project purposes varied with each alternative and holding the water demand constant with each alternative allowed a comparison of impacts on other project purposes. As the remaining storage in Lake Lanier varied with each alternative, the yield of the remaining storage to meet the water supply demand from the lake also varied. The six parameters listed above are surrogate measures of remaining storage in the lake and capability to meet water supply demand during more severe hydrologic conditions. Consequently, there is lower risk of water supply shortage with increased available water in storage as measured by the six parameters. Therefore the higher pool elevations result in lower risk of water supply demand shortages during more severe conditions. The values for the parameters shown in Table 4.3-12 were ranked as shown in Table 4.3-13. Based on this ranking, Water Management Alternative 7 provides the best support of the water supply purpose.

Table 4.3-12.
Water Supply Performance for Water Management Alternatives at Lake Lanier

Water Management Alternative	Buford Project Minimum Pool Elevation (ft)	Buford Project Percent Time Storage >/= Zone 1 (%)	Buford Project yrs in or below Zone 3 by December 1	Percent Time Refill from Zone 3 to Zone 1 by May 1 the Next yr	Buford Project Percent Time at Full Pool by May 1 (1,071 ft)	Percent Time Buford Project Pool Elevation > 1,066 ft
1	1055.63	68%	14	31%	63%	76%
2	1053.87	69%	14	46%	63%	75%
3	1053.59	60%	14	46%	56%	68%
4	1045.26	62%	13	33%	47%	69%
5	1053.59	69%	13	42%	55%	76%
6	1051.90	53%	15	21%	38%	64%
7	1054.07	70%	12	55%	64%	78%

Table 4.3-13.
Ranking Water Management Alternatives for Water Supply Performance at Lake Lanier

Water Management Alternative	Buford Project Minimum Pool Elevation (ft) Rank	Buford Project Percent Time Storage >/= Zone 1 (%) Rank	Buford Project yrs in or below Zone 3 by December 1 Rank	Percent Time Refill from Zone 3 to Zone 1 by May 1 the Next yr Rank	Buford Project Percent Time At Full Pool by May 1 (1,071 ft) Rank	Percent Time Buford Project Pool Elevation > 1,066 ft Rank	Sum of Rankings	Composite Ranking
1	1	4	4	6	2	3	20	**3**
2	3	3	4	2	2	4	18	**2**
3	4	6	4	2	4	6	26	**5**
4	7	5	2	5	6	5	30	**6**
5	5	2	2	4	5	2	20	**3**
6	6	7	7	7	7	7	41	**7**
7	2	1	1	1	1	1	7	**1**

4.3.7 Proposed Water Management Alternative

After ranking the water management alternatives based on how well they achieved the authorized project purposes, an overall ranking was developed as shown in Table 4.3-14. The rankings by project purpose were added and the water management alternative with the lowest sum received a composite ranking of 1 and the water management alternative with the highest sum received a composite ranking of 7. The water management alternative that best balances the authorized project purposes is Water Management Alternative 7. Therefore, it was identified as the Proposed Water Management Alternative that, together with Water Management Alternative 1, was carried forward to Phase 2 of formulation.

The ranking process used to evaluate the performance of the water management alternatives considered each project purpose to be equally important and did not employ any unequal weighting of the purposes. The ACF Basin projects must be operated to meet all project purposes under a wide range of hydrological conditions, and the relative importance of the purposes could vary somewhat as conditions vary. In lieu of *weighting* project purposes in the evaluation process, USACE formulated an array of water management alternatives that emphasized operation for one or more project purposes with a lesser emphasis (or lower priority) on others.

Table 4.3-14.
Composite Ranking of Water Management Alternatives

Water Management Alternative	Composite Ranking						
	Navigation	Hydropower	Recreation	Fish & Wildlife	Water Supply	Sum of Rankings	Composite Ranking
1	**5**	**1**	**1**	**5**	**3**	15	**3**
2	**1**	**5**	**3**	**2**	**2**	13	**2**
3	**1**	**6**	**5**	**7**	**5**	24	**6**
4	**6**	**7**	**6**	**4**	**6**	29	**7**
5	**7**	**2**	**3**	**6**	**3**	21	**5**
6	**1**	**4**	**7**	**1**	**7**	20	**4**
7	**1**	**1**	**2**	**3**	**1**	8	**1**

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5 Development and Descriptions of Proposed Action and Alternatives

As discussed in section 4, the approach to formulating alternatives adopted in this EIS employed two phases[7].

- In the Phase 1 of alternative formulation, water management measures were developed and screened to identify the set of measures that were subsequently combined into water management alternatives. The water management alternatives were then evaluated and ranked based on performance metrics aligned with ACF project purposes. The result of alternative formulation phase 1 was the identification of the proposed water management alternative.
- In the Phase 2 of alternative formulation, measures for considering whether and how to accommodate current and future water supply demand, up to and including the Georgia 2015 request for water supply from Lake Lanier and for downstream withdrawers, were developed and screened to identify the set of water supply options that were then combined with either Water Management Alternative 1 or Water Management Alternative 7 to form alternatives that were evaluated in detail. The PAA resulting from this two-phased formulation process consists of the proposed water management alternative and a selected option for providing water supply to Metro Atlanta.

5.1 Alternative Formulation (Phase 2)

In addition to the water management challenges identified in section 4.2, there are problems related to water supply for Metro Atlanta that will be addressed by the Master WCM update process, the WSSA, and this EIS. Up to 128 mgd of water is being withdrawn from Lake Lanier without storage agreements. With the exception of two relocation agreements signed in the 1950s, all contractual agreements for water supply withdrawals from Lake Lanier were terminated in 1990. There have been several attempts at resolution (e.g., memorandum of agreement, Comprehensive Study, ACF Interstate River Basin Compact, court-ordered mediation, and administration-led negotiations), during which the parties (i.e., Alabama, Florida, and Georgia) informally agreed to a *live and let live policy*, which allowed water supply providers without storage agreements to continue current withdrawals and make reasonable increases in those withdrawals until a resolution was achieved. No mutually agreeable resolution among the states has been achieved and no water supply agreements have been executed (apart from the aforementioned relocation agreements).

The draft EIS considered the State of Georgia's 2013 water supply request. During public coordination of the draft EIS for the Master WCM update, the State of Georgia submitted a revised water supply request on December 4, 2015, based upon revised future population projections and water demands for Metro Atlanta. The State of Georgia's 2015 request indicates that withdrawals from Lake Lanier in 2050 amounting to 242 mgd, including 20 mgd for relocation contracts, are required to satisfy the needs of communities currently withdrawing from Lake Lanier under existing or expired contracts (e.g., 214 mgd for the City of Buford, City of Cumming/Forsyth County, City of Gainesville, and Gwinnett County) as well as communities located upstream of Lake Lanier[8] (e.g.,8 mgd for Habersham, Lumpkin, and White Counties and localities in those counties).

[7] The rationale for adopting a two-phase formulation process is explained in detail in section 4.

[8] A water supply need for Dawson County had been included in Georgia's 2013 request, but the updated demographic and water demand data indicated that no unmet need is expected to exist in Dawson County in 2050.

Georgia's 2015 water supply request is based on county-level water demand projections. These projections are a function of two variables: (1) future population and employment and (2) future water use by residents and employees. Projections of future water use includes specific projections of future per capita water use; future per employee water use; the impacts of water conservation measures, including codes and standards and the requirements of the Georgia Water Stewardship Act; and an adjustment to total demand to account for potential uncertainty in future projections.

Two sets of population and employment forecasts were used to project future water demand: (1) population and employment forecasts for 2020, 2030, 2040, and 2050 prepared by the Atlanta Regional Commission's Research and Analytics Division (ARC Forecasts) and (2) population forecasts for 2020, 2030, 2040, and 2050 issued by the Office and Planning and Budget in 2015 and correlating employment forecasts prepared by ARC (OPB Forecasts). ARC provided county-level population and employment forecasts that were calculated using a Regional Econometric Model (REMI model). Because OPB and ARC used differing methodologies, OPB did not provide corresponding forecasts of future employment. Therefore, corresponding forecasts of future employment were developed by ARC's Research and Analytics Division and included in all water demand scenarios using the OPB Forecasts.

Current and projected future water use for each county were calculated based on demographic data from the US census, water withdrawal data from GAEPD, water audit information from GAEPD and data from the MNGWPD regarding plumbing fixture stock. Additionally, customer billing data and water loss audit information was collected from utilities in the MNGWPD, including water use by customer class (e.g., residential, multi-family residential, commercial, institutional), water production, peak day demands, and water audit information. Water use data were standardized and compiled on a county basis, reflecting the individual mix of water uses across each county (e.g., residential, multi-family residential, commercial, institutional, municipal, irrigation, other, and self-supplied). Base water demand was calculated for each county for the years 2010, 2011, 2012, and 2014, as available, to create a representative base year. Because 2013 was atypically wet and water demands were unusually low, this year was not considered as a base year. The base year water demand incorporates the effects of the MNGWPD conservation program and existing state codes and standards.

Base water demands for each county were then paired with corresponding county-level population and employment forecasts from the OPB Forecasts and ARC Forecasts, and analyzed to develop two "baseline" water demand scenarios for each county: "Scenario 1 Baseline" using the ARC Forecasts and "Scenario 2 Baseline" using the OPB Forecasts. The effects of existing state and federal plumbing codes and laws, including the Georgia Water Stewardship Act, the National Energy Policy Act of 1992 and the US EPA Energy Star program. The analysis considered the replacement of toilets, urinals, showerheads, and clothes washing machines on a county-specific basis. This resulted in two additional sets of projections for each county in the MNGWPD: "Scenario 1 Enhanced Efficiency" and "Scenario 2 Enhanced Efficiency."

An uncertainty factor was used to adjust water demand projections to account for potential variability. This uncertainty factor was derived by analyzing historical variability in four water demand drivers (1) population growth rate, (2) Employment/population ratio, (3) per capita residential water use; and (4) per employee commercial water use. Probability distributions based on historical data were created for each demand driver and then used a Monte Carlo analysis (50,000 simulations) to determine future water demand probabilities based on the observed historical variability in the demand drivers. The results of this Monte Carlo analysis were used to estimate the range of probabilities around the median "enhanced efficiency" projections. The 65th percentile demand projection was used to calculate the uncertainty factor that was applied to each individual county. These county level water demand projections for the counties withdrawing from Lake Lanier were further refined to account for self-supplied sources and municipal groundwater production. A more detailed explanation of the water demand projection methodology is contained in Georgia's 2015 water supply request (GAEPD 2015a).

Table 5.1-1 shows the 2050 projected water supply demand for each county currently withdrawing or expected to withdraw from Lake Lanier.

Table 5.1-1.
State of Georgia 2015 Water Supply Request Lake Lanier

County	2050 Projected Demand (mgd)
Counties currently withdrawing from Lake Lanier	
• Forsyth	59
• Gwinnett	143
• Hall	32
Counties expected to withdraw from Lake Lanier located upstream of the lake	
• Habersham	0.88
• Lumpkin	4.47
• White	2.45
Total Lake Demand	242

Withdrawals downstream at Atlanta are currently accommodated by releases from Buford Dam as an originally authorized project purpose of the River and Harbor Act (RHA) of 1946; 277 mgd are currently withdrawn downstream, and Georgia has projected an increase of these withdrawals to be between 355 mgd and 379 mgd by 2050. Georgia's 2015 water supply request stipulates that "the variability in project river demands is driven largely by uncertainty regarding the supply available to the Cobb County-Marietta Water Authority (CCMWA) from Allatoona Lake in the ACT Basin, which is contested by the State of Alabama and others and is the subject of ongoing litigation against USACE. All Cobb County projections assume demands not met through withdrawals from Allatoona Lake will be met through withdrawals from the Chattahoochee River." Any additional reallocation for water supply for the CCMWA is subject to further analysis and approval and it is unknown when or if that action will take place. For the analysis in this final EIS, therefore, it is assumed that CCMWA will have no additional reallocation from Allatoona Lake and that 61 mgd will be withdrawn from the Chattahoochee River. This results in a total projected water supply demand of 379 mgd. Table 5.1-2 shows the 2050 projected water supply demand for each county currently withdrawing and expected to withdraw from the Chattahoochee River upstream of Peachtree Creek.

Table 5.1-2.
State of Georgia 2015 Water Supply Request
Chattahoochee River Upstream of Peachtree Creek

County	2050 Projected Demand (mgd)
Cobb	61
DeKalb	95
Fulton	223
Total Chattahoochee River Demand	379

The draft 1989 Master WCM that has guided project operations does not describe operations for providing 379 mgd. Additionally, no water supply storage has been formally allocated in Lake Lanier, for either current or future withdrawals. Therefore, the following problems with regard to water supply have been identified and will be addressed in the WSSA, the WCM update process, and this EIS:

- Current operations accommodate withdrawals that are not reflected in current water supply storage agreements, and would require execution of a storage agreement to continue under an updated Master WCM.
- Current operations of Buford Dam do not reflect the operations for downstream municipal and industrial (M&I) water supply identified in Georgia's 2015 request.
- Current operations of Buford Dam and Lake Lanier do not provide for Georgia's 2015 request for withdrawals from Lake Lanier for M&I water supply.

After identifying the water supply problems, USACE developed objectives for the WSSA to address the issues. In the context of this EIS, an *objective* is a statement of what the updated the Master WCM and the WSSA should try to achieve. Accordingly, the following objectives have been developed:

- To improve system operation to provide for Georgia's current and 2050 water supply demand downstream of Buford Dam.
- To determine whether, and in what amount, to reallocate storage in Lake Lanier to support environmentally sustainable withdrawals for M&I water supply while ensuring a sufficient quantity of water is available to meet other authorized project purposes of the ACF project.

5.1.1 Water Supply Measures Eliminated from Further Consideration (First Screening)

Among the scoping comments received, a number of specific water supply measures (or alternatives) were identified that were outside the scope of this EIS. Additionally, scoping comments identified a number of other specific water supply measures (or alternatives), some of which were eliminated from further consideration because they did not pass the screening criteria presented in section 1.4.4. Appendix D presents in detail specific water supply measures (or alternatives) identified in scoping that were eliminated from consideration for further evaluation. The scope of this EIS and the WSSA with respect to water supply is limited to considering Georgia's 2015 request. Accordingly, any measure proposed during public scoping that recommended addressing the water supply needs of any other entities not included in Georgia's 2015 request were not carried further for consideration.

5.1.2 Water Supply Measures Considered for Further Evaluation

Based on the June 2011 11th Circuit Court of Appeals ruling and the USACE legal opinion of June 25, 2012, USACE has concluded that it has sufficient authority under the original Buford Dam project authorization (1946 RHA), the Water Supply Act (WSA) of 1958, and the 1956 Act specific to Gwinnett County to accommodate both the current and increased levels of releases from Buford Dam. Additionally, USACE has concluded that it has discretion under the WSA of 1958 to accommodate additional direct withdrawals from Lake Lanier for water supply beyond the 20 mgd already authorized under relocation agreements (see sections 3.5.2.8.2 and 3.5.2.8.3). For analytical purposes, the EIS and WSSA assume that withdrawals from Lake Lanier at either current or increased levels would be accommodated by a reallocation of storage under the WSA of 1958; whether some subset of those withdrawals might be

accommodated instead under the authority of the 1956 Act would not affect the impacts analysis.[9] Releases from Buford Dam at current or increased levels would be authorized by the 1946 RHA. Accordingly, USACE is concurrently performing an assessment of a possible storage reallocation to accommodate current levels as well as increased levels of withdrawals for water supply from Lake Lanier and current levels and increased levels of releases for downstream water supply as specified in Georgia's 2015 request.

In addressing the downstream needs for water supply, the updated Master WCM and EIS will consider two levels of water supply for downstream Atlanta:

- 277 mgd (current withdrawals)
- 379 mgd (Georgia's 2015 request)

Glades Reservoir is another source of water supply considered by the draft WSSA and draft EIS in conjunction with potential reallocation of storage. As discussed in section 2.1.1.1.6.10 of the draft EIS, the Board of Commissioners, Hall County, Georgia, had applied for a Department of the Army (DA) permit under section 404 of the CWA for a proposed water supply reservoir project (Glades Reservoir) in Hall County to operate as part of a public water supply system. Since this project was still in the permitting process, it was not known when or if the project would be implemented. In considering alternative measures for water supply in the draft EIS, however, USACE took Glades Reservoir into account together with other water supply measures to satisfy Georgia's 2013 request. The assumption that Glades Reservoir would be constructed was made for analytical purposes only and did not constitute an agency decision on the merits of the project. In commenting on the draft EIS, GAEPD noted that the certification of need for Glades Reservoir had been rescinded and that Glades will not be constructed and operated for water supply during the 2015 request horizon (2050) because it is no longer needed for this purpose.[10] Subsequently, Hall County withdrew their DA permit application. Accordingly, the information in the final EIS about Glades Reservoir is presented only for informational purposes as it relates to alternatives considered in the draft EIS.

The measures listed below have been identified for satisfying Georgia's 2015 request for M&I water supply from Lake Lanier and are carried forward for further consideration in this final EIS.

- Conservation
- Groundwater
- Desalination and pumping to the service areas
- Existing surface water sources (other than Lake Lanier)
- New reservoir construction (nonfederal)
- Chattahoochee River withdrawal and pumping system
- Reallocation from flood control pool
- Reallocation from inactive storage
- Reallocation from conservation pool

The Glades Reservoir is no longer reasonably foreseeable and was not considered as a potential measure for satisfying a portion of Georgia's 2015 water supply request in the final EIS. For comparative purposes only, however, the PAA from the draft EIS, which assumed that Glades Reservoir would provide a portion of Georgia's 2040 need for water supply, has been retained, as described in section 5.1.3.8.

[9] Unless otherwise noted, discussion throughout this EIS of reallocation of storage to accommodate withdrawals from Lake Lanier assumes that the storage would be subject to a WSA agreement, encompassing the withdrawals that might otherwise be accommodated under an agreement pursuant to the 1956 Act.
[10] GAEPD letter dated January 29, 2016, page 10 of 31 (see ACF238 in appendix C) and exhibit H thereto.

5.1.3 Water Supply Measures Eliminated from Detailed Evaluation (Second Screening)

The measures for satisfying Georgia's 2015 request for M&I water supply from Lake Lanier identified above were considered and a preliminary evaluation was performed. When deciding which measures to consider in a more detailed evaluation, USACE assessed the results of the preliminary analysis against the screening criteria described in section 1.4. The results of the preliminary evaluation and screening process are described in the following paragraphs.

5.1.3.1 Conservation

Conservation is often the first step in reducing consumption and overall demand for water supply. Water providers within the district have been implementing multiple conservation measures to reduce demand. Conservation has been an important focus of the MNGWPD and is a cornerstone of their water supply plan. Measures include conservation pricing, leak detection and repair, plumbing and toilet retrofit programs, education programs, multifamily submetering, and water recycling (e.g., car washes). In 2011 per capita water use for the metro area was 148 gpcd (gallons per capita per day). GAEPD projects water use will decrease to an average of 135 gpcd by 2040. It is unlikely that additional conservation measures would result in a significant reduction in Georgia's 2050 need. To the extent that the MNGWPD adopts additional conservation measures, Georgia's 2015 request will satisfy needs beyond 2050. A more detailed summary of MNGWPD conservation-related activities is available in appendix G.

Although water conservation measures have been implemented within the basin with the intent to decrease per capita water use, the degree to which those measures will be effective is unknown. The water demand analysis conducted for this final EIS and the WSSA assumed that per capita water use rates would remain constant over the period of analysis. As a result, the full impact of implementing water conservation measures in the basin might not have been adequately captured in the water demand analysis; therefore, the water demand projections included in the final EIS and the WSSA should be considered to be on the high end of the range of potential future water demands in the basin.

5.1.3.2 Groundwater

Following the Phase I ruling of the Federal District Court for the Middle District Court of Florida in July 2009, the State of Georgia created the Water Task Force to develop a contingency plan to prioritize a set of water conservation and water supply options. The report detailed options for meeting the water supply needs of current and future Lake Lanier users if water withdrawals from Lake Lanier and releases from Buford Dam were halted. The report was prepared by a collection of architect-engineer firms and stakeholders. In the Georgia Water Task Force Report that was completed in 2009 (GWCTF 2009), groundwater was evaluated as a potential option to meet the water supply needs of the stakeholders. The potential groundwater sources identified were either for nonpotable reuse or were located in isolated areas and in relatively small quantities and would not be readily available to water supply systems dependent on Lake Lanier. Groundwater resources in MNGWPD are limited in quantity and are quite costly compared to other options; therefore, they are not considered adequate potential sources of water supply and were eliminated from further evaluation.

5.1.3.3 Desalination

In the Georgia Water Task Force Report, desalination was evaluated as a potential option to meet the water supply needs of the stakeholders. The study showed an estimated cost of approximately $21 billion over the project life. While the preliminary evaluation showed that this option could supply approximately 200 mgd, this was seen as the most expensive option and, therefore, is not carried forward in this evaluation. Other less expensive alternatives to reallocation described in sections 5.1.3.5 and 5.1.3.6 are considered in the WSSA for financial analysis purposes.

5.1.3.4 Existing Surface Water Sources (other than Lake Lanier)

The Georgia Water Task Force Report also evaluated the feasibility of existing surface water sources to meet the need if Lake Lanier and Buford Dam could no longer be operated for water supply. Potential sources include Lake Burton, West Point Lake, Lake Hartwell, and Nickajack Reservoir. Several of these sources would require interbasin transfer agreements or legislation before they could be used for the water supply purpose. Further, based on information in the report, none of these sources would satisfy the 2050 water supply need. All of these transfers were considered contentious or highly contentious by the stakeholders involved. Additionally, obtaining water from another USACE reservoir would require reallocation of storage. Existing surface water sources were not carried forward for further evaluation.

5.1.3.5 New Reservoir Construction (Nonfederal)

Under this alternative a several new water supply reservoirs would be developed upstream of Lake Lanier or on a tributary to Lake Lanier to serve the water supply needs of communities currently withdrawing from Lake Lanier. At this time specific sites have not been identified. The location, size, pump capacity, hydrologic information, and safe yield for any individual reservoir cannot be determined without a much more detailed study that would accompany actual pursuit of such an option. This alternative is considered in the WSSA for financial analysis purposes, but was found to be more expensive than other alternatives. Accordingly, this alternative was not carried forward for further evaluation.

5.1.3.6 Chattahoochee River Withdrawal and Pumping System

Another alternative considered would involve constructing new intakes for withdrawing water from the Chattahoochee River downstream of Buford Dam and pumping it upstream for use by users that otherwise would withdraw directly from Lake Lanier. It is assumed that a pipeline would be constructed on the eastern side of the Chattahoochee River to carry water to meet the water supply needs of the City of Buford, City of Gainesville, Gwinnett County, and Hall County, and that a pipeline would be constructed on the western side of the Chattahoochee River to meet the needs of the City of Cumming, Dawson County, Forsyth County, Habersham County, Lumpkin County, and White County. This alternative is considered in the WSSA for financial analysis purposes, but was found to be more expensive than other alternatives. Accordingly, this alternative was not carried forward for further evaluation.

5.1.3.7 Reallocation from Flood Control Storage and Inactive Storage

Flood storage at Buford Reservoir exists between elevations 1071 and 1085 and consists of 602,151 acre-feet (ac-ft). Reallocation from the flood pool could accommodate a portion of the future demand; however, reallocation from the flood control pool will not be carried forward for further evaluation for several reasons. Reallocation from the Lanier flood pool would represent an increased flood risk because compromised downstream channel capacity and development encroachment restrict Lanier flood water releases from Buford Dam to 10,000 cfs. Because flood releases must be limited to 10,000 cfs, it is necessary to maintain maximum amount of flood storage. Additionally, a permanent incursion into the flood pool could represent a dam safety risk due to saddle dike leaks that would increase as flood waters are retained, as well as increased guide curve elevations that could impact recreation facilities and private property resulting in significant economic impacts and increased shoreline erosion.

Reallocation from inactive storage also was considered and eliminated from further consideration because the Buford Dam hydropower project is designed with head limits at the bottom of the conservation pool. Hydropower generation utilizing water from the inactive pool damages equipment and is inefficient. The design of hydropower equipment at Buford Dam is optimized to function within the head range which corresponds to the conservation pool. Operation below the minimum rated head (bottom of conservation pool, inactive pool) would result in excessive cavitation and often vibration which could damage equipment. In addition operation in this range would decrease the efficiency and output of the unit.

5.1.3.8 Glades Reservoir

As stated in section 2.1.1.1.6.10, Glades Reservoir is estimated to have a safe yield of 72.5 mgd on an annual average daily basis. Georgia's 2013 request, however, assumed that the reservoir would yield 30–40 mgd. And, while this reservoir would not be a complete solution to the region's water supply needs as identified in Georgia's 2013 request, it could be part of a more comprehensive plan. Accordingly, in the draft EIS, Glades Reservoir was combined with other water supply measures to form more complete alternatives. For analytical purposes, USACE assumed that Glades Reservoir would have a yield of 40 mgd. As stated in section 5.1.2, Glades Reservoir is no longer reasonably foreseeable and is not considered in the final EIS as a potential measure for satisfying a portion of Georgia's 2015 water supply request. For comparative purposes only, however, the PAA from the draft EIS, which assumed that Glades Reservoir would provide a portion of Georgia's 2040 need for water supply, has been retained.

5.1.4 Water Supply Measures Combined into Options

Following the second screening, two measures remained for detailed evaluation in the draft EIS. Those measures were:

- Reallocation from conservation pool
- Reallocation from conservation pool with Glades Reservoir

The water supply options considered in the final EIS consist of combinations of downstream withdrawals and returns to the Chattahoochee River and withdrawals of various quantities from and returns to Lake Lanier as shown in Table 5.1-3. Options A through H were considered in the draft EIS. Some of those water supply options, however, are no longer valid in accordance with Georgia's 2015 request. For this reason, the highlighted water supply options C through G have been eliminated from further discussion in this final EIS. Option A has been retained as part of the NAA. Option B has been retained to facilitate comparisons with other alternatives. Option H has been retained only for comparison other water supply options considered in the final EIS. Several new water supply options, I through M, have been added and are described in subsequent paragraphs.

Table 5.1-3.
Water Supply Options Considered

Water Supply Option[a]	Lake Lanier Relocation (mgd)	Lake Lanier Reallocation (mgd)	Lake Lanier Total Withdrawals (mgd)	Lake Lanier Returns (mgd/% returned)	Glades Reservoir Withdrawals (mgd)	Glades Reservoir Returns (mgd/% returned)	Net Withdrawals from Lake Lanier (mgd)	Storage Required To Support Reallocation (ac-ft)	River Withdrawals (mgd)	River Returns (mgd/% returned)
A – No Action	20	108	128	37/29%	0	0	91	123,057	277	227/82%
B – Relocation only	20	0	20	10/50%	0	0	10	n/a	277	227/82%
C – FWOPC (w/ Glades pumping)	20	0	20	10/50%	40	20/50%	30	n/a	408	335/82%
D – GA 2013 request	20	277	297	163/55%	0	0	134	318,126	408	384/94%
E – GA 2013 request w/ Glades pumping	20	237	257	141/55%	40	22/55%	134	272,187	408	384/94%
F – GA 2013, projected return volume for 2035	20	277	297	91/30.6%	0	0	206	318,126	408	335/82%
G – GA 2013 max treatment facility capacity	20	277	297	128/43%	0	0	169	–[b]	408	477/117%
H – Projected return volume for 2035 w/ Glades pumping	20	165	185	75/40.4%	40	16/40.4%	134	188,003	408	384/94%
I – 225-mgd lake withdrawal, GA 2015 request downstream	20	205	225	91/40.4%	0	0	134	233,580	379	361/95%
J – FWOPC-revised	20	0	20	10/50%	0	0	10	n/a	379	361/95%
K – GA 2015 request	20	222	242	104/43%	0	0	137.4	254,170	379	361/95%
L – Current lake withdrawals, GA 2015 request downstream	20	108	128	37/29%	0	0	91	123,057	379	361/95%
M – Option H for Lanier w/o Glades, GA 2015 request downstream	20	165	185	40.4%	0	0	110.3	188,003	379	361/95%

Notes:
[a.] Water supply options shaded gray are not considered in the final EIS.
[b.] Storage for this water supply option was not computed because the option was not carried forward for further consideration, as explained in section 5.1.4.1.1.
FWOPC = future without project conditions

5.1.4.1 Return Rates

Responding to Georgia's water supply request involved considering not only the quantity of water requested and alternative methods of satisfying the requested quantity of water supply, but also the rates at which treated wastewater would be returned to Lake Lanier and downstream. The following paragraphs describe the return rates considered for the various water supply options presented in the draft EIS, as well as those considered in the final EIS.

5.1.4.1.1 Returns to Lake Lanier

Of the 128 mgd currently being withdrawn from Lake Lanier, current wastewater treatment infrastructure returns 37 mgd to Lake Lanier, a return rate of 29 percent (37/128=0.29). This return rate was used for water supply options A and L, as shown in Table 5.1-4. For water supply options B and C considered in the draft EIS, which considered a withdrawal of only 20 mgd, a 50-percent return rate was selected based on the capacity of the existing wastewater treatment infrastructure. Water supply option B is retained in the final EIS together with the 50-percent return rate; however, water supply option C was not retained in the final EIS. The 50-percent return rate also was used for water supply option J considered in the final EIS.

The analysis that accompanied Georgia's 2013 water supply request for 297 mgd assumed that in 2040, 165 mgd would be returned to Lake Lanier and its upstream tributaries resulting in a return rate of 55 percent (165/297= 0.55). This return rate was used for water supply options D and E in the draft EIS, neither of which is considered in the final EIS.

Table 5.1-4.
Current and 2035 Expanded Wastewater Treatment Plant Capacities above Buford Dam

Treatment Plant	County	NPDES Permit Discharge Limit (monthly avg mgd)	Current Plant Capacity (mgd)	2035 Expanded Plant Capacity (mgd)	Total Capacity in 2035 (mgd)
Clarkesville WPCP	Habersham	0.75	0.75		0.75
Demorest WPCP	Habersham	0.4	0.4		0.4
Cornelia WPCP	Habersham	3	3		3
Baldwin WPCP	Habersham	0.8	0.8		0.8
Cleveland WPCP	White	0.75	0.75		0.75
Dahlonega WPCP	Lumpkin	1.44	1.44		1.44
Limpkin Co. WPCP (proposed)	Lumpkin		0		0
Gainesville #2, Linwood WPCP	Hall	5	5	9	14
Gainesville #1, Flat Creek	Hall	12	12	6	18
Flowery Branch WPCP	Hall	0.4	0.91	8.09	9
Spout Springs LAS (proposed)	Hall		0.75	10.25	11
Hall County (proposed)	Hall		0	6	6
Lula WPCP (proposed)	Hall		0	1.8	1.8
F Wayne Hill	Gwinnett	40	40	25	65
Cumming Lake Lanier WRF (proposed)	Forsyth		0	15	15
Forsyth Lake Lanier WRF (proposed)	Forsyth		0	10	10
TOTAL		**64.54**	**65.8**	**91.14**	**156.94**

Note: NPDES = National Pollutant Discharge Elimination System.

Wastewater treatment plans developed by the MNGWPD identify new wastewater treatment plants and plant expansions that in the future (2035) would return a greater volume of water to Lake Lanier than currently occurs. USACE reviewed the current wastewater infrastructure returning to Lake Lanier as published in the MNGWPD Wastewater Plan to determine the total treatment capacity of the existing treatment plants, as well as planned plant expansions and new plants, anticipated by 2035. These plants and their current and expected expansions by 2035 are shown in Table 5.1-5. Additionally, USACE developed information regarding the percent of capacity at which the existing plants are currently operating. This analysis determined that, on average, all plants are currently operating at about 58 percent of capacity. Based on the new plants and plant expansions identified by the MNGWPD Wastewater Plan for 2035, USACE estimated that the total treatment capacity of all plants would be about 157 mgd, as shown in Table 5.1-4. Based on this analysis, achieving the 55 percent rate of return (165 mgd) indicated in Georgia's 2013 request would not be possible based on the wastewater treatment infrastructure expected to be in place by 2035. With the plants expected to be in-place by 2035 operating at 58 percent capacity, consistent with current operations, however, they would more realistically be capable of returning 91 mgd (157 mgd x .58=91 mgd) to Lake Lanier. This return volume was used for water supply option F in the draft EIS, which resulted in a return rate of 30.6 percent (91/297= 0.306). Water supply option F is not considered in the final EIS.

The 43 percent return rate used for water supply option G considered in the draft EIS represents the maximum treatment capacity of the existing waste treatment infrastructure in 2035. Option G, however, was not carried forward for more detailed consideration because it is not reasonable to expect waste treatment plants to operate at their maximum capacities on a consistent basis. Additionally, the impacts of this alternative would fall between two other alternatives that were considered in more detail. Water supply option G is not considered in the final EIS.

A preliminary evaluation of the effects of providing various levels of water supply from Lake Lanier indicated that Georgia's 2013 request for withdrawing 297 mgd and returning 55 percent, for a net withdrawal of 134 mgd, would satisfy both of the objectives identified in section 5.1. USACE also determined that the environmental effects associated with a net withdrawal of 134 mgd showed no change from the NAA or, for the most part, only slightly adverse effects. However, the return rate assumed in Georgia's 2013 request would require the waste treatment infrastructure expected to be in place by 2040 to operate at or near capacity. As stated above, this assumption seemed unreasonable. Accordingly, based on the analysis of potential future wastewater returns to Lake Lanier described above, USACE determined that a return of treated wastewater amounting to 91 mgd would be a more realistic estimate of potential wastewater returns by the future wastewater infrastructure, requiring the facilities to operate at 58 percent of capacity. Adding net withdrawals of 134 mgd (a net withdrawal that can be accommodated while satisfying other objectives) and returns of 91 mgd (the expected return in 2040) results in a figure of 225 mgd in gross withdrawal that can be supported by some combination of Lake Lanier and Glades Reservoir. Based on this rationale, water supply option H was developed whereby 20 mgd would be withdrawn from Lake Lanier under relocation contracts, storage in Lake Lanier would be reallocated to support gross withdrawals of 165 mgd, and Glades Reservoir would provide an additional 40 mgd for a total withdrawal for the ACF system above Buford Dam of 225 mgd. Under water supply option H, which was considered in the draft EIS, the return rate of 40.4 percent (91/225= .404) was used. Option H and the associated return rate of 40.4 percent also are considered in the final EIS, but only for comparative purposes. The return rate also is used for water supply options I and M, which both are considered in the final EIS.

Georgia's letter dated January 29, 2016, which provided comments on the draft EIS, included two memoranda regarding return rates associated with Georgia's revised water supply demands for 2050 (comment letter ACF238 in appendix C). One memorandum was from Wei Zeng, dated January 29, 2016 (exhibit F), and included information on return rates from counties upstream of Lake Lanier that are

expected to withdraw from the lake in the future. The other memorandum was from Katherine Zitsch, MNGWPD director, dated January 25, 2016 (exhibit I), and provided further details about the return rates to Lake Lanier and the Chattahoochee River applicable to MNGWPD counties. Information from the memoranda is summarized in the following paragraphs to document the return rates used for water supply option K.

MNGWPD is currently updating its 2009 water supply and water conservation management, wastewater management, and watershed management plans for 15-county Metro Atlanta. As part of this effort, MNGWPD has prepared water demand projections for the planning period extending to the year 2050. Those projections provided the basis for Georgia's 2015 request. The proportion of total water uses projected for 2050 was divided into indoor and outdoor water use fractions based on an analysis of historical seasonal water demand trends across customer categories for each county. County-level wastewater flow projections were developed based on the county-level indoor water use projections. To be consistent with the final MNGWPD water demand projections, the amount of indoor water use projected for each county was then increased by an uncertainty factor (3 percent in 2016, increasing to approximately 13 percent for the 2050 projections) to yield a projected wastewater flow for each county. The estimated wastewater flow for each county was then reduced by the projected volume of septic flow to yield the projected volume of wastewater entering the public wastewater collection system (i.e., sewered flow). Additionally, the estimated wastewater flow was adjusted for infiltration and inflow and interjurisdictional sewered flows.

Sewered flows described above were projected for each MNGWPD county without regard to the receiving water body. To determine treated wastewater discharge projections for each facility and receiving water body, MNGWPD evaluated projected wastewater treatment amounts along with local municipality input regarding planned future wastewater treatment capacities. MNGWPD then evaluated the total amount of treated wastewater generated and the amount expected to be returned to Lake Lanier by Forsyth County, Gwinnett County, and Hall County (and their respective cities and wastewater systems). In addition, GAEPD estimated that an additional 5.6 mgd would be returned in 2050 by the three upstream counties (Habersham, Lumpkin, and White) based upon a 70-percent return rate from the 8-mgd additional withdrawal from Lake Lanier by the three riparian counties upstream of Lanier. The 70-percent return rate is derived from the current return rate of 63 percent for the upstream counties, plus additional increases in sewered flow anticipated as those jurisdictions develop in the future. Table 5.1-5 shows the projected wastewater returns by county discharging into Lake Lanier for 2050. The return rate associated with Georgia's 2015 request is 43 percent (104.6/242=0.43) and was used for water supply option K in the final EIS.

Table 5.1-5.
Projections of Treated Wastewater Returns into Lake Lanier

County	2050 Projected Returns (aadf-mgd)
Forsyth	22.4
Gwinnett	60.0
Hall	16.6
Upstream Counties	5.6
Total Lake Returns	104.6

Note: aadf-mgd = average annual daily flow-million gallons per day.

5.1.4.1.2 Returns to the Chattahoochee River

To determine the current return rate for Metro Atlanta (Buford to Whitesburg), data were obtained for withdrawals of water from the Chattahoochee River and discharges of treated wastewater to the Chattahoochee River. This comparison for 2012 yielded a return rate of 82 percent, which was used for water supply options A, B, C, and F in the draft EIS, as shown in Table 5.1-3. As indicated above, water supply options C and F are not considered in the final EIS.

Georgia's 2013 request for 408 mgd from the Chattahoochee River also assumed that 384 mgd would be returned to the river, resulting in a return rate of 94 percent (384/408=0.94). USACE determined that this return rate was reasonable and used it for water supply options D, E, and H in the draft EIS. As indicated above, however, water supply options D and E are not considered in the final EIS.

A third return rate considered was based on the maximum wastewater treatment plant capacity in 2035 (MNGWPD 2009), resulting in a return rate of 117 percent. That return rate represents the maximum treatment capacity of the existing waste treatment infrastructure in 2035 and was used with water supply option G. As noted above, option G was not carried forward for more detailed consideration in the draft EIS or the final EIS because it is not reasonable to expect waste treatment plants to operate at their maximum capacities on a consistent basis.

A fourth return rate considered for the Metro Atlanta (Buford Dam to Whitesburg) reach was provided by MNGWPD Director Katherine Zitsch's memorandum referred to in section 5.1.4.1.1. Three counties—Forsyth, Fulton, and Gwinnett— discharge treated wastewater to the Chattahoochee River and tributaries upstream of Peachtree Creek and four counties—Cobb, Coweta, Douglas, and Fulton—discharge treated wastewater to the Chattahoochee River downstream of Peachtree Creek. Using a methodology similar to the one described in section 5.1.4.1.1 for the counties discharging into Lake Lanier, MNGWPD evaluated the total amount of treated wastewater generated and the amount expected to be returned to the Chattahoochee River downstream of Peachtree Creek. Table 5.1-6 shows the projected wastewater returns by county discharging into the Chattahoochee River and its tributaries for 2050. The return rate to the Chattahoochee River associated with Georgia's 2015 request is 95 percent (361/379=0.95) and was used for water supply options I, J, K, L, and M in the final EIS.

Table 5.1-6.
Projections of Treated Wastewater Return into the Chattahoochee River and Tributaries

County	2050 Projected Returns (aadf-mgd)
Returns above Peachtree Creek	
• Forsyth	6.8
• Fulton	52.9
• Gwinnett	22.2
Returns below Peachtree Creek	
• Cobb	66.8
• Coweta	8.0
• Douglas	10.2
• Fulton	194.0
Total Returns	361

Note: aadf-mgd = average annual daily flow-million gallons per day.

5.2 Development and Descriptions of Proposed Action and Alternatives

The alternatives described in subsequent sections combine either Water Management Alternative 1 described in section 4.2.1 or Water Management Alternative 7 (i.e., the Proposed Water Management Alternative described in section 4.2.7) with one of the water supply options A through M shown in Table 5.1-3.[11] The alternatives are identified by the number of the water management plan followed by the letter designating the water supply option included in the alternative. Table 5.2-1 shows the combination of water management alternatives and water supply options considered as alternatives. An *X* in Table 5.2-1 is used to indicate which water management measures are included in Water Management Alternative 1 and Water Management Alternative 7. Each of these alternatives was modeled in HEC-ResSim as described in section 4.1 and in appendix E.

The following paragraphs summarize each alternative and make comparisons to the NAA (Alternative 1A [Alt1A]). As a result of the comparisons of alternatives in this section, the PAA was identified. All alternatives, however, were evaluated in detail and the environmental consequences of each one are described in section 6.

5.2.1 No Action Alternative (Alternative 1A)

5.2.1.1 Description of No Action Alternative

Alt1A, the NAA, combines Water Management Alternative 1 with water supply option A, as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Alternative 1 (current operations)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Continuation of unauthorized gross water supply withdrawals from Lake Lanier of 108 mgd
- Releases from Buford Dam to support current downstream withdrawals of 277 mgd
- A return rate to Lake Lanier of 29 percent and a return rate to the Chattahoochee River of 82 percent (see Table 5.1-3 and section 5.1.4.1)

As stated in section 4.2.1.1, the NAA represents no change from the current management direction or level of management intensity. The NAA represents continuation of the current water management operations at each of the USACE projects in the ACF Basin. Basinwide management of all seven project purposes (i.e., flood risk management, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water quality, and water supply) also is considered in the alternative. The Council on Environmental Quality (CEQ) regulations for implementing NEPA require detailed analysis of the NAA (40 *Code of Federal Regulations* [CFR] 1502.14); therefore, Alt1A was carried forward for further evaluation.

5.2.1.2 Performance Relative to Authorized Purposes

5.2.1.2.1 Flood Risk Management

Under the NAA, flood risk management operations would continue as they have since 1989.

[11] Based on public comments on the draft EIS and Georgia's 2015 water supply request, water supply options C, D, E, F, and G included in the draft EIS have been eliminated from consideration and water supply options I, J, K, L, and M have been added.

Table 5.2-1.
Summary of Alternatives (Water Management / Water Supply)

Water Management Measures			1A (NAA)	1L	7A	7B	7H	7I	7J	7K	7L	7M
Guide Curves	Maintain existing guide curve		X	X	X	X	X	X	X	X	X	X
Action Zones	Maintain existing action zones		X	X								
	Revised Level 1 action zones				X	X	X	X	X	X	X	X
Drought Operations	Drought operations trigger[a]		Zone 4	Zone 4	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3	Zone 3
	Drought zone operations		X	X	X	X	X	X	X	X	X	X
	Drought operations suspension trigger[a]		Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1	Zone 1
Peachtree Creek Minimum Flows	Current (750 cfs)		X	X								
	Seasonal flow (750 cfs / 650 cfs)				X	X	X	X	X	X	X	X
Hydropower Generation	Current generation schedule		X	X								
	Modified generation schedule with drought operations				X	X	X	X	X	X	X	X
Navigation	Current-no navigation operations		X	X								
	4/5 Month				X	X	X	X	X	X	X	X
Basin Inflow	Current computational method		X	X	X	X	X	X	X	X	X	X
Fish and Wildlife	Current fish spawn and passage		X	X	X	X	X	X	X	X	X	X
Listed Species Management	RIOP May 2012		X	X								
	Ramping Rate	Current ramping rate[b]	X	X	X	X	X	X	X	X	X	X
		Suspend during prolonged low flow			X	X	X	X	X	X	X	X
		Suspend in drought[a]	X	X	X	X	X	X	X	X	X	X
	Current (seasonal) minimum flow provision[b]		X	X	X	X	X	X	X	X	X	X

Water Management Measures										
		1A (NAA)	**1L**	**7A**	**7B**	**7H**	**7I**	**7J**	**7K**	**7L**	**7M**
Water Supply Options (Table 5.1-3)[c]	A – No action	L=128 D=277		L=128 D=277							
	B – Relocation contracts only (in Lake Lanier)				L=20 D=277						
	H – GA 2013 (projected return volume for 2035 with Glades Reservoir pumping)					L=185 G=40 D=408					
	I – 225-mgd lake withdrawal, GA 2015 Request Downstream						L=225 D=379				
	J – FWOPC							L=20 D=379			
	K – GA 2015 Request								L=242 D=379		
	L – Current lake withdrawals, GA 2015 Request Downstream		L=128 D=379							L=128 D=379	
	M – Option H for Lanier w/o Glades, GA 2015 Request Downstream										L=205 D=379
		1A (NAA)	**1L**	**7A**	**7B**	**7H**	**7I**	**7J**	**7K**	**7L**	**7M**

Notes:

[a.] Based upon composite conservation storage zones (cumulative conservation storage [by zone] for USACE ACF reservoirs [Lanier, West Point, and Walter F. George]).

[b.] Component of the May 2012 Revised Interim Operations Plan (RIOP).

[c.] Numbers indicate withdrawals in mgd from Lake Lanier (L), Glades Reservoir (G), and the Chattahoochee River downstream (D) of Buford Dam.

5.2.1.2.2 Hydroelectric Power Generation

Under the NAA, the current typical hydroelectric power generation schedule shown in Table 4.1-5 would be maintained. Project operations under this alternative produce system annual generation of 1,023,469 megawatt-hours (MWh) and system annual weekday generation of 760,035 MWh. Annual and weekday generation at Buford, West Point, and Walter F. George dams is shown in Table 5.2-2. Generation at Jim Woodruff Lock and Dam is primarily a byproduct of the release requirements for federally listed species. Peaking operation occurs only when conditions allow, perhaps 1–2 hours a day, when releases are above 6,700 cfs. The project generates power 7 days a week, except when flow falls below 6,700 cfs. For these reasons and because all water management alternatives include protected species provisions, the power generation at Jim Woodruff Lock and Dam was not considered relevant to the comparison of alternatives.

Table 5.2-2.
Hydroelectric Power Generation by Project

Project	Annual Generation (MWh)	Annual Weekday Generation (MWh)	Weekday/Weekend Ratio
Buford	126,337	103,184	1.53
West Point	175,468	134,227	1.42
Walter F. George	466,973	341,353	1.13

5.2.1.2.3 Navigation

The NAA would continue the existing water management practices which do not include any specific measures to address the specific objective to *increase the reliability of navigation on the ACF system*. Without specific operations for navigation, the NAA would provide a 9-ft navigation channel (Blountstown flow >/= 20,600 cfs) 34.4 percent of the time on a year-round basis and a 7-ft navigation channel (Blountstown flow >/= 16,200 cfs) 49.8 percent of the time. Since this alternative has no specific operations for navigation, the reliability of adequate navigation flows is low. In comparison with other alternatives, the NAA would have the 7-ft channel fully available 20.5 percent of the time and 90 percent available 49.3 percent of the time during the January-May navigation season included in some alternatives. The 9-ft channel would be fully available 2.7 percent of the time and 90 percent available 17.8 percent of the time during January–May.

5.2.1.2.4 Fish and Wildlife Conservation

Under the NAA, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic Division Regulation (DR) PDS-O-1 (May 2010) and draft USACE, Mobile District Standard Operating Procedure (SOP) 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced. Additionally, operations defined in Mobile District SOPs that were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low dissolved oxygen (DO) values are observed in the tailrace would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and of USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources, consistent with other project purposes would also continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 17,858 ac; the median fall rate is 0.12 feet per day (ft/day); and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-3. Under this alternative, flows in the Apalachicola River would not be expected to drop below 5,000 cfs over the period of record and the system would be in drought operations 7 percent of the time. Drought zone operations would not be triggered in the NAA.

Table 5.2-3.
Listed Species Performance Measures for the NAA

Flow	% of yrs with flow less than	Median number of days/yr flow less than	Median number of consecutive days/yr flow less than
< 5,000	0.0	0	0
< 6,000	30.1	0	0
< 7,000	43.8	0	0
< 8,000	58.9	5	5
< 9,000	79.5	36	12
< 10,000	93.2	63	25

5.2.1.2.5 Recreation

Table 5.2-4. shows, for each USACE project, the percent of time the reservoir level is below the various impact levels during the recreation season for the NAA.

Table 5.2-4.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep)

Project	% of Time below IIL	% of Time below RIL	% of Time below WAL
Buford	23	8	3
West Point	22	3	1
Walter F. George	3	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.1.2.6 Water Quality

Under the NAA, Buford Dam, West Point Dam, and Jim Woodruff Lock and Dam all provide continuous minimum releases which, in addition to meeting other project purposes and providing associated benefits, also benefits downstream water quality. At West Point Dam, a small generating unit provides a continuous release of approximately 675 cfs. In addition to these flows, Buford Dam is operated in conjunction with the downstream Georgia Power Company (GPC) Morgan Falls Dam to ensure a minimum in-stream flow of 750 cfs on the Chattahoochee River at Peachtree Creek to meet state water quality commitments.

5.2.1.2.7 Water Supply

Under this alternative, releases from Buford Dam would be sufficient to provide for the current need of 277 mgd for downstream withdrawals by Metro Atlanta water providers and current withdrawals from Lake Lanier amounting to 128 mgd, including 20 mgd for the relocation contracts. The minimum reservoir elevation under this alternative would be 1,054.25 ft, and Lake Lanier would be in Zone 1 60 percent of the time.

5.2.2 Alternative 1L

5.2.2.1 Description of Alternative 1L

Alternative 1L (Alt1L) combines Water Management Alternative 1 with water supply option L, as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Alternative 1 (current operations)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Reallocation of storage in Lake Lanier sufficient to provide gross water supply withdrawals of 108 mgd
- Releases from Buford Dam to support downstream withdrawals of the estimated 2050 need of 379 mgd
- A return rate to Lake Lanier of 29 percent and a return rate to the Chattahoochee River of 95 percent (see Table 5.1-3 and section 5.1.4.1)

5.2.2.2 Performance Relative to Authorized Project Purposes

5.2.2.2.1 Flood Risk Management

Under Alt1L, flood risk management operations would continue as they have since 1989.

5.2.2.2.2 Hydroelectric Power Generation

Under Alt1L, the current typical hydroelectric power generation schedule shown in Table 4.1-5 would be maintained. Project operations under this alternative would produce system annual generation of 1,028,627 MWh and system annual weekday generation of 762,079 MWh. This is an increase in system power generation over the NAA resulting from the increase in releases from Buford Dam to accommodate the anticipated 2050 water supply needs for Metro Atlanta. Annual and weekday generation at Buford, West Point, and Walter F. George dams is shown in Table 5.2-5. Annual generation and annual weekday generation under Alt1L at Buford Dam would be slightly less than under the NAA and slightly greater than under the NAA at West Point Dam and Walter F. George Lock and Dam. The reduction in generation at Buford Dam is likely attributable to a slightly lower average daily head than under the NAA.

Table 5.2-5.
Hydroelectric Power Generation by Project for Alt1L Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt1L	NAA	Alt1L	NAA	Alt1L
Buford	126,337	126,305	103,184	102,075	1.53	1.46
West Point	175,468	177,710	134,227	135,536	1.42	1.40
Walter F. George	466,973	469,520	341,353	342,896	1.13	1.12

5.2.2.2.3 Navigation

Alt1L would continue the existing water management practices which do not include any specific measures to address the specific objective to *increase the reliability of navigation on the ACF system*. Under this alternative, a 9-ft navigation channel (Blountstown flow >/= 20,600 cfs) would be available 34.4 percent of the time on a year-round basis and a 7-ft navigation channel (Blountstown flow >/= 16,200 cfs) would be available 49.8 percent of the time. Since this alternative has no specific operations for navigation, the reliability of adequate navigation flow would low. Under Alt1L during the January-May timeframe, a 7-ft channel would be available in the Apalachicola River 20.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time, the same as under the NAA. A comparison of navigation channel availabilities under this alternative compared to the NAA is shown in Table 5.2-6.

Table 5.2-6.
Navigation Channel Availability under Alt1L Compared to the NAA

	NAA	Alt1L	Change from NAA
9-ft channel Jan–Dec	34.4%	34.5%	0.1%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	17.8%	0.0%
7-ft channel Jan–Dec	49.8%	50.0%	0.2%
7-ft channel Jan—May 100% reliability	20.5%	20.5%	0.0%
7-ft channel Jan—May 90% reliability	49.3%	49.3%	0.0%

5.2.2.2.4 Fish and Wildlife Conservation

Under Alt1L, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as currently practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as

currently practiced. Operations for listed species under Alt1L would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under Alt1L, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 17,878 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-7. Under this alternative, flows in the Apalachicola River would not be expected to drop below 5,000 cfs over the period of record (the same as under the NAA) and the system would be in drought operations 8 percent of the time (compared to 7 percent for the NAA). Drought zone operations would not be triggered in either the NAA or Alt1L.

Table 5.2-7.
Listed Species Performance Measures for Alt1L Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt1L	NAA	Alt1L	NAA	Alt1L
< 5,000	0.0	0.0	0	0	0	0
< 6,000	30.1	32.9	0	0	0	0
< 7,000	43.8	45.2	0	0	0	0
< 8,000	58.9	60.3	5	6	5	5
< 9,000	79.5	80.8	36	37	12	12
< 10,000	93.2	93.2	63	62	25	27

5.2.2.2.5 Recreation

In general, recreational opportunities under Alt1L would be restricted slightly more often at Lake Lanier and less often at West Point Lake than under the NAA. Recreational opportunities at Walter F. George Lake under this alternative would be restricted to about the same degree as under the NAA. Table 5.2-8 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-8.
Percent of Time below Established Recreational Impact Levels during the Recreation Season for Alt1L (May-Sep)

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt1L	NAA	Alt1L	NAA	Alt1L
Buford	23	24	8	9	3	3
West Point	22	21	3	2	1	1
Walter F. George	3	3	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.2.2.6 Water Quality

The implications of Alt1L relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for the NAA in section5.2.1.2.6.

5.2.2.2.7 Water Supply

Under Alt1L, releases from Buford Dam would be sufficient to provide for the anticipated 2050 need of 379 mgd for downstream withdrawals by Metro Atlanta water providers and withdrawals from Lake Lanier amounting to the current withdrawal of 128 mgd, including 20 mgd for the relocation contracts. The minimum reservoir elevation under this alternative would be 1,053.83 ft as compared to 1054.25 ft for the NAA. Lake Lanier would be in Zone 1 59 percent of the time, 1 percentage point less than for the NAA.

5.2.3 Alternative 7A

5.2.3.1 Description of Alternative 7A

Alternative 7A (Alt7A) combines Water Management Alternative 7 with water supply option A, as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Reallocation of storage in Lake Lanier sufficient to provide gross water supply withdrawals of 108 mgd
- Releases from Buford Dam to support current downstream withdrawals of 277 mgd
- A return rate to Lake Lanier of 29 percent and a return rate to the Chattahoochee River of 82 percent (see Table 5.1-3 and section 5.1.4.1)

Comparing performance metrics of this alternative to those of the NAA shows the effects of Water Management Alternative 7.

5.2.3.2 Performance Relative to Authorized Purposes

5.2.3.2.1 Flood Risk Management

Under this alternative, flood risk management operations would continue as they have since 1989.

5.2.3.2.2 Hydroelectric Power Generation

Under Alt7A, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,022,642 MWh and system annual weekday generation of 759,021 MWh. This is a slight decrease from the NAA and is a result of operating under Water Management Alternative 7. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-9.

Table 5.2-9.
Hydroelectric Power Generation by Project for Alt7A Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt7A	NAA	Alt7A	NAA	Alt7A
Buford	126,337	126,531	103,184	102,391	1.53	1.48
West Point	175,468	175,480	134,227	133,552	1.42	1.40
Walter F. George	466,973	466,229	341,353	342,052	1.13	1.15

5.2.3.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7A addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative and under the NAA is shown in Table 5.2-10. Under this alternative, a 7-ft channel would be fully available in the Apalachicola River 42.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time, the same as under the NAA. Due to the provision for the 4/5 month navigation season provided by Water Management Alternative 7, the full availability of the 7-ft channel would be increased by 22.0 percentage points.

Table 5.2-10.
Navigation Channel Availability under Alt7A Compared to the NAA

	NAA	Alt7A	Change from NAA
9-ft channel Jan–Dec	34.4%	34.1%	-0.3%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	17.8%	0.0%
7-ft channel Jan–Dec	49.8%	53.0%	3.2%
7-ft channel Jan—May 100% reliability	20.5%	42.5%	22.0%
7-ft channel Jan—May 90% reliability	49.3%	74.0%	24.7%

5.2.3.2.4 Fish and Wildlife Conservation

Under Alt7A, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced.

Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under Alt7A, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,123 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-11. Under this alternative, flows in the Apalachicola River would be expected to drop below 5,000 cfs 0.2 percent of the time over the period of record (0.2 percent more than under the NAA) and the system would be in drought operations 16 percent of the time (compared to 7 percent for the NAA). Drought zone operations would be triggered one time for 2 months compared to none for the NAA.

Table 5.2-11.
Listed Species Performance Measures for Alt7A Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7A	NAA	Alt7A	NAA	Alt7A
< 5,000	0.0	1.4	0	0	0	0
< 6,000	30.1	32.9	0	0	0	0
< 7,000	43.8	49.3	0	0	0	0
< 8,000	58.9	63.0	5	6	5	5
< 9,000	79.5	79.5	36	41	12	12
< 10,000	93.2	91.8	63	62	25	26

5.2.3.2.5 Recreation

In general, recreational opportunities would be restricted slightly more often under Alt7A than under the NAA due to the provisions of the Water Management Alternative 7, most notably the 4/5-month navigation provision. Table 5.2-12 shows for each USACE project the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-12.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7A Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7A	NAA	Alt7A	NAA	Alt7A
Buford	23	24	8	7	3	2
West Point	22	23	3	4	1	1
Walter F. George	3	5	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.3.2.6 Water Quality

Under Alt7A, Buford Dam, West Point Dam, and Jim Woodruff Lock and Dam would continue to provide continuous minimum releases which, in addition to meeting other project purposes and providing associated benefits, also would benefit downstream water quality. At West Point Dam, a small generating unit provides a continuous release of approximately 675 cfs. In addition to these flows, Buford Dam is operated in conjunction with the downstream GPC Morgan Falls Dam to ensure a minimum in-stream flow of 650 cfs during November–April and 750 cfs during May–October on the Chattahoochee River at Peachtree Creek to meet state water quality commitments.

5.2.3.2.7 Water Supply

Under this alternative, releases from Buford Dam would be sufficient to provide for the current need of 277 mgd for downstream withdrawals by Metro Atlanta water providers and current withdrawals from Lake Lanier amounting to 128 mgd, including 20 mgd for the relocation contracts. The minimum reservoir elevation under this alternative would be 1,053.7 ft as compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 for 63 percent of the time, 3 percent more time than for the NAA.

5.2.4 Alternative 7B

5.2.4.1 Description of Alternative 7B

Alternative 7B (Alt7B) combines the Water Management Alternative 7 with water supply option B, as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Releases from Buford Dam to support current downstream withdrawals 277 mgd
- A return rate to Lake Lanier of 50 percent and a return rate to the Chattahoochee River of 82 percent (see Table 5.1-3 and section 5.1.4.1)

5.2.4.2 Performance Relative to Authorized Purposes

5.2.4.2.1 Flood Risk Management

Under Alt7B, flood risk management operations would continue as they have since 1989.

5.2.4.2.2 Hydroelectric Power Generation

Under Alt7B, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,046,403 MWh and system annual weekday generation of 775,561 MWh, which is an increase over the NAA attributable to the hydropower generation provisions of Water Management Alternative 7 together with the reduced water supply withdrawals from Lake Lanier. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-13.

Table 5.2-13.
Hydroelectric Power Generation by Project for Alt7B Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt7B	NAA	Alt7B	NAA	Alt7B
Buford	126,337	139,266	103,184	112,019	1.53	1.47
West Point	175,468	180,384	134,227	136,709	1.42	1.37
Walter F. George	466,973	471,847	341,353	342,518	1.13	1.14

5.2.4.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7B addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative and under the NAA is shown in Table 5.2-14. Under this alternative, a 7-ft channel would be fully available in the Apalachicola River 43.8 percent of the time and a 9-ft channel would be available 4.1 percent of the time during the January-May timeframe. Due to the provision for the 4/5 month navigation season provided by Water Management Alternative 7, the availability of the 7-ft channel would be increased by 23.3 percentage points over the NAA.

Table 5.2-14.
Navigation Channel Availability under Alt7B Compared to the NAA

	NAA	Alt7B	Change from NAA
9-ft channel Jan–Dec	34.4%	34.4%	0.0%
9-ft channel Jan–May 100% reliability	2.7%	4.1%	1.4%
9-ft channel Jan–May 90% reliability	17.8%	17.8%	0.0%
7-ft channel Jan–Dec	49.8%	53.8%	4.0%
7-ft channel Jan—May 100% reliability	20.5%	43.8%	23.3%
7-ft channel Jan—May 90% reliability	49.3%	75.3%	26.0%

5.2.4.2.4 Fish and Wildlife Conservation

Under Alt7B, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced.

Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under Alt7B, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,464 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-15. Under this alternative, flows in the Chattahoochee River would not be expected to drop below 5,000 cfs over the period of record (the same as under the NAA) and the system would be in drought operations 15 percent of the time (compared to 7 percent for the NAA). Drought zone operations would not be triggered for this alternative (the same as for the NAA).

Table 5.2-15.
Listed Species Performance Measures for Alt7B Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7B	NAA	Alt7B	NAA	Alt7B
< 5,000	0.0	0.0	0	0	0	0
< 6,000	30.1	32.9	0	0	0	0
< 7,000	43.8	46.6	0	0	0	0
< 8,000	58.9	61.6	5	6	5	5
< 9,000	79.5	78.1	36	37	12	13
< 10,000	93.2	91.8	63	61	25	28

5.2.4.2.5 Recreation

In general, recreational opportunities would be restricted more often under Alt7B than under the NAA due to the provisions of the Water Management Alternative 7, most notably the 4/5-month navigation provision. Recreational opportunities at Lake Lanier, however, would be restricted less often due to the lack of water supply withdrawals from the lake. Table 5.2-16 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-16.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7B Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7B	NAA	Alt7B	NAA	Alt7B
Buford	23	19	8	5	3	0
West Point	22	23	4	3	1	1
Walter F. George	3	6	1	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.4.2.6 Water Quality

The implications of Alt7B relative to water quality purposes associated with federal projects in the ACF Basin would be essentially the same as those described for the Alt7A in section 5.2.3.2.6.

5.2.4.2.7 Water Supply

Under Alt7B, releases from Buford Dam would be sufficient to provide for the current need for downstream withdrawals of 277 mgd by Atlanta and current withdrawals from Lake Lanier would be limited to 20 mgd for the relocation contracts. The minimum reservoir elevation under this alternative would be 1,053.7 ft as compared to 1,054.2 ft under the NAA. Lake Lanier would be in Zone 1 70 percent of the time, 10 percent more time than for the NAA.

5.2.5 Alternative 7H

5.2.5.1 Description of Alternative 7H

Alternative 7H (Alt7H) combines the Water Management Alternative 7 with water supply option H, as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Reallocation of storage in Lake Lanier sufficient to provide gross water supply withdrawals of 165 mgd (the same withdrawal amount as under the PAA in the draft EIS)
- Glades Reservoir would provide 40 mgd of Georgia's 2013 request
- Releases from Buford Dam to support downstream withdrawals of the estimated 2040 need of 408 mgd
- A return rate to Lake Lanier of 40.4 percent and a return rate to the Chattahoochee River of 94 percent (see Table 5.1-3 and section 5.1.4.1)

Alt7H was the PAA in the draft EIS. It is no longer a viable alternative because of revised water supply needs provided by the State of Georgia in December 2015 (Georgia 2015 request); however, this alternative has been retained for comparative purposes only.

5.2.5.2 Performance Relative to Authorized Purposes

5.2.5.2.1 Flood Risk Management

Under this alternative, flood risk management operations would continue as they have since adoption of the draft Master WCM in 1989 (USACE, Mobile District 1989).

5.2.5.2.2 Hydroelectric Power Generation

Under Alt7H, the typical hydroelectric power generation schedule would be the same shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,016,106 MWh and system annual weekday generation of 753,190 MWh. This is a decrease over the NAA resulting from the increased water supply withdrawals from Lake Lanier. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-17.

Table 5.2-17.
Hydroelectric Power Generation by Project for Alt7H Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt7H	NAA	Alt7H	NAA	Alt7H
Buford	126,337	119,578	103,184	96,133	1.53	1.42
West Point	175,468	175,455	134,227	133,644	1.42	1.39
Walter F. George	466,973	466,282	341,353	342,134	1.13	1.15

5.2.5.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7H addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative compared to the NAA is shown in Table 5.2-18. Under this alternative, a 7-ft channel would be available in the Apalachicola River 42.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time. The 7-ft channel would be available more frequently under this alternative than under the NAA because of the 4/5-month navigation provision of Water Management Alternative 7.

Table 5.2-18.
Navigation Channel Availability under Alt7H Compared to the NAA

	NAA	Alt7H	Change from NAA
9-ft channel Jan–Dec	34.4%	34.2%	-0.2%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	16.4%	-1.4%
7-ft channel Jan–Dec	49.8%	52.8%	3.0%
7-ft channel Jan—May 100% reliability	20.5%	42.5%	22.0%
7-ft channel Jan—May 90% reliability	49.3%	74.0%	24.7%

5.2.5.2.4 Fish and Wildlife Conservation

Under Alt7H, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under Alt7H, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,033 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-19. Under this alternative, flows in the Apalachicola River would be expected to drop below 5,000 cfs 0.2 percent of the time over the period of record compared to zero under the NAA, and the system would be in drought operations 18 percent of the time (compared to 7 percent for the NAA). Drought zone operations would be triggered one time for 2 months for this alternative compared to none for the NAA.

Table 5.2-19.
Listed Species Performance Measures for Alt7H Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7H	NAA	Alt7H	NAA	Alt7H
< 5,000	0.0	1.4	0	0	0	0
< 6,000	30.1	34.2	0	0	0	0
< 7,000	43.8	47.9	0	0	0	0
< 8,000	58.9	63.0	5	7	5	5
< 9,000	79.5	79.5	36	42	12	12
< 10,000	93.2	91.8	63	64	25	28

5.2.5.2.5 Recreation

In general, recreational opportunities would be restricted somewhat more often at Lake Lanier and slightly more often at West Point Lake under this alternative than under the NAA due to increased water supply withdrawals from Lake Lanier and the 4/5 month navigation provision of Water Management Alternative 7. Table 5.2-20 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-20.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7H Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7H	NAA	Alt7A	NAA	Alt7H
Buford	23	27	8	9	3	3
West Point	22	22	3	2	1	0
Walter F. George	3	5	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.5.2.6 Water Quality

The implications of Alt7H relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Alt7A in section 5.2.3.2.6.

5.2.5.2.7 Water Supply

Under Alt7H, releases from Buford Dam would be sufficient to provide for the 2040 need for downstream withdrawals of 408 mgd by Metro Atlanta and withdrawals from Lake Lanier amounting to 185 mgd, including 20 mgd for the relocation contracts. The minimum reservoir elevation under this alternative would be 1,050.2 ft compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 58 percent of the time, 2 percent less time than for the NAA.

5.2.6 Alternative 7I

5.2.6.1 Description of Alternative 7I

Alternative 7I (Alt7I) combines Water Management Alternative 7 with water supply option I, as shown in Table 5.2-1. It includes the following features:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Withdrawals from Lake Lanier 205 mgd,[12]
- Releases from Buford Dam to support downstream withdrawals of the estimated 2050 need of 379 mgd
- A return rate to Lake Lanier of 40.4 percent and a return rate to the Chattahoochee River of 95 percent (see Table 5.1-3 and section 5.1.4.1)

5.2.6.2 Performance Relative to Authorized Purposes

5.2.6.2.1 Flood Risk Management

Under Alt7I, flood risk management operations would continue as they have since 1989.

5.2.6.2.2 Hydroelectric Power Generation

Under Alt7I, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,015,149 MWh and system annual weekday generation of 752,873 MWh. This is a decrease over the NAA resulting from an increase in water supply withdrawals from Lake Lanier. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-21.

[12] This amount was derived based on adding the amount that would have been provided by Glades Reservoir under the PAA in the draft EIS (40 mgd) to the amount considered to be reallocated from Lake Lanier by the PAA in the draft EIS (185 mgd).

Table 5.2-21.
Hydroelectric Power Generation by Project for Alt7I Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (Mwh)		Weekday/Weekend Ratio	
	NAA	Alt7I	NAA	Alt7I	NAA	Alt7I
Buford	126,337	119,679	103,184	96,537	1.53	1.44
West Point	175,468	175,028	134,227	133,355	1.42	1.40
Walter F. George	466,973	465,796	341,353	341,799	1.13	1.12

5.2.6.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7I addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative and that under the NAA is shown in Table 5.2-22. Under this alternative, a 7-ft channel would be available in the Apalachicola River 42.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time.

Table 5.2-22.
Navigation Channel Availability under Alt7I Compared to the NAA

	NAA	Alt7I	Change from NAA
9-ft channel Jan–Dec	34.4%	34.1%	-0.3%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	16.4%	-1.4%
7-ft channel Jan–Dec	49.8%	52.8%	3.0%
7-ft channel Jan—May 100% reliability	20.5%	42.5%	22.0%
7-ft channel Jan—May 90% reliability	49.3%	72.6%	23.3%

5.2.6.2.4 Fish and Wildlife Conservation

Under Alt7I, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,536 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-23. Under this alternative, flows in the Apalachicola River would be less than 5,000 cfs 0.3 percent of the time (compared to no occurrences under the NAA), and the system would be in drought operations 18 percent of the time (compared to 7 percent for the NAA). Drought zone operations would be triggered one time for 3 months for this alternative compared to zero for the NAA.

Table 5.2-23.
Listed Species Performance Measures for Alt7I Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7I	NAA	Alt7I	NAA	Alt7I
< 5,000	0.0	1.4	0	0	0	0
< 6,000	30.1	34.2	0	0	0	0
< 7,000	43.8	50.7	0	1	0	1
< 8,000	58.9	63.0	5	8	5	5
< 9,000	79.5	79.5	36	42	12	12
< 10,000	93.2	91.8	63	64	25	28

5.2.6.2.5 Recreation

In general, recreational opportunities under Alt7I as compared to the NAA would be restricted somewhat more often at Lake Lanier. Recreational opportunities at West Point Lake and Walter F. George Lake under this alternative would be about the same as under the NAA. Table 5.2-24 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-24.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7I Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7I	NAA	Alt7I	NAA	Alt7I
Buford	23	27	8	9	3	3
West Point	22	23	3	2	1	1
Walter F. George	3	5	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.6.2.6 Water Quality

The implications of Alt7I relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Alt7A in section 5.2.3.2.6.

5.2.6.2.7 Water Supply

Under this alternative, releases from Buford Dam would be sufficient to provide for the 2050 need for downstream withdrawals of 379 mgd by Atlanta and withdrawals from Lake Lanier amounting to 205 mgd, including the relocation contracts, satisfying a portion of the 2050 need for communities withdrawing from the reservoir. The minimum reservoir elevation under this alternative would be 1,051.1 ft compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 58 percent of the time, 2 percent less than for the NAA.

5.2.7 Alternative 7J (Future without Project Condition Alternative)

5.2.7.1 Description of Alternative 7J

Alternative 7J (Alt7J) combines Water Management Alternative 7 with water supply option J, as shown in Table 5.2-1. Alt7J is the *Future without Project Condition* (FWOPC) alternative and is the condition expected to exist in the future in the absence of reallocation of storage under the 1958 WSA for the communities currently withdrawing water from Lake Lanier under expired agreements. This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Releases from Buford Dam to support downstream withdrawals of the estimated 2050 need of 379 mgd
- A return rate to Lake Lanier of 50 percent and a return rate to the Chattahoochee River of 95 percent (see Table 5.1-3 and section 5.1.4.1)

Alt7J provides the basis from which reallocation alternatives considered in the WSSA were compared and evaluated.

5.2.7.2 Performance Relative to Authorized Purposes

5.2.7.2.1 Flood Risk Management

Under Alt7J, flood risk management operations would continue as they have since adoption of the draft Master WCM in 1989 (USACE, Mobile District 1989).

5.2.7.2.2 Hydroelectric Power Generation

Under Alt7J, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,051,535 MWh and system annual weekday generation of 778,178 MWh. This is an increase over the NAA resulting from the elimination of all water supply withdrawals from Lake Lanier other than those associated with relocation contracts, an increase in downstream releases from Buford Dam to meet the 2050 demand for Atlanta, and the 4/5-month navigation operations associated with Water Management Alternative 7. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-25.

Table 5.2-25.
Hydroelectric Power Generation by Project for Alt7J Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt7J	NAA	Alt7J	NAA	Alt7J
Buford	126,337	139,245	103,184	111,095	1.53	1.42
West Point	175,468	182,584	134,227	138,078	1.42	1.35
Walter F. George	466,973	474,376	341,353	347,246	1.13	1.15

5.2.7.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7J addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative with that under the NAA is shown in Table 5.2-26. Under this alternative, a 7-ft channel would be available in the Apalachicola River 43.8 percent of the time and a 9-ft channel would be available 4.1 percent of the time. The 7-ft channel would be available more frequently under this alternative than under the NAA because of the 4/5-month navigation provision of the Water Management Alternative 7.

Table 5.2-26.
Navigation Channel Availability under Alt1J Compared to the NAA

	NAA	Alt1J	Change from NAA
9-ft channel Jan–Dec	34.4%	34.6%	0.2%
9-ft channel Jan–May 100% reliability	2.7%	4.1%	1.4%
9-ft channel Jan–May 90% reliability	17.8%	17.8%	0.0%
7-ft channel Jan–Dec	49.8%	54.0%	4.2%
7-ft channel Jan—May 100% reliability	20.5%	43.8%	23.3%
7-ft channel Jan—May 90% reliability	49.3%	75.3%	26.0%

5.2.7.2.4 Fish and Wildlife Conservation

Under Alt7J, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum growing season (i.e., April–October) floodplain connectivity (ac) to the main channel for 30 consecutive days is 18,058 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-27. Under this alternative, flows in the Apalachicola River would not be expected to drop below 5,000 cfs over the period of record (the same as under the NAA), and the system would be in drought operations 14 percent of the time (compared to 7 percent for the NAA). Drought zone operations would not be triggered in either the NAA or this alternative.

Table 5.2-27.
Listed Species Performance Measures for Alt7J Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7J	NAA	Alt7J	NAA	Alt7J
< 5,000	0.0	0.0	0	0	0	0
< 6,000	30.1	34.2	0	0	0	0
< 7,000	43.8	46.6	0	0	0	0
< 8,000	58.9	63.0	5	5	5	5
< 9,000	79.5	78.1	36	36	12	12
< 10,000	93.2	91.8	63	60	25	28

5.2.7.2.5 Recreation

In general, recreational opportunities would be restricted somewhat less often at Lake Lanier and slightly more often at Walter F. George Lake under Alt7J than under the NAA due to the lack of water supply withdrawals from Lake Lanier and the 4/5 month navigation provision of Water Management Alternative 7. Table 5.2-28 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-28.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7J Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7J	NAA	Alt7J	NAA	Alt7J
Buford	23	20	8	6	3	1
West Point	22	22	3	2	1	1
Walter F. George	3	5	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.7.2.6 Water Quality

The implications of Alt7J relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Alt7A in section 5.2.3.2.6.

5.2.7.2.7 Water Supply

Under Alt7J, releases from Buford Dam would be sufficient to provide for the 2050 need for downstream withdrawals of 379 mgd by Atlanta and withdrawals from Lake Lanier amounting to 20 mgd for the relocation contracts. The minimum reservoir elevation under this alternative would be 1,054.6 ft compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 69 percent of the time, 9 percent more time than for the NAA.

5.2.8 Alternative 7K

5.2.8.1 Description of Alternative 7K

Alternative 7K (Alt7K) combines Water Management Alternative 7 with water supply option K (Georgia's 2015 request), as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Reallocation of storage in Lake Lanier sufficient to provide gross water supply withdrawals of 222 mgd (the same withdrawal amount as under the PAA in the draft EIS)
- Releases from Buford Dam to support downstream withdrawals of the estimated 2050 need of 379 mgd
- A return rate to Lake Lanier of 43 percent and a return rate to the Chattahoochee River of 95 percent (see Table 5.1-3 and section 5.1.4.1)

5.2.8.2 Performance Relative to Authorized Purposes

5.2.8.2.1 Flood Risk Management

Under Alt7K, flood risk management operations would continue as they have since 1989.

5.2.8.2.2 Hydroelectric Power Generation

Under Alt7K, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,014,054 MWh and system annual weekday generation of 752,138 MWh. This is a decrease over the NAA resulting from the increased water supply withdrawals from Lake Lanier. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-29.

Table 5.2-29.
Hydroelectric Power Generation by Project for Alt7K Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (Mwh)		Weekday/Weekend Ratio	
	NAA	Alt7K	NAA	Alt7K	NAA	Alt7K
Buford	126,337	119,076	103,184	96,103	1.53	1.44
West Point	175,468	174,801	134,227	133,216	1.42	1.40
Walter F. George	466,973	465,533	341,353	341,643	1.13	1.15

5.2.8.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7K addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative compared to the NAA is shown in Table 5.2-30. Under this alternative, a 7-ft channel would be available in the Apalachicola River 42.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time.

Table 5.2-30.
Navigation Channel Availability under Alt7K Compared to the NAA

	NAA	Alt7K	Change from NAA
9-ft channel Jan–Dec	34.4%	34.1%	-0.3%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	16.4%	-1.4%
7-ft channel Jan–Dec	49.8%	52.8%	4.0%
7-ft channel Jan—May 100% reliability	20.5%	42.5%	22.0%
7-ft channel Jan—May 90% reliability	49.3%	74.0%	24.7%

5.2.8.2.4 Fish and Wildlife Conservation

Under Alt7K, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,058 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-31. Under this alternative, flows in the Apalachicola River would be less than 5,000 cfs 0.3 percent of the time (compared to no occurrences under the NAA), and the system would be in drought operations 18 percent of the time (compared to 7 percent for the NAA). Drought zone operations would be triggered one time for 3 months for this alternative compared to zero for the NAA.

Table 5.2-31.
Listed Species Performance Measures for Alt7K Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7K	NAA	Alt7K	NAA	Alt7K
< 5,000	0.0	1.4	0	0	0	0
< 6,000	30.1	34.2	0	0	0	0
< 7,000	43.8	49.3	0	0	0	0
< 8,000	58.9	63.0	5	8	5	5
< 9,000	79.5	79.5	36	43	12	12
< 10,000	93.2	91.8	63	64	25	28

5.2.8.2.5 Recreation

In general, recreational opportunities would be restricted somewhat more often at Lake under this alternative than under the NAA. Table 5.2-32 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-32.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7K Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7K	NAA	Alt7K	NAA	Alt7K
Buford	23	27	8	9	3	3
West Point	22	22	3	2	1	1
Walter F. George	3	5	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.8.2.6 Water Quality

The implications of Alt7K relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Alt7A in section 5.2.3.2.6.

5.2.8.2.7 Water Supply

Under Alt7K, releases from Buford Dam would be sufficient to provide for the 2050 need for downstream withdrawals of 379 mgd by Atlanta and withdrawals from Lake Lanier amounting to 242 mgd for the relocation contracts and the 2050 need for communities withdrawing from the reservoir. The minimum reservoir elevation under this alternative would be 1,050.7 ft compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 58 percent of the time, 2 percent less time than for the NAA.

5.2.9 Alternative 7L

5.2.9.1 Description of Alternative 7L

Alternative 7L (Alt7L) combines the Water Management Alternative 7 with water supply option L, as shown in Table 5.2-1. This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e., Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Reallocation of storage in Lake Lanier sufficient to provide gross water supply withdrawals of 108 mgd
- Releases from Buford Dam to support downstream withdrawals of the estimated 2050 need of 379 mgd
- A return rate to Lake Lanier of 29 percent and a return rate to the Chattahoochee River of 95 percent (see Table 5.1-3 and section 5.1.4.1)

5.2.9.2 Performance Relative to Authorized Purposes

5.2.9.2.1 Flood Risk Management

Under this alternative, flood risk management operations would continue as they have since 1989.

5.2.9.2.2 Hydroelectric Power Generation

Under Alt7L, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,027,860 MWh and system annual weekday generation of 761,573 MWh. This is an increase over the NAA resulting from an increase in downstream releases from Buford Dam to meet the 2050 demand for Atlanta and the 4/5-month navigation operations associated with the Water Management Alternative 7. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-33.

Table 5.2-33.
Hydroelectric Power Generation by Project for Alt7L Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt7L	NAA	Alt7L	NAA	Alt7L
Buford	126,337	126,487	103,184	101,605	1.53	1.43
West Point	175,468	177,665	134,227	134,971	1.42	1.38
Walter F. George	466,973	468,791	341,353	343,596	1.13	1.17

5.2.9.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7L addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season under that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative compared to the NAA is shown in Table 5.2-34. Under this alternative, a 7-ft channel would be available in the Apalachicola River 42.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time.

Table 5.2-34.
Navigation Channel Availability under Alt7L Compared to the NAA

	NAA	Alt7L	Change from NAA
9-ft channel Jan–Dec	34.4%	34.2%	-0.2%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	17.8%	0.0%
7-ft channel Jan–Dec	49.8%	53.2%	3.4%
7-ft channel Jan—May 100% reliability	20.5%	42.5%	22.0%
7-ft channel Jan—May 90% reliability	49.3%	74.0%	24.7%

5.2.9.2.4 Fish and Wildlife Conservation

Under Alt7L, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,158 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-35. Under this alternative, flows in the Apalachicola River would be expected to drop below 5,000 cfs 0.1 percent of the time over the period of record (0.1 percent more than under the NAA), and the system would be in drought operations 16 percent of the time (compared to 7 percent for the NAA). Drought zone operations would be triggered one time for 2 months for this alternative compared to zero for the NAA.

Table 5.2-35.
Listed Species Performance Measures for Alt7L Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7L	NAA	Alt7L	NAA	Alt7L
< 5,000	0.0	1.4	0	0	0	0
< 6,000	30.1	32.9	0	0	0	0
< 7,000	43.8	47.9	0	0	0	0
< 8,000	58.9	63.0	5	5	5	5
< 9,000	79.5	78.1	36	39	12	12
< 10,000	93.2	91.8	63	60	25	28

5.2.9.2.5 Recreation

In general, recreational opportunities would be restricted slightly less often at Lake Lanier and West Point Lake and slightly more often at Walter F. George Lake under this alternative than under the NAA. Table 5.2-36 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-36.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7L Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7L	NAA	Alt7L	NAA	Alt7L
Buford	23	23	8	7	3	3
West Point	22	21	3	2	1	0
Walter F. George	3	4	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.9.2.6 Water Quality

The implications of Alt7L relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Alt7A in section 5.2.3.2.6.

5.2.9.2.7 Water Supply

Under Alt7L, releases from Buford Dam would be sufficient to provide for the 2050 need for downstream withdrawals of 379 mgd by Metro Atlanta and withdrawals from Lake Lanier amounting to 128 mgd for the relocation contracts and the current need for communities withdrawing from the reservoir. The minimum reservoir elevation under this alternative would be 1,053.0 ft compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 62 percent of the time, 2 percent more time than for the NAA.

5.2.10 Alternative 7M

5.2.10.1 Description of Alternative 7M

Alternative 7M (Alt7M) combines the Water Management Alternative 7 with water supply option M, as shown in Table 5.2-1.

This alternative consists of the following:

- Water Management Proposed Action Alternative (i.e. Water Management Alternative 7)
- Withdrawals from Lake Lanier under relocation contracts (20 mgd)
- Reallocation of storage in Lake Lanier sufficient to provide gross water supply withdrawals of 165 mgd (the same withdrawal amount as under the PAA in the draft EIS)
- Releases from Buford Dam to support downstream withdrawals of the estimated 2050 need of 379 mgd
- A return rate to Lake Lanier of 40.4 percent and a return rate to the Chattahoochee River of 95 percent (see Table 5.1-3 and section 5.1.4.1)

5.2.10.2 Performance Relative to Authorized Purposes

5.2.10.2.1 Flood Risk Management

Under this alternative, flood risk management operations would continue as they have since 1989.

5.2.10.2.2 Hydroelectric Power Generation

Under Alt7M, the typical hydroelectric power generation schedule would be the same as shown in Table 4.1-6. Project operations under this alternative would produce system annual generation of 1,022,160 MWh and system annual weekday generation of 757,591 MWh. This is a decrease over the NAA resulting from an increase in water supply withdrawals from Lake Lanier. Annual and weekday generation at Buford, West Point, and Walter F. George dams for this alternative compared to the NAA is shown in Table 5.2-37.

Table 5.2-37.
Hydroelectric Power Generation by Project for Alt7M Compared to the NAA

Project	Annual Generation (MWh)		Annual Weekday Generation (MWh)		Weekday/Weekend Ratio	
	NAA	Alt7M	NAA	Alt7M	NAA	Alt7M
Buford	126,337	123,434	103,184	99,247	1.53	1.43
West Point	175,468	176,477	134,227	134,196	1.42	1.39
Walter F. George	466,973	467,453	341,353	342,851	1.13	1.15

5.2.10.2.3 Navigation

Assuming basin hydrologic conditions allow, Alt7M addresses the specific objective to *increase the reliability of navigation on the ACF system* by including a typical navigation season that would begin in January of each year and continue for 4 to 5 consecutive months (i.e., January–April or May), as described in section 4.1.2.6.4. A comparison of the navigation channel availability under this alternative compared to the NAA is shown in Table 5.2-38. Under this alternative, a 7-ft channel would be available in the Apalachicola River 42.5 percent of the time and a 9-ft channel would be available 2.7 percent of the time.

Table 5.2-38.
Navigation Channel Availability under Alt7M Compared to the NAA

	NAA	Alt7M	Change from NAA
9-ft channel Jan–Dec	34.4%	34.2%	-0.2%
9-ft channel Jan–May 100% reliability	2.7%	2.7%	0.0%
9-ft channel Jan–May 90% reliability	17.8%	16.4%	-1.4%
7-ft channel Jan–Dec	49.8%	53.1%	3.3%
7-ft channel Jan—May 100% reliability	20.5%	42.5%	22.0%
7-ft channel Jan—May 90% reliability	49.3%	74.0%	24.7%

5.2.10.2.4 Fish and Wildlife Conservation

Under Alt7M, water management activities for fish and wildlife conservation in Lake Lanier and the other reservoirs would be consistent with current practices as reflected in South Atlantic DR PDS-O-1 (May 2010) and draft USACE, Mobile District SOP 1130-2-9 (February 2005), as described in section 4.1.2.8.1. Operations to support fish spawning in reservoirs and rivers, consistent with other project purposes, and lockages to promote fish passage at Jim Woodruff Lock and Dam would continue as practiced. Additionally, operations defined in Mobile District SOPs, which were established in 1988 and updated in 1993 to address conditions at the Walter F. George project when low DO values are observed in the tailrace, would continue to be implemented (USACE, Mobile District 1993a). Management of the Eufaula NWR and USACE-owned project lands around the ACF reservoirs for the benefit of fish and wildlife resources consistent with other project purposes also would continue as currently practiced. Operations for listed species under this alternative would be conducted in accordance with the provisions of the 2012 RIOP, as described in section 2.1.1.2.4.4.

Under this alternative, the annual maximum growing season (i.e., April–October) floodplain connectivity to the main channel for 30 consecutive days is 18,116 ac, the median fall rate is 0.12 ft/day, and the maximum fall rate is 2.08 ft/day. Other performance measures associated with this alternative are shown in Table 5.2-39. Under this alternative, flows in the Apalachicola River would be less than 5,000 cfs 0.2 percent of the time (compared to no occurrences under the NAA), and the system would be in drought operations 17 percent of the time (compared to 7 percent under the NAA). Drought zone operations would be triggered one time for 2 months over the period of record for this alternative compared with zero for the NAA.

Table 5.2-39.
Listed Species Performance Measures for Alt7M Compared to the NAA

Flow	% of yrs with flow less than		Median number of days/yr flow less than		Median number of consecutive days/yr flow less than	
	NAA	Alt7M	NAA	Alt7M	NAA	Alt7M
< 5,000	0.0	1.4	0	0	0	0
< 6,000	30.1	34.2	0	0	0	0
< 7,000	43.8	47.9	0	0	0	0
< 8,000	58.9	63.0	5	6	5	5
< 9,000	79.5	78.1	36	42	12	12
< 10,000	93.2	91.8	63	63	25	28

5.2.10.2.5 Recreation

In general, recreational opportunities would be restricted somewhat more often at Lake Lanier under this alternative than under the NAA. Table 5.2-40 shows, for each USACE project, the percent of time the reservoir level would be below the various impact levels during the recreation season.

Table 5.2-40.
Percent of Time below Established Recreational Impact Levels during the Recreation Season (May-Sep) for Alt7M Compared to the NAA

Project	% of Time below IIL		% of Time below RIL		% of Time below WAL	
	NAA	Alt7M	NAA	Alt7M	NAA	Alt7M
Buford	23	25	8	8	3	3
West Point	22	22	3	2	1	0
Walter F. George	3	4	0	0	0	0

Notes: IIL = initial impact level; RIL = recreation impact level; WAL = water access limited level.

5.2.10.2.6 Water Quality

The implications of Alt7M relative to water quality purposes associated with USACE projects in the ACF Basin would be essentially the same as those described for Alt7A in section 5.2.3.2.6..

5.2.10.2.7 Water Supply

Under Alt7M, releases from Buford Dam would be sufficient to provide for the 2050 need for downstream withdrawals of 379 mgd by Atlanta and withdrawals from Lake Lanier amounting to 185 mgd for the relocation contracts and a portion of the 2050 need for communities withdrawing from the reservoir. The minimum reservoir elevation under this alternative would be 1,051.7 ft compared to 1,054.5 ft under the NAA. Lake Lanier would be in Zone 1 61 percent of the time, 1 percent more time than under the NAA.

5.3 Rationale for Selecting the Proposed Action Alternative (PAA)

Based on a comparison of the effects of the various alternatives described in sections 5.2 and 6, Alternative 7K is the PAA. This section describes the rationale for selecting Alt7K as the PAA over the other alternatives considered in detail. The effects of all of the alternatives are described in detail in section 6 (Environmental Consequences). The description of alternative effects in subsequent paragraphs uses information detailed section 6, particularly the summary of change and summary of effects tables.

The NAA was not selected as the PAA because it does not address either the established objectives for water management (described in section 4.1) or the established objectives for water supply (described in section 5.1). The NAA would not update the Master WCM to include a drought plan or increase reliability of navigation, and would accommodate only the current water supply needs for communities currently withdrawing from Lake Lanier and from the Chattahoochee River. The NAA, however, is carried forward for detailed evaluation in accordance with NEPA requirements to provide a basis for assessing the impacts of alternatives that would satisfy the water management and water supply objectives to greater extent.

The PAA (Alt7K) would satisfy the water management objectives (as described in section 4.1) and the established objectives for water supply (as described in section 5.1). The PAA would update the Master WCM to include a drought plan, increase the reliability of navigation, and incorporate other changes to improve system performance for authorized project purposes, including protection of listed species. The PAA also would satisfy the anticipated 2050 water supply needs (242 mgd) for communities relying on Lake Lanier and the 2050 needs (379 mgd) for communities currently withdrawing from the Chattahoochee River. Compared to the NAA, the PAA results in some slightly adverse effects to lake levels and land use at Lake Lanier, slightly beneficial effects to lake levels at West Point Lake, and adverse effects to lake levels at Walter F. George Lake. Flow conditions under the PAA in the Buford Dam to Bull Sluice Lake would be slightly beneficial as compared to the NAA; and flows in the Morgan Falls Dam-to-Peachtree Creek and Walter F. George Lock and Dam-to-Jim Woodruff Lock and Dam reaches would be slightly adverse. Alt7K would meet the full projected water supply need through 2050 with effects on both lake levels and flow conditions downstream of USACE reservoirs that would be no greater than the effects of other Alt7H, Alt7I, and Alt7L that do not fully meet the stated future water supply need. With regard to water quality, the effects of the PAA compared to the NAA would range from slightly beneficial to adverse depending on the parameter and location in the basin. The PAA's effects on DO would be largely unchanged compared to the NAA except in Lake Lanier and the Atlanta-to-West Point Lake reach, where the effects would be slightly adverse. The effect of the PAA on phosphorus would be unchanged in most of the basin but would be slightly adverse in the Buford Dam-to-Atlanta reach and in West Point Lake and substantially adverse in the Atlanta-to-West Point Lake and West Point Dam-to-Walter F. George Lake reaches. The effects on nitrogen under the PAA would be slightly adverse to adverse in the Chattahoochee River down to Lake Seminole. These effects on nitrogen are essentially the same effects as observed for Alt1L indicating the increased releases from Buford Dam for downstream water supply accounts for the most of the adverse effects on nitrogen. Effects of the PAA on vegetation and wildlife resources, reservoir fish and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources would be expected to experience slightly adverse to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Effects of the PAA on navigation are substantially beneficial. The impacts to hydroelectric power generation by the PAA would be negligible. Recreation would experience slightly adverse effects at Lake Lanier and Walter F. George Lake and slightly beneficial effects at West Point Lake. The PAA has the least overall adverse effects on lake levels, streamflow conditions, water quality, and other natural resource and socioeconomic resource considerations of all the alternatives that fully or partially meet both the water management and water

supply objectives. USACE found that the PAA would have the following notable affects compared to the NAA:

- Varying degrees of changes to authorized project purposes and project operations:
  - Substantially net beneficial changes compared to the NAA to municipal and industrial water supply with no change to agricultural water supply or water supply intake structure operations ($54,315,000 average annual benefits for reallocation of storage in Lake Lanier).
  - Substantially net beneficial changes compared to the NAA to navigation conditions in the Apalachicola River (provides 7-ft channel 42.5 percent of the time during January-May over the 73-year period of record).
  - Negligible/no changes overall compared to the NAA to recreation (reduction in average annual benefits of $202,900 (-0.15%)). Changes to the visitation varies from project to project within the ACF system.
  - Negligible/no changes compared to the NAA to hydropower (reduction in average annual benefits of $915,000 (-0.52 percent)).
  - Negligible/no changes to flood risk management effectiveness within the ACF system.
  - Varying changes to lake levels with adverse changes compared to the NAA occurring at Walter F. George Lake.
  - Varying changes to flow conditions downstream of Buford Dam with slightly adverse changes compared to the NAA occurring at Morgan Falls Dam (a non-federal project) to Peachtree Creek and Walter F. George Lock and Dam to Jim Woodruff Lock and Dam.
- Drought operations under the PAA would have a slightly beneficial overall effect from a system operations perspective compared to the NAA. The PAA would take a more proactive approach to conserving reservoir storage as drier conditions develop in the basin than continued operations under the NAA, while continuing to meet downstream commitments and needs.
- Varying degrees of adverse changes to water quality parameters.
  - Slightly adverse changes compared to the NAA in dissolved oxygen with a decrease by nearly 0.5 mg/L in the reach from Atlanta to West Point Lake and by 0.1 mg/L in Lake Lanier.
  - Substantially adverse changes compared to the NAA in total phosphorus with an increase by 0.01 mg/L from Buford Dam to Atlanta and in West Point Lake. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the total phosphorus and nitrogen loads in the river. Under limited circumstances, the wastewater return loads would result in substantial adverse changes compared to the NAA to water quality. Water quality standards violations may similarly be expected in the headwaters of both West Point and Walter F. George lakes. Any modifications to Georgia wastewater return loads would be subject to appropriate requirements under the State of Georgia's NPDES permitting procedures.
  - Adverse changes compared to the NAA in total nitrogen with an increase by as much as 0.82 mg/L from Atlanta to West Point Lake.
  - Negligible/no changes compared to the NAA would be expected to water temperature or chlorophyll *a*.
- Varying degrees of adverse changes to fish and wildlife conservation. Substantially adverse changes are a result of the indirect impacts to water quality.

- Substantially adverse changes compared to the NAA to riverine fish and aquatic resources due to adverse water quality impacts from Atlanta into West Point Lake.
- Negligible/no changes compared to the NAA would be expected to vegetation, wildlife, reservoir fish and aquatic resources, and estuarine species or to fish hatcheries and the Eufaula National Wildlife Refuge.
- Negligible/no changes compared to the NAA would be expected to oyster industry in Apalachicola Bay.
- Varying degrees of changes to protected species. In accordance with ESA section 7, the USFWS issued a Biological Opinion dated September 14, 2016, determining that the PAA would not jeopardize the continued existence of any federally listed species or adversely modify designated critical habitat:
  - Slightly adverse changes compared to the NAA would be expected to Gulf Sturgeon.
  - A mix of slightly beneficial to adverse changes compared to the NAA would be expected on various USFWS defined metrics for assessing impacts to mussels. Slightly beneficial changes would occur in the median number of days per year with flows less than 10,000 cfs, median number of consecutive days per year with flows less than 10,000 cfs, and maximum number of consecutive days per year with flows between 5,000 cfs and 10,000 cfs. Adverse changes would occur in the frequency of daily stage changes (a 5 percent increase from the NAA) and frequency of daily stage changes when releases at Woodruff Dam are < 10,000 cfs (a 10 percent higher than the NAA).
  - Beneficial changes to shoal bass recruitment with an increased age-3 abundance from 5.6 under the NAA to 9.0 in the PAA.

Alt1L was not selected as the PAA because it does not address the established objectives for water management (as described in section 4.1) and would only partially satisfy the established objectives for water supply, as described in section 5.1. It would not update the Master WCM to include a drought plan or increase reliability of navigation and would accommodate only the current water supply needs for communities currently withdrawing from Lake Lanier, although it would accommodate the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River. A comparison of the effects of Alt1L with those of the NAA shows the effects on the ACF Basin of increasing downstream withdrawals to accommodate the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River under current water control operations. With respect to lake level conditions, Alt1L would have slightly adverse effects on Lake Lanier and slightly beneficial effects on West Point Lake, and would result in negligible or no change in lake levels at the remaining reservoirs. The same effects also can been seen with respect to land use. The effects of Alt1L on streamflow between Buford Dam and Bull Sluice Lake would be slightly beneficial; between Morgan Falls Dam and Peachtree Creek, the effects would be slightly adverse; and between Peachtree Creek and West Point Lake, the effects would be slightly beneficial. Below West Point Dam, this alternative would have no noticeable impact on streamflows. Water quality throughout the basin under Alt1L would remain essentially the same as under the NAA with a few exceptions. The effects of this alternative on DO in the Atlanta-to-West Point Lake reach would be slightly adverse. Effects of this alternative on phosphorus would be slightly adverse to substantially adverse from Atlanta-to-Walter F. George Lake in response to increased water supply withdrawals and discharges downstream of Buford Dam. Nitrogen would be slightly adversely to adversely affected from Buford Dam-to-Walter F. George Lake due to increased water supply withdrawals and discharges downstream of Buford Dam. Effects of the Alt1L on vegetation and wildlife resources, reservoir fish and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources would be expected to experience slightly to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Alt1L would not be expected to have an effect

on navigation or hydroelectric power generation. Recreation would experience slightly adverse effects at Lake Lanier and slightly beneficial effects at Walter F. George and West Point lakes.

Alt7A, which includes the proposed water management alternative, satisfies the water management objectives (as described in section 4.1) but does not satisfy the established objectives for water supply (as described in section 5.1). It would update the Master WCM to include a drought plan and increase reliability of navigation but would accommodate only the current water supply needs for communities currently withdrawing from Lake Lanier. Additionally, this alternative would not accommodate the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River, which, based on the 2011 decision of the 11th Circuit Court of Appeals, is a project purpose of the ACF under the 1946 RHA. A comparison of the effects of Alt7A and the NAA shows the effects of the changes in the water management operations. Based on that comparison, some slightly beneficial effects to lake levels at Lake Lanier and West Point Lake, adverse effects to lake levels at Walter F. George Lake, and negligible to no change at the downstream reservoirs would occur. Effects of Alt7A on streamflow is slightly adverse in all reaches except West Point Dam-to-Walter F. George Lake and below Jim Woodruff Lock and Dam, which would experience negligible to no change in effects. Water quality throughout the basin under this alternative would not be expected to change from that observed under the NAA. Effects of the Alt7A on vegetation and wildlife resources, riverine fish and aquatic resources reservoir fish and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Effects of the Alt7A on navigation are substantially beneficial. The impacts to hydroelectric power generation by Alt7A would be negligible . Recreation would experience slightly adverse effects at Lake Lanier and Walter F. George Lake and slightly beneficial effects at West Point Lake. Because Alt7A does not satisfactorily satisfy the water supply objectives, it was not selected as the PAA.

Alt7B satisfies the water management objectives (as described in section 4.1), but does not satisfy the established objectives for water supply (as described in section 5.1). This alternative would update the Master WCM to include a drought plan and increase reliability of navigation but would not accommodate any water supply needs for communities currently withdrawing from Lake Lanier (other than relocation contracts). Additionally, this alternative would not accommodate the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River, which, based on the 2011 decision of the 11th Circuit Court of Appeals, is a project purpose of the ACF under the 1946 RHA. Because Alt7B does not satisfactorily address the water supply objectives, it was not selected as the PAA.

Alt7H was the PAA in the draft EIS and is presented here for comparative purposes only and was not an alternative eligible for selection as the PAA for the final EIS. This alternative would satisfy the water management objectives (as described in section 4.1) and partially satisfy the established objectives for water supply (as described in section 5.1). It would update the Master WCM to include a drought plan, increase the reliability of navigation, and incorporate other changes to improve system performance for authorized project purposes, including listed species. Alt7H also would satisfy a portion of the anticipated 2050 water supply needs for communities relying on Lake Lanier (i.e., 185 mgd out of the 242 mgd requested). It would provide for releases from Buford Dam to provide for withdrawals of 408 mgd by downstream communities, which exceeds the 2050 needs for those communities as stated in Georgia's 2015 request. The effects of this alternative on lake levels would be slightly adverse at Lake Lanier, slightly beneficial at West Point Lake, adverse at Walter F. George Lake, and have no incremental effect at downstream reservoirs. Alt7H would have a slightly beneficial effect on streamflows between Buford Dam and Bull Sluice Lake and a slightly adverse effect between Morgan Falls Dam and Peachtree Creek. Downstream reaches of the Chattahoochee and Apalachicola rivers under this alternative would experience negligible to no change in streamflows, except for the Walter F. George Lock and Dam-to Jim-Woodruff Lock and Dam reach which would be slightly adverse. Water quality throughout the basin under Alt7H would remain unchanged from the NAA with a few exceptions. Effects on DO in the Buford

Dam-to-Atlanta reach would be slightly adverse; effects on phosphorus would be slightly adverse to substantially adverse between and Walter F. George Lake; effects on nitrogen would be slightly adverse to adverse from Buford Dam to Lake Seminole; and effects on chlorophyll *a* would be slightly adverse throughout the basin below Buford Dam. Effects of the Alt7H on vegetation and wildlife resources, and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources reservoir fish would be expected to experience slightly to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Effects of the Alt7H on navigation are substantially beneficial. The impacts to hydroelectric power generation by Alt7H would be negligible . Recreation would experience slightly adverse effects at Lake Lanier and Walter F. George Lake and slightly beneficial effects at West Point Lake.

Alt7I satisfies both the water management objectives (as described in section 4.1) and partially satisfies the established objectives for water supply (as described in section 5.1). It would update the Master WCM to include a drought plan and increase reliability of navigation, would meet a portion of the anticipated 2050 water supply needs for communities relying on Lake Lanier (225 mgd out of 242 mgd requested), and would meet all the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River. The effects of Alt7I on lake levels, streamflow, and water quality parameters are similar to the effects of Alt7H and Alt7K. Effects of the Alt7I on vegetation and wildlife resources, and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources reservoir fish would be expected to experience slightly to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Effects of the Alt7I on navigation are substantially beneficial. The impacts to hydroelectric power generation by Alt7I would be negligible. Recreation would experience slightly adverse effects at Lake Lanier and Walter F. George Lake and slightly beneficial effects at West Point Lake. Because this alternative has effects similar to Alt7K, but only partially satisfies the established water supply objectives, it was not selected as the PAA.

Alt7J satisfies the water management objectives (as described in section 4.1), but does not satisfy the established objectives for water supply (as described in section 5.1). It would update the Master WCM to include a drought plan and increase reliability of navigation but would not accommodate any water supply needs for communities currently withdrawing from Lake Lanier (other than relocation contracts). Alt7J would, however, accommodate the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River. The effects of this alternative on lake levels would be beneficial at Lake Lanier and West Point Lake, but adverse at Walter F. George Lake, and would cause negligible to no change at downstream reservoirs. Alt7J would have slightly beneficial-to-slightly adverse effects on streamflow in various reaches, except below Jim Woodruff Lock and Dam, which would experience negligible to no change compared to the NAA. Alt7J would have substantially the same effects on water quality parameters as Alt7I with a few exceptions. The effects of this alternative on DO in the Buford Dam-to-Atlanta reach would be slightly beneficial; and the effects on nitrogen in Lake Lanier would be slightly beneficial. Effects of the Alt7J on vegetation and wildlife resources, and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources reservoir fish would be expected to experience slightly to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Effects of the Alt7J on navigation are substantially beneficial. The impacts to hydroelectric power generation by Alt7J would be negligible . Recreation would experience slightly beneficial effects at Lake Lanier and West Point Lake and slightly adverse effects at Walter F. George Lake. Alt7J is the FWOPC alternative, as required by USACE planning regulations, and is used in the WSSA to determine the benefits of water supply reallocation and the effects of reallocation on other project purposes. It is presented in this final EIS for comparative purposes only and was not an alternative eligible for selection as the PAA.

Alt7L satisfies the water management objectives (as described in section 4.1), but does not satisfy the established objectives for water supply (as described in section 5.1). It would update the Master WCM to include a drought plan or increase reliability of navigation but would accommodate only the current water supply needs for communities currently withdrawing from Lake Lanier. It would, however, accommodate the anticipated 2050 water supply needs for communities currently withdrawing from the Chattahoochee River. The effects of Alt7L on lake levels would be similar to the effects of Alt7H and Alt7K except at Lake Lanier, where the effects would be slightly beneficial. Streamflow effects of this alternative would be similar to those of Alt7H and Alt7K. Its effects on water quality parameters would be the same as those of Alt7I and Alt7K which involve greater withdrawals from Lake Lanier for water supply. Effects of the Alt7L on vegetation and wildlife resources, and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources reservoir fish would be expected to experience slightly to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Effects of the Alt7L on navigation are substantially beneficial. The impacts to hydroelectric power generation by Alt7L would be negligible . Recreation would experience slightly beneficial effects at Lake Lanier and West Point Lake and slightly adverse effects at Walter F. George Lake. Because this alternative has similar effects as Alt7K but does not satisfy the 2050 water supply need for communities currently withdrawing from Lake Lanier, it was not selected as the PAA.

Alt7M satisfies both the water management objectives (as described in section 4.1) but only partially satisfies the established objectives for water supply (as described in section 5.1). It provides a portion of the anticipated water supply needs for communities relying on Lake Lanier (i.e., 185 mgd out of 242 mgd requested) and accommodates the anticipated 2050 water supply needs of communities currently withdrawing water from the Chattahoochee River. Effects of Alt7M on lake levels and streamflow are similar to those of Alt7H and Alt7K. Its effects on water quality parameters would be the same as for Alt7I and Alt7K. Effects of the Alt7M on vegetation and wildlife resources, and aquatic resources, and estuarine fish and aquatic resources are not expected to change from those experienced under the NAA. Riverine fish and aquatic resources reservoir fish would be expected to experience slightly to substantially adverse effects due primarily to the increased water supply downstream of Buford Dam. Effects of the Alt7M on navigation are substantially beneficial. The impacts to hydroelectric power generation by Alt7M would be negligible . Recreation would experience slightly adverse effects at Lake Lanier and Walter F. George Lake and slightly beneficial effects at West Point Lake. Because this alternative has similar effects as Alt7K but does not satisfy the 2050 water supply need for communities currently withdrawing from Lake Lanier, it was not selected as the PAA.

5.4 Description of the PAA

Under the PAA, USACE would continue to operate projects in the ACF Basin in a balanced manner to achieve all authorized project purposes, while continuously monitoring the total system water availability to ensure that project purposes can at least be minimally satisfied during critical drought periods. The intent would be to maintain a balanced use of conservation storage rather than to maintain the pools at or above certain predetermined elevations; however, in times of high-flow conditions, flood risk management regulation would supersede all other project functions. At all times, USACE would seek to conserve the water resources entrusted to its regulation authority. The PAA does not include construction of any new facilities or infrastructure. It is consistent with USACE's legal opinion, which sets forth the following:

- USACE has the legal authority under the RHA of 1946 to release water from Buford Dam sufficient to accommodate Georgia's requested downstream withdrawals of 379 mgd.
- Withdrawals of 20 mgd from Lake Lanier are authorized under relocation agreements and the 1956 Act (Public Law 84-841).

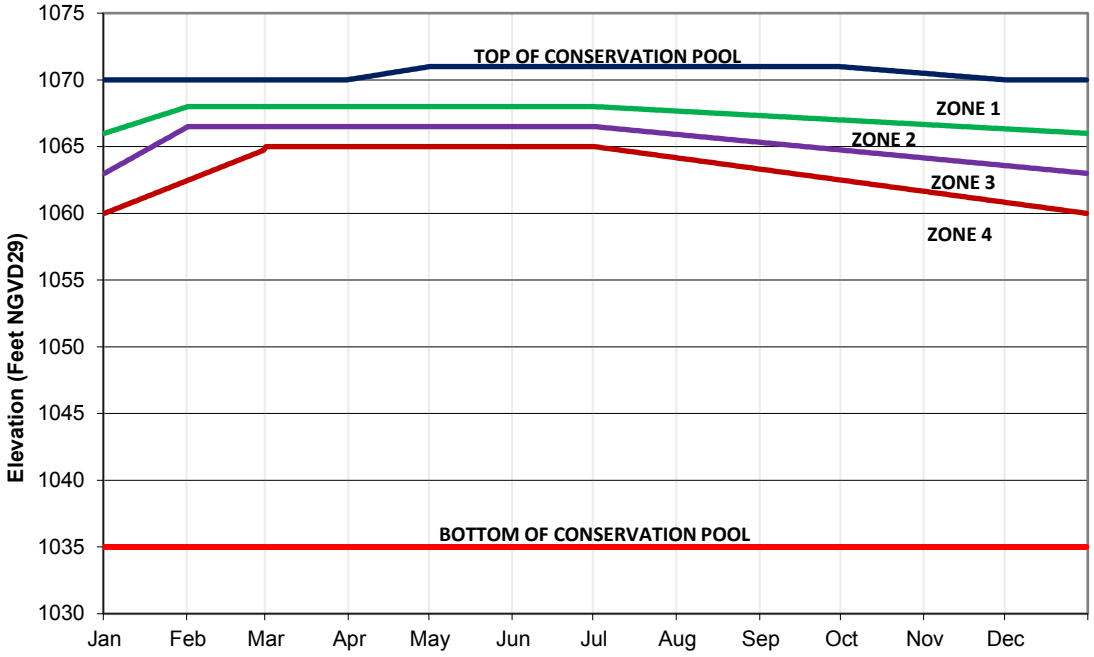
- USACE has discretion under the WSA of 1958 to accommodate additional net withdrawals of 127 mgd from Lake Lanier (including withdrawals of 222 mgd and returns of 95 mgd to the reservoir), because accommodating those withdrawals and returns would not fundamentally depart from congressional intent for the Buford project and the ACF system.

5.4.1 Guide Curves and Action Zones

Under the PAA, USACE would not modify any guide curves of the ACF projects but would modify the action zones for Lake Lanier, West Point Lake, and Walter F. George Lake. The zones are used to manage the lakes at the highest level possible while balancing the needs of all the authorized purposes. Zone 1, the highest in each lake, defines a reservoir condition where all authorized project purposes can be met. As lake levels decline, zones 2 through 4 define increasingly critical system status where purposes can no longer fully be met. The action zones also provide guidance on meeting minimum hydroelectric power needs at each project.

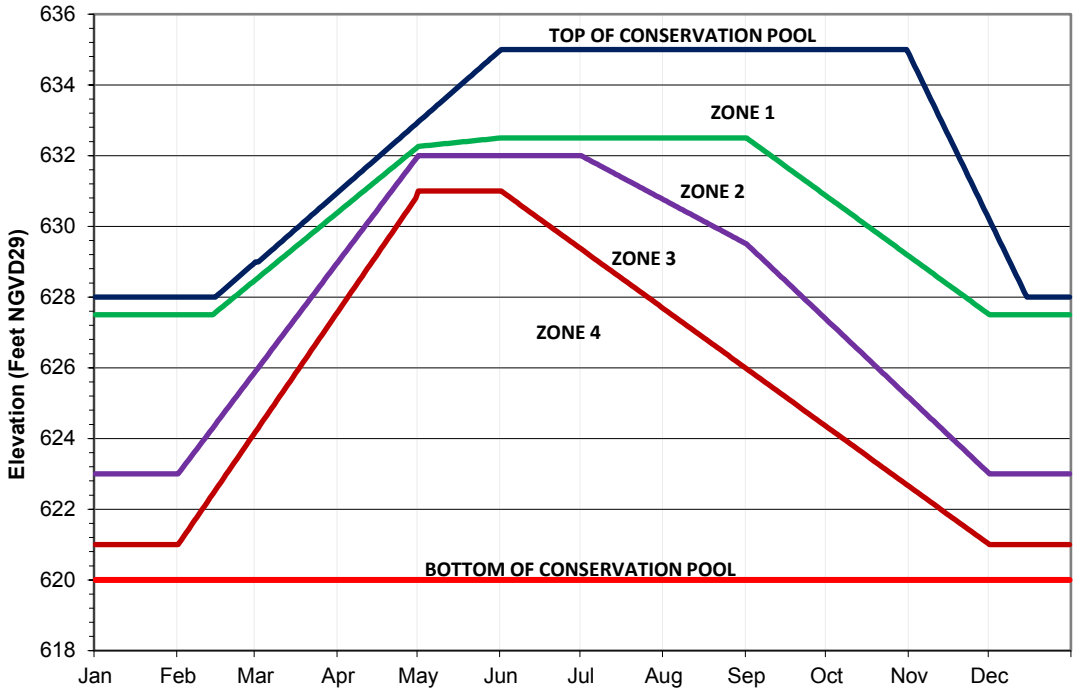
The revised action zones were derived considering numerous factors, including the ability of the reservoirs to refill (considering hydrology, watershed size, and physical constraints of each reservoir), recreation effects and hazard levels, and the proportionality of zone drawdown between projects. Other factors or activities might cause the lakes to operate differently than the action zones are described, including exceptional flood risk management measures, fish spawn operations, approved deviations, maintenance and repair of turbines, emergency situations (such as a drowning and chemical spills), drawdowns because of shoreline maintenance, releases made to free grounded barges, and other special circumstances.

The storage projects (Lake Lanier, West Point Lake, and Walter F. George Lake) would be operated to maintain their respective lake level in the same action zones concurrently. Because of the hydrologic and physical characteristics of the ACF Basin and factors mentioned above, however, there might be periods when one lake would be in a higher or lower action zone than another. When that occurs, USACE would conduct operations to bring the lakes back into balance with each other as soon as conditions allow. By doing so, effects within the ACF Basin would be shared equitably among the projects. The action zones for the PAA are shown in Figure 5.4-1, Figure 5.4-2, and Figure 5.4-3. A more complete discussion of action zones of the PAA may be found in section VII of the Master Manual and each project WCM found in appendix A.



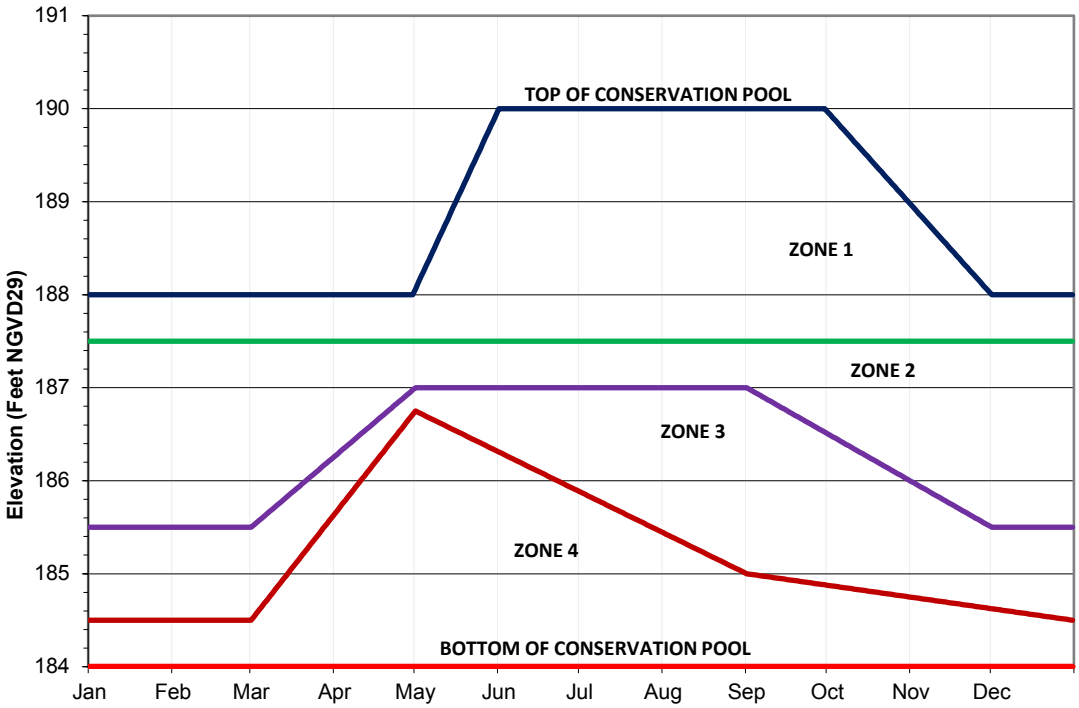
Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 5.4-1. Lake Lanier Water Control Action Zones for the PAA.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 5.4-2. West Point Lake Water Control Action Zones for the PAA.



Note: NGVD29 = National Geodetic Vertical Datum of 1929.

Figure 5.4-3. Walter F. George Lake Water Control Action Zones for the PAA.

5.4.2 Drought Operations

The drought plan included in the PAA specifies a minimum release from Jim Woodruff Lock and Dam and would temporarily suspend the normal minimum release and maximum fall rate provisions of the listed species operation, described in section 5.4.6, until composite conservation storage in the basin could be replenished to a level that could support them. Under the drought plan, minimum discharge would be determined in relation to the composite conservation storage. The drought plan would be triggered when the composite conservation storage falls below the bottom of Zone 2 into Zone 3 (Figure 5.4-4). At that time, all the provisions for composite conservation storage zones 1 through 3 (seasonal storage limitations, maximum fall rate schedule, and minimum flow thresholds) would be suspended, and management decisions would be based on the provisions of the drought plan. The suspension of the maximum fall rate schedule is delayed, however, if releases from Jim Woodruff Lock and Dam have not yet reached the 5,000 cfs minimum flow when the drought plan is implemented. The drought plan would include the option for a temporary waiver from the water control plan to allow temporary storage above the winter pool guide curve at the Walter F. George and West Point projects to provide additional conservation storage for future needs, if conditions in the basin dictate the need for such action.

The drought plan of the PAA prescribes two minimum releases on the basis of composite conservation storage in zones 3 and 4 and an additional zone referred as the *Drought Zone*. The Drought Zone delineates a volume of water roughly equivalent to the inactive storage in Lake Lanier, West Point Lake, and Walter F. George Lake, plus Zone 4 storage in Lake Lanier. The Drought Zone line was adjusted to include a smaller volume of water at the beginning and end of the calendar year. When the composite conservation storage is within Zone 4 and above the Drought Zone, the minimum release from Jim Woodruff Lock and Dam would be 5,000 cfs and all basin inflow (BI) above 5,000 cfs that is capable of being stored could be stored.

Once the composite conservation storage falls into the Drought Zone, the minimum release from Jim Woodruff Lock and Dam would be 4,500 cfs and all BI above 4,500 cfs that is capable of being stored could be stored. When transitioning from a minimum release of 5,000 to 4,500 cfs, fall rates would be limited to a 0.25-ft/day drop. The 4,500 cfs minimum release would be maintained until composite conservation storage returns to a level above the top of the Drought Zone, at which time the 5,000 cfs minimum release would be reinstated. The drought plan provisions would remain in place until conditions improve such that the composite conservation storage reaches Zone 1. At that time, the temporary drought plan provisions would be suspended and all the other provisions of the basin water control plan would be reinstated. During drought operations, a monthly monitoring plan that tracks composite conservation storage to determine water management operations (the first day of each month will represent a decision point) would be implemented to determine which operational triggers are applied. There is a special provision for the month of March under drought operations: If recovery conditions are achieved in February (after February 1), drought plan provisions will not be suspended until April 1, unless the level of composite conservation storage reaches the top of Zone 1 (i.e., all USACE reservoirs are full) before March 1. This provision is intended to ensure full recovery before the higher minimum flow provisions are put in place during normal operations in the sturgeon spawning season. When recovery conditions are achieved, the temporary drought plan provisions will be suspended and all the other provisions will be reinstated.

For the purpose of managing water supply storage, the Mobile District would employ a storage accounting methodology that applies a proportion of inflows and losses, as well as direct withdrawals by specific users, to each account. The amount of water that may actually be withdrawn is ultimately dependent on the amount of water available in the storage account, which will naturally change over time.

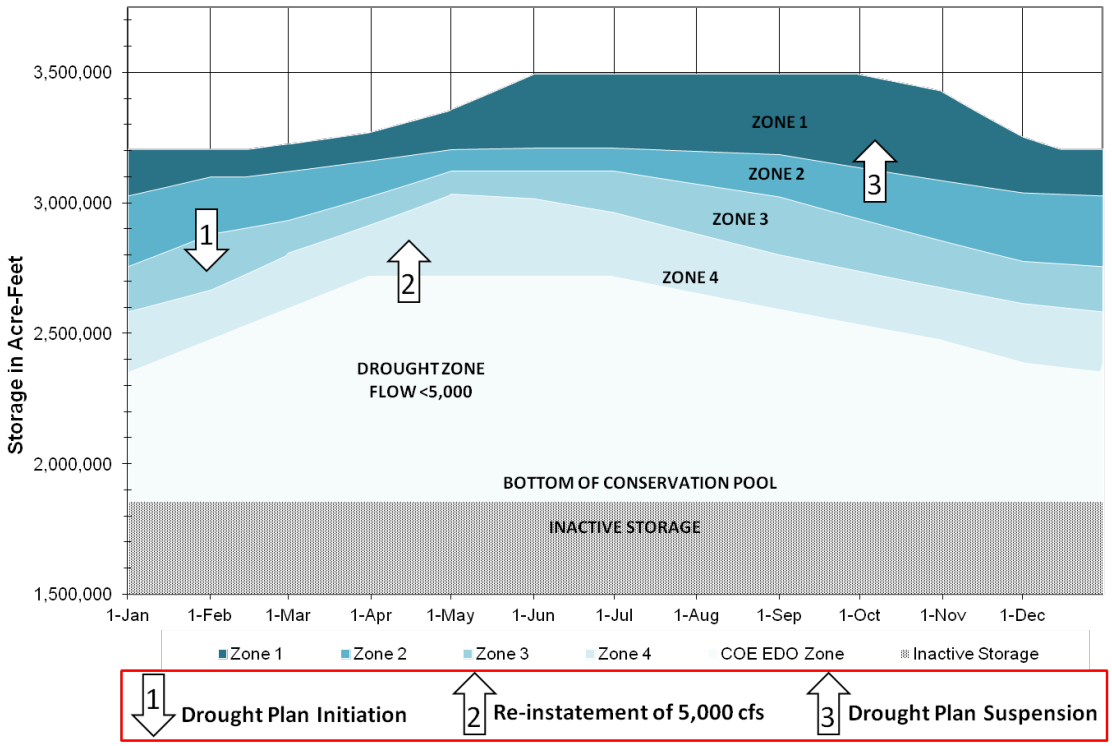


Figure 5.4-4. Composite Conservation Storage Zones and Drought Plan Triggers.

When the remaining composite conservation storage is about 10 percent of the total capacity, additional emergency actions might be necessary. When conditions have worsened to that extent, use of the inactive storage must be considered. For example, such an occurrence could be contemplated in the second or third year of a drought. Inactive storage zones have been designated for the three USACE projects with significant storage (Figure 5.4-5). Table 5.4-1 shows the inactive storage capacity within each inactive storage zone for each project. The use of inactive storage during extreme drought conditions would be based on the following actions:

(1) Inactive storage availability would be identified to meet specific critical water use needs within existing project authorizations. Any water supply storage contract that may be executed would not include the use of the inactive storage pool.

(2) Emergency uses would be identified in accordance with emergency authorizations and through stakeholder coordination. Typical critical water use needs within the basin are associated with public health and safety.

(3) Weekly projections of the inactive storage water availability to meet the critical water uses from Buford Dam downstream to the Apalachicola River would be used when making water control decisions regarding withdrawals and water releases from the USACE reservoirs.

(4) The inactive storage action zones would be instituted as triggers to meet the identified priority water uses (releases will be restricted as storage decreases). Figure 5.4-5 lists the typical critical water uses for each inactive storage zone.

(5) Dam safety considerations would always remain the highest priority. The structural integrity of the dams due to static head limitations (Jim Woodruff, 38.5 ft; George W. Andrews, 26 ft; Walter F. George, 88 ft) would be maintained.

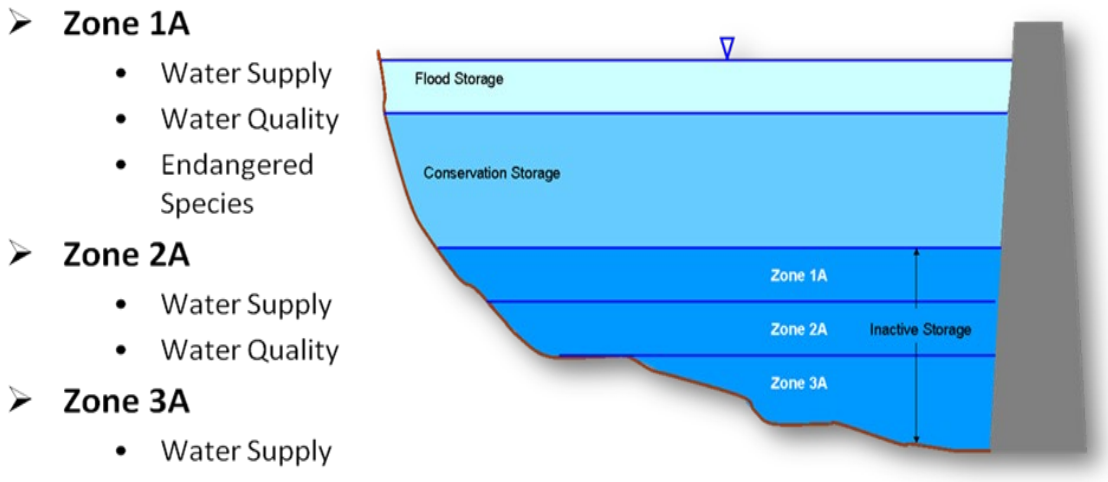


Figure 5.4-5. Inactive Storage Zones and Typical Water Use Needs.

Table 5.4-1.
Reservoir Inactive Storage Zone Capacities (ac-ft)

Project	Zone 1A	Zone 2A	Zone 3A	Unusable Inactive
Buford Dam	528,696	232,245	113,327	0
West Point Dam	53,620	138,331	33,344	73,101
Walter F. George Lock and Dam	311,207	169,605	0	170,960
Total	893,523	540,181	146,671	244,061

5.4.3 Flood Risk Management

When developing the PAA, flood risk management capabilities and capacities of reservoirs were not reduced. The flood operations described in section 2.1.1.2.4.1 would basically remain unchanged.

The prime objective of flood risk management operations at the West Point Dam project is to reduce peak flows at West Point, Georgia, based on the downstream U.S. Geological Survey (USGS) Chattahoochee River at West Point, Georgia, gage (# 02339500). This objective is met by regulating releases to maintain the USGS West Point, Georgia, gage within the nondamaging bankfull flow of 40,000 cfs until the induced surcharge schedule calls for greater release. The flood risk management pool at the West Point Dam project is designed to reduce the flood wave from small and moderate-sized floods. It does not have enough storage capacity to provide beneficial flood damage reduction for large flood events. During the early stages of a flood event, the outflow from West Point Dam is planned to control, or limit, the peak outflow as the flood develops. The basic plan for flood risk management is defined by three flood action zones (A, B, and C) within the flood risk management storage of the pool similar to manner in which conservation storage is defined by action zones to guide operations. The flood action zones are used to evacuate stored floodwater in a timely manner, either through the turbine units or the tainter gates, while allowing flexible scheduling for hydropower production. Detailed descriptions of the water management instructions within each flood zone are provided in the West Point Dam and Lake Water Control Manual (appendix A, appendix E).

No flood action zones have been defined for flood risk management storage at the Buford Dam project. Evacuation of the flood risk management pool at that project occurs only by way of releases through the tubines and the sluice gate at the bottom of the reservoir until the pool elevation reaches 1,085 ft, at which point flood waters also would begin to flow over the fixed crest emergency spillway.

5.4.4 Hydroelectric Power Generation

The PAA would result in changes to hydroelectric power generation operations at West Point Dam, Walter F. George Lock and Dam, and Jim Woodruff Lock and Dam to call for a more flexible generation schedule in all action zones under nondrought conditions and a more constrained generation schedule under drier conditions. The Buford, West Point, and Walter F. George projects are operated as peaking plants, and provide electricity during the peak demand periods of each day and week. Hydroelectric power peaking involves increasing the discharge for a few hours each day to near the full capacity of one or more of the turbines. Typically, the Buford, West Point, and Walter F. George projects provide generation five days a week at plant capacity throughout the year, as long as their respective lake levels are above Zone 4 and drought operations have not been triggered. For example, demand for peak hydroelectric power at Buford Dam typically occurs on weekdays from 5:00 a.m. to 9:00 a.m. Central time and from 3:00 p.m. to 10:00 p.m. between October 1 and March 31, and on weekdays from 1:00 p.m. to 7:00 p.m. between April 1 and September 30. The proposed typical hours represent releases that normally meet water system demands and provide the capacity specified in power marketing

arrangements. During dry periods, generation could be eliminated or limited to conjunctive releases. Typical, but not required, hours of operation by action zone are depicted in Table 5.4-2.

Table 5.4-2.
Proposed Typical Hours of Peaking Hydroelectric Power Generation by Federal Project

Action Zone	Buford Dam (hrs of operation) Normal Ops/Drought Ops	West Point Dam (hrs of operation)	Walter F. George Lock and Dam (hrs of operation)
Zone 1	3/2	4	4
Zone 2	2/1	2	2
Zone 3	2/1	2	2
Zone 4a	0	0	0

Note:
a While hydropower would still be generated in Zone 4, it could not be generated on a regular peaking schedule under severe drought conditions.

5.4.5 Navigation

When supported by ACF Basin hydrologic conditions, the PAA would provide a reliable navigation season. The water management objective for navigation is to ensure a predictable minimum navigable channel in the Apalachicola River for a continuous period that is sufficient for navigation use.

Assuming basin hydrologic conditions allow, a typical navigation season would begin in January of each year and continue for 4 to 5 consecutive months (January–April or May). Figure 5.4-6 graphically represents the navigation season and its relationship to composite conservation storage. During the navigation season, the flows at the USGS gage at Blountstown, Florida, should be adequate to provide a minimum channel depth of 7 ft. The most recent channel survey and discharge-stage rating was used to determine the flow required to sustain a minimum navigation depth during the navigation season. Flows of 16,200 cfs provide a channel depth of 7 ft. Flows of 20,600 cfs provide a channel depth of 9 ft. USACE's capacity to support a navigation season would be dependent on actual and projected system-wide conditions in the ACF Basin before and during January, February, March, April, and May. Those conditions include the following:

- A navigation season can be supported only when ACF Basin composite conservation storage is in Zone 1 or Zone 2.
- A navigation season will not be supported when the ACF Basin composite conservation storage is in Zone 3 and below. Navigation support will resume when basin composite conservation storage level recovers to Zone 1.
- A navigation season will not be supported when drought operations are in effect. Navigation will not be supported until the ACF Basin composite conservation storage recovers to Zone 1.
- The determination to extend the navigation season beyond April will depend on ACF BIs, recent climatic and hydrologic conditions, meteorological forecasts, and basin-wide model forecasts. On the basis of an analysis of those factors, USACE will determine if the navigation season will continue through part or all of May.
- Down-ramping of flow releases will adhere to the Jim Woodruff Lock and Dam fall rate schedule (see Table 5.4-3) for federally listed threatened and endangered species during the navigation season.
- Releases that augment the flows to provide a minimum 7-ft navigation depth will also be dependent on navigation channel conditions that ensure safe navigation.

When it becomes apparent that, because of diminishing inflows, downstream flows and depths must be reduced, notices would be issued to project users to give barge owners and other waterway users sufficient time to make arrangements to light load or remove their vessels before action is taken at Jim Woodruff Lock and Dam to reduce releases.

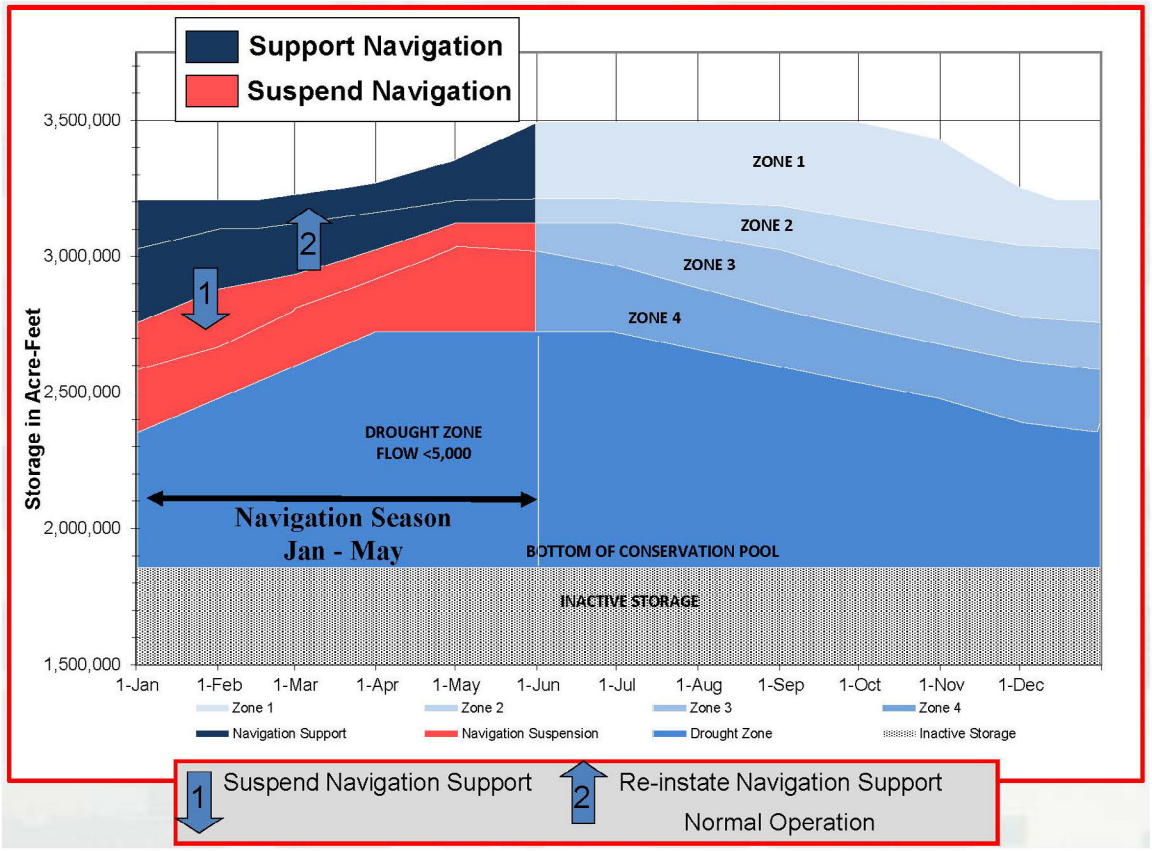


Figure 5.4-6. Composite Conservation Storage for Navigation.

Although special releases would not be standard practice, they could occur for a short duration to assist navigation during the navigation season. For instance, releases can be requested to achieve up to a 9-ft channel. Special releases also could occur outside of the navigation season; however, USACE would evaluate such requests on a case-by-case basis, subject to applicable laws and regulations and the conditions above.

5.4.6 Fish and Wildlife Conservation

There is no single operation for fish and wildlife conservation; rather, there are several related operations that are implemented in the PAA. West Point Dam is the only federal project in the ACF Basin with fish and wildlife recreation specifically included in its original congressional authorization. Nonetheless, the ACF Basin USACE reservoirs (i.e., Lanier, West Point, Walter F. George, Andrews, and Seminole lakes) operate to support fish and wildlife conservation pursuant to the authority in either the Fish and Wildlife Coordination Act or the Endangered Species Act. Generally, reservoir operations for fish and wildlife conservation consist of either maintaining pool elevations during fish spawns or making special releases to minimize the possibility of fish kills. Special drawdowns for specific environmental purposes may be

specified from time to time, but only after coordination with state and federal resource agencies and others, as appropriate. Although the possibility of requiring water control actions may extend throughout a season, the actual actions are usually of short duration. In addition to fishery management, operations include aquatic plant control, waterfowl, and other terrestrial habitat management. The various projects in the basin have specific operations for fish and wildlife, which are described in the individual project WCMs.

Under the PAA, current operations for reservoir fish spawn, fish passage, and tailrace DO and management of project lands would continue as described in section 2.1.1.2.4.4. Each of the WCMs describe the environmental commitments for fish and wildlife in section 7-08. Specific fish and wildlife conservation operations included in the PAA for federally listed species are addressed in more detail in the following paragraphs.

Federally Listed Species—Under the PAA, USACE would continue to make releases for federally listed, threatened and endangered species below Jim Woodruff Lock and Dam on the basis of seasonal requirements (spawning, nonspawning, and winter), composite conservation storage, and BIs as discussed in section 2.1.1.2.4.4, with several modifications. Release requirements dictated by composite conservation storage (Figure 5.4-4) would be in accordance with the revised action zones discussed in section 5.4.1.

USACE would manage releases from Jim Woodruff Lock and Dam to support the federally protected Gulf sturgeon and mussel species (fat threeridge, purple bankclimber, and Chipola slabshell) in the Apalachicola River. Daily releases to provide support for fish and wildlife conservation from Jim Woodruff Lock and Dam are dictated by two parameters: a minimum discharge (measured in cfs) and a maximum fall rate (measured in ft/day).

Minimum discharges from Jim Woodruff Lock and Dam would vary according to composite conservation storage (Figure 5.4-4), BI per the 7-day moving average and by month. Table 5.4-3 shows these minimum releases, which are measured as a daily average flow in cfs at the USGS gage at Chattahoochee, Florida. During normal and above normal hydrological conditions within the basin, releases greater than the minimum release provisions could occur consistent with the maximum fall rate schedule described below, or as needed to achieve other project purposes, such as hydroelectric power generation or flood risk management.

During the spawning period (March to May), two sets of four BI thresholds and corresponding releases would exist according to composite conservation storage in zones 1 and 2 or composite conservation storage in Zone 3 (Table 5.4-3). When composite conservation storage falls below the bottom of Zone 2 into Zone 3, the drought contingency operations would be triggered. However, since the decision to implement drought contingency operations occurs monthly, a minimum flow provision while in composite conservation Zone 3 is also included. USACE would operate Jim Woodruff Lock and Dam to avoid potential Gulf sturgeon take. Potential Gulf sturgeon take is defined as an 8-ft or greater drop in Apalachicola River stage over the last 14-day period (i.e., considering if today's stage is greater than 8 ft lower than the stage of any of the previous 14 days) when flows are less than 40,000 cfs.

During the nonspawning period (June–November), one set of four BI thresholds and corresponding releases would exist according to composite conservation storage in Zones 1–3. When composite conservation storage falls below the bottom of Zone 2 into Zone 3, drought operations would be triggered. Since the decision to implement drought contingency operations occurs monthly, however, a minimum flow provision while in composite conservation Zone 3 also is included.

During the winter season (December–February), only one BI threshold and corresponding minimum release (5,000 cfs) would exist while in composite conservation storage Zones 1–4. That would provide the greatest opportunity to refill the storage reservoirs. No BI storage restrictions are in effect as long as this minimum flow is met under such conditions.

When composite conservation storage falls below the bottom of Zone 2 into Zone 3, drought operations are triggered and the minimum flow from Jim Woodruff is reduced to 5,000 cfs. If composite conservation storage continues to fall into Zone 4, the minimum flow would continue to be the same as in Zone 3. When the composite conservation storage drops further into the Drought Zone, the minimum flow from Jim Woodruff Lock and Dam would be further reduced to 4,500 cfs. A description of the drought operations is provided in section 5.4.2.

Table 5.4-3.
Jim Woodruff Lock and Dam, Apalachicola River Minimum Discharge for Federally Listed Species by Month and by Basin Inflow Rates

Months	Composite Conservation Storage Zone	Basin Inflow (cfs)	Min. Releases from Jim Woodruff Lock and Dam (cfs)	Basin Inflow Available for Storage[a]
March–May	Zones 1 and 2	≥ 34,000 ≥ 16,000 and < 34,000 ≥ 5,000 and < 16,000 < 5,000	= 25,000 = 16,000+50% BI > 16,000 = BI = 5,000	Up to 100% BI>25,000 Up to 50% BI>16,000
	Zone 3	≥ 39,000 ≥ 11,000 and < 39,000 ≥ 5,000 and < 11,000 < 5,000	= 25,000 = 11,000+50% BI > 11,000 = BI = 5,000	Up to 100% BI>25,000 Up to 50% BI>11,000
June–November	Zones 1, 2, and 3	≥ 22,000 ≥ 10,000 and < 22,000 ≥ 5,000 and < 10,000 < 5,000	= 16,000 = 10,000+50% BI > 10,000 = BI = 5,000	Up to 100% BI>16,000 Up to 50% BI>10,000
December–February	Zones 1, 2, and 3	≥ 5,000 < 5,000	= 5,000 = 5,000	Up to 100% BI > 5,000
If Drought Triggered	Zone 3	NA	= 5,000	Up to 100% BI > 5,000
At all times	Zone 4	NA	= 5,000	Up to 100% BI > 5,000
At all times	Drought Zone	NA	= 4,500[b]	Up to 100% BI > 4,500

Notes:

[a] Consistent with safety requirements, flood risk management purposes, and equipment capabilities.

[b] Once composite conservation storage falls below the top of the Drought Zone, ramp down to a minimum release of 4,500 cfs at rate of 0.25 ft/day based on the USGS gage at Chattahoochee, Florida (02358000).

The federally listed species operations of the PAA include a fall rate, also called down-ramping rate, defined as the vertical drop in river stage (water surface elevation) that occurs over a given period of time. The fall rates are expressed in units of ft/day measured at the USGS Chattahoochee, Florida, gage as the difference between the daily average river stages on consecutive calendar days. Rise rates (e.g., today's average river stage is higher than yesterday's) are not addressed. The maximum fall rate schedule is provided in Table 5.4-4. When composite conservation storage falls into Zone 3, the drought operations described in section 5.4.2 would be implemented, the maximum fall rate schedule would be suspended, and more conservative drought operations would begin. The suspension of the maximum fall rate schedule would be delayed, however, if releases from Jim Woodruff Lock and Dam have not yet reached the 5,000 cfs minimum flow when the drought plan is implemented. Maintaining the maximum fall rate

schedule under these conditions would facilitate the movement of listed mussels and other aquatic species to lower stages as the river flow drops to stages that have not been recently dewatered. Down-ramping rates are also suspended during periods of prolonged low flow (flows less than 7,000 cfs for a period of more than 30 consecutive days). A prolonged low flow period would be considered over and down-ramping rates would be reinstated when flows are greater than 10,000 cfs for 30 consecutive days When the maximum fall rate schedule is suspended due to prolonged low flow, down-ramping operations would be managed to match the 1-day fall rate of the BI. This prolonged low-flow provision could occur under both normal and drought operations.

Table 5.4-4.
Maximum Down-Ramping (Fall) Rate[a]

Approximate Release Range (cfs)	Maximum Fall Rate (ft/day)	Maximum Fall Rate (cfs/day)
> 30,000 [b]	No ramping restriction [c]	
> 20,000 and ≤ 30,000 [a]	1.0 to 2.0	2,300 to 5,000
Exceeds Powerhouse Capacity (~ 16,000) and ≤ 20,000 [a]	0.5 to 1.0	1,060 to 2,300
Within Powerhouse Capacity and > 10,000 [a]	0.25 to 0.5	500 to 1,060
Within Powerhouse Capacity and ≤ 10,000 [a]	0.25 or less	220 to 500

Notes:

[a.] Maximum fall rate schedule is suspended in Composite Zone 3

[b.] Consistent with safety requirements, flood risk management purposes, and equipment capabilities.

[c.] For flows greater than 30,000 cfs, it is not reasonable or prudent to attempt to control the down-ramping rate, and no ramping rate is required.

5.4.7 Recreation

Under the PAA, operations for recreation would remain the same as current operations. Recreation benefits would be maximized at the lakes to the extent possible consistent with meeting other project purposes by maintaining full or nearly full pools during the primary recreation season which are the warm summer months. In response to meeting other authorized project purposes, lake levels could decline during the primary recreation period, particularly during drier than normal years. Recreation impact levels have been identified for various water surface elevations at each of the reservoir projects (see section 2.1.1.2.4.5 and Table 2.1-7). Recreational impact levels are not applicable to the George W. Andrews or Jim Woodruff projects due to the lack of conservation storage and the run-of-river operation at these projects.

When pool levels must be lowered, the rates at which the drawdowns occur are as steady as possible. The action zones at Lake Lanier and West Point Lake are drawn down to correlate the line between Zone 2 and Zone 3 near the initial impact level (IIL) at the beginning of the recreation season (May through early September). This is an attempt to maximize the time these projects are above the IIL during the recreation season.

5.4.8 Water Quality

Under the PAA, Buford, West Point, and Jim Woodruff projects would provide continuous minimum flow releases that would benefit the water quality immediately downstream of the dams. There would be no minimum flow provisions downstream of Walter F. George Lock and Dam. However, when low DO values are observed below the dam, spillage siphons are used to improve downstream DO. Occasional special releases would also be made at Buford Dam to ensure adequate DO and water temperature at the

Buford Fish Hatchery downstream of the dam. In 2005, vented turbines were also installed at Buford Dam to increase downstream DO (section 2.1.2.2.1). Each of the WCMs describe the environmental commitments for water quality in section 7-07.

At Buford Dam, the small turbine generator would run continuously to provide a minimum flow from the dam, which would range from approximately 500 to 700 cfs, depending on head conditions. This minimum flow from Buford Dam would help meet the seasonal minimum flow requirements of 650 cfs and 750 cfs at Atlanta in the Chattahoochee River just upstream of the confluence with Peachtree Creek. At West Point Dam, the minimum flow requirement is 670 cfs and a similar small generating unit would provide a continuous release of approximately 675 cfs. A varying minimum flow from 4,500 to 25,000 cfs, dependent upon basin conditions, would be maintained as a release from the Jim Woodruff Lock and Dam to the Apalachicola River, which would ensure an adequate water supply for downstream industrial use and water quality. Walter F. George Lock and Dam has two siphons on each spillway gate. The siphon discharge would range up to 400 cfs when all 12 siphons are in use. Typically, the siphon tubes would be opened continuously from May through the end of September and all 12 would be used at full capacity. The siphons would provide a gravity-fed, typically continuous, minimum flow that would benefit DO levels below the dam.

5.4.9 Water Supply

Under the PAA, the cities of Gainesville and Buford would continue to withdraw water directly from Lake Lanier under relocation agreements at rates not exceeding 8 mgd (net) and 2 mgd, respectively[13]. Additionally, pursuant to the WSA of 1958, the PAA would reallocate 254,170 ac-ft in Lake Lanier for water supply. The amount of storage is estimated to yield 222 mgd during the critical drought (i.e., during the worst drought on record at the time the agreement was executed). The severity and frequency of droughts change over time, therefore, the yield of this storage may change over time. For the purpose of managing water supply storage, USACE would employ a storage accounting methodology that applies a proportion of inflows and losses, as well as direct withdrawals by specific users, to each account. The amount of water that may actually be withdrawn is ultimately dependent on the amount of water available in the storage account, which will naturally change over time. As explained in the WSSA (Appendix B), users of the reallocated water supply storage will initially pay $3,364,000 per year over a period of 30 years from the date the storage is available consisting of $2,892,000 for the annual cost of the reallocated storage plus the user's estimated share of annual O&M cost of $472,000[14]. The user's annual payment will also include a share of repair, rehabilitation, and replacement cost, which initially is zero because there have been no repair, rehabilitation, and replacement (RR&R) costs to date. To account for actual OMRR&R costs, an adjustment to the payment together with a recaluculation of the federal interest rate will made every 5- years.

[13]Relocation contracts are provided as compensation for inundation of existing water intakes at the time of project construction. All withdrawal amounts are shown in gross withdrawals, the only contract that utilizes a net withdrawal figure is the relocation contract for the City of Gainesville due to the specific terms of the contract. Presently, Gainesville withdraws 18 mgd and returns 10 mgd resulting in a net withdrawal of 8 mgd. The total gross withdrawal under relocation contracts for Gainesville and Buford is 20 mgd.

[14] Dollar values are based on September 2016 (fiscal year 2016) price levels and fiscal year 2017 interest rate of 2.875 percent over a 50-year period of economic analysis. At the time of printing the latest available index was September 2016.

Under the PAA releases from Buford Dam would be made to accommodate downstream water demands. Peaking hydroelectric power generation would generally accommodate most water supply needs of communities currently withdrawing from the Chattahoochee River; however, under the 1946 RHA, generation might occur at nonpeaking times to meet the downstream water supply needs, not to exceed 379 mgd.

6 Environmental Consequences

This section of the EIS describes the environmental and socioeconomic effects of proposed updates to water management operations at USACE reservoirs in the ACF Basin and water supply storage options related to operations at Buford Dam/Lake Lanier. The affected environment described in section 2 serves as a baseline from which potential environmental and socioeconomic effects likely to result from the proposed changes were determined.

The HEC-ResSim model was used to simulate water management operations alternatives and water supply storage options in the ACF Basin. Section 4.1 provides a detailed description of the model development and its application to the phase 1 plan formulation and evaluation of ACF water management operations alternatives and the phase 2 formulation and evaluation of the final array of Master WCM update alternatives. The final array of alternatives derived from the phase 2 plan formulation process is comprised of the recommended water management operations alternative (see section 4) combined with various water supply storage options for Lake Lanier (see section 5). Additional details on the HEC-ResSim modeling for the WCM update process are presented in the HEC-ResSim modeling report in appendix E.

USACE determined that the 73-year hydrologic period of record (1939–2011) would provide a reasonable range of future hydrologic conditions by which to assess and compare the effects of the final array of alternatives plans to current project operations, or the NAA. For the NAA, net diversions for municipal and industrial (M&I) water supply (withdrawals minus returns of treated wastewater) and agricultural diversions for irrigation (assuming no returns) throughout the ACF Basin were simulated by using 2007 values and applying them over the entire hydrologic period of record. All water use data to support this analysis were provided by the pertinent state agencies responsible for regulating and tracking water withdrawals and returns in the respective states. Net diversion values in the ACF Basin in 2007 represent the greatest annual amount of net water diversion in the basin during the period of simulation and, consequently, the year of greatest stress on the system from water withdrawals. Starting with average monthly values for each diversion, average daily values were calculated for each month (by dividing by the number of days), resulting in a year of daily values. The HEC-ResSim simulation applied these 2007 diversion values to hydrologic conditions for each year in the period of record. The HEC-ResSim modeling report (appendix E) and the updated Unimpaired Flow Dataset (appendix O) provide more information on how diversions were addressed.

Withdrawals and returns for the alternatives that include future water supply withdrawal options associated with Lake Lanier and the Chattahoochee River between Buford Dam and Peachtree Creek were simulated in the following manner. Each alternative includes a potential set of withdrawal and return values for Lake Lanier and for the Chattahoochee River (one of which is specifically based upon Georgia's revised December 2015 water supply request to USACE). Sections 5.1.4 and 5.2 describe the withdrawal and return assumptions for each alternative in more detail. For the balance of the ACF Basin downstream of Metro Atlanta, year 2007 M&I net withdrawals, as well as agricultural withdrawals, were simulated as described for the NAA.

The water quality effects associated with the water management alternatives and water supply storage options in the ACF Basin were analyzed with the HEC-5Q model developed by the USACE Hydrologic Engineering Center. USACE selected Hydrologic Engineering Center water quality model (HEC-5Q) as the tool most capable of faithfully representing river-reservoir temperature and water-quality at the culmination of a 3-year model development and verification process. In accordance with Engineering and Construction Bulletin 2007-6, *Model Certification Issues for Engineering Software in Planning Studies*, issued April 10, 2007, HEC-5Q falls under the category of "engineering models used in planning

studies," leaving certification to the Science & Engineering Technology initiative associated with the USACE's Technical Excellence Network (TEN). As of January 2010, the TEN guidance listed HEC-5Q as "allowed for use" for the purpose of water quality modeling.

For the simulation of water quality conditions under the various alternatives, HEC-5Q inputs included in-stream flows, tributary flows, water quality data, withdrawals, reservoir operations, and other point and nonpoint source flows and quality loads to the system. The HEC-5Q model was linked with the HEC-ResSim model through an input of flows by reach. In addition to the BASINS model loadings developed in previous modeling efforts, observed data was used to represent the nonpoint inputs to the HEC-5Q model for the period of record from 2001 through 2011. The HEC-5Q model also included nontributary inflows, wastewater treatment discharges, and cooling water returns. Inputs for wastewater treatment discharges were based on discharge monitoring reports (DMRs). When DMRs were not available, permitted limits, concentrations representative of the type of discharge, or an average of DMRs was used. The point source inputs considered only dischargers that contributed more than 1 mgd.

The water quality effects on the mainstems of the ACF Basin were examined with HEC-5Q. The operation of USACE reservoirs would not be expected to affect tributaries in the basin. A principal benefit of the HEC-5Q model is its ability to simulate the entire riverine and reservoir system in a single model. It can perform a holistic examination of the basin from top to bottom and simulate the watershed inflows, reservoirs, and river segments. Modeled output produced in that way allows for a clear, longitudinal presentation of conditions to facilitate comparisons between various operations scenarios.

Model inputs, assumptions, and calibration for application of HEC-5Q to the Master Manual update are presented in the HEC-5Q modeling report in appendix K.

For each natural and socioeconomic resource area discussed in this section, an impact matrix table summarizes the expected environmental consequences for each alternative compared to existing conditions under the NAA. The impact matrix for each resource area includes relevant parameters and/or indicators upon which to base the assessment of effects. The following terms characterize or define the various levels of impact presented in each impact matrix:

- Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
- Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.
- Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.
- Adverse—Any adverse impact is clearly detectable and would have an appreciable effect.
- Beneficial—Any beneficial impact is clearly detectable and would have an appreciable effect.
- Substantially adverse—Any adverse impact would result in a highly noticeable effect.
- Substantially beneficial—Any beneficial impact would result in a highly noticeable effect.

The characterization of environmental consequences in the impact matrix for each natural and socioeconomic resource area is intended to provide only a general overview or summary of the nature and relative intensity of the effects with respect to the specific resource area. The text in this section of the EIS provides more detailed information and analysis, both qualitative and quantitative, to support the general characterization in the impact matrix. In some cases, pertinent appendices include additional details for reference by the reader.

Compliance with federal laws and executive orders (EOs) relevant to this EIS is summarized in Table 6-1. Sections of this EIS referenced in the table provide more detailed discussion of compliance with and applicability to the pertinent federal laws and EOs.

Table 6-1.
Environmental Compliance with Applicable Laws and EOs

Applicable Authority	Status of Compliance[a]	Remarks
Federal Laws		
Preservation of Historical and Archeological Data at 54 U.S.C. Chapter 3125	Full compliance	See section 6.7. Adverse effects on cultural resources are not expected as a result of the PAA.
Archeological Resources Protection Act, 16 U.S.C. 470aa–470ll	Full compliance	See section 6.7. Adverse effects on cultural resources are not expected as a result of the PAA.
Clean Water Act, 33 U.S.C. 1344 *et seq.*; also known as the Federal Water Pollution Control Act of 1972	Full compliance	State water quality certification under section 401 of the Clean Water Act is not applicable to the PAA; the PAA does not involve a discharge of dredged or fill material into waters of the U.S. The effects of the alternatives with respect to state water quality standards are described in section 6.1.2.
Clean Air Act, 42 U.S.C. 7401	Full compliance	See section 2.7 (full compliance attained upon EPA review of the final EIS).
Coastal Zone Management Act of 1972, as amended, Public Law (P.L.) 92-583, 16 U.S.C. 1451–1464	Full compliance	No change to the coastal zone would be expected based on the analysis in the EIS. The PAA would be consistent with the FCMP to the maximum extent practicable. See appendix L.
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601–9675	Not applicable	The PAA would not be expected to have an effect on hazardous and toxic materials in the basin, nor would the presence of any such materials have an impact on project operations. See section 2.11.
Emergency Wetlands Resources Act of 1986, 16 U.S.C. 3901–3932	Full compliance	See section 6.4.2. Wetlands would not be appreciably affected by the PAA.
Endangered Species Act (ESA), 16 U.S.C. 1531	Fulll compliance	See section 6.4.4 for discussion of ESA compliance activities. A Biological Opinion for the PAA was issued by the US Fish and Wildlife Service (USFWS) on September 14, 2016.
Fish and Wildlife Coordination Act (FWCA), 16 U.S.C. 661–667e	Full compliance	See section 6.4.1 for discussion of coordination activities during the ACF Master WCM update process. The final FWCA report was submitted by USFWS to USACE on September 14, 2016.
Federal Land Policy and Management Act (FLPMA) of 1976, 43 U.S.C. 1701–1784	Not applicable	FLPMA declares specific policy regarding inventory, land use planning, management, and disposal of federal lands, but the provisions of the law specifically apply to federal lands administered by the Secretary of the Interior through the Bureau of Land Management. NOTE: The PAA for the ACF Master WCM update would not adversely affect management of USACE project lands. See section 6.3.

Applicable Authority	Status of Compliance[a]	Remarks
Magnuson-Stevens Fishery Conservation Management Act, as amended by the Sustainable Fisheries Act of 1996 (P.L. 104-267; 16 U.S.C. 1801)	Full compliance	Essential Fish Habitat (EFH) recommendation provided to USACE by National Marine Fisheries Services letter dated January 15, 2016. No appreciable effect on EFH is expected as documented in section 6.4.3.3.
Marine Protection, Research, and Sanctuaries Act of 1972 33 U.S.C. 1401–1445, 16 U.S.C. 1431 *et seq*. and 33 U.S.C. 1271	Not applicable	No ocean dredged material disposal would be expected under the PAA.
Migratory Bird Treaty Act, 16 U.S.C. 701–719c	Full compliance	See section 6.4.2. Water management operations in the ACF Basin have little to no discernable effect on terrestrial vegetative communities and wildlife, including migratory birds.
National Environmental Policy Act, P.L. 91-190	Full compliance	Full compliance attained upon completion of final EIS coordination and signed Record of Decision. Section 6 addresses effects on the natural and human environment associated with the PAA.
The National Historic Preservation Act, 54 U.S.C. Chapter 3001.	Full compliance	See section 6.7. Adverse effects on cultural resources are not expected as a result of the PAA.
Noise Control Act of 1972 as amended, 42 U.S.C. 4901 *et seq*.	Full compliance	See section 2.9. No increased noise effects are expected as a result of the PAA.
North American Wetlands Conservation Act, 16 U.S.C. 4401 *et seq*.	Full compliance	See section 6.4.2 and 6.4.3.3. Wetlands would not be appreciably affected by the PAA.
Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901–6992k	Not applicable	The PAA would not be expected to have an effect on hazardous and toxic materials. See section 2.11.
Safe Drinking Water Act as amended, 42 U.S.C. 300f *et seq*. 6939b and 15 U.S.C. 1261 *et seq*.	Full compliance	See section 6.1.2. No adverse drinking water effects are expected.
Toxic Substances Control Act of 1976, 15 U.S.C. 2601	Not applicable	The PAA would not be expected to have an effect on hazardous and toxic materials. See section 2.11.
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001	Full compliance	See section 6.2. Adverse effects on the watershed, soils, and soil erosion are not excpected as a result of the PAA.
Executive Orders		
EO 11988: Floodplain Management	Full compliance	The PAA would not increase flood risk or induce development into the floodplain compared to the NAA (see section 6.5.6.8). The effects of the PAA and other alternatives on floodplain values from a biological perspective (connectivity, inundation, productivity, etc.) are described in section 6.4.2, 6.4.3, and 6.4.4.

Applicable Authority	Status of Compliance[a]	Remarks
EO 11990: Protection of Wetlands	Full compliance	See section 6.4.2 and 6.4.3.3. Wetlands would not be appreciably affected by the PAA.
EO 12088: Federal Compliance with Pollution Control Standards	Full compliance	The subsequent subsections in section 6 consider impacts on the human environment from the PAA.
EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Full compliance	See section 6.5.7.4. No environmental justice issues are expected as a result of the PAA.
EO 13045: Protection of Children from Environmental Health Risks and Safety Risks	Full compliance	See section 6.5.9. No increased environmental health or safety risks to children are expected as a result of the PAA.
EO 13061: American Heritage Rivers	Not applicable	There are no designated American Heritage Rivers in the ACF Basin
EO 13101: Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition	Not applicable	EO does not apply to the update of the ACF WCM.
EO 13123: Greening the Government Through Efficient Energy Management	Not applicable	EO does not apply to the update of the ACF WCM.
EO 13148: Greening the Government Through Leadership in Environmental Management	Not applicable	EO does not apply to the update of the ACF WCM.
EO 13175: Consultation and Coordination with Indian Tribal Governments	Full compliance	Cultural resources effects are presented in section 6.7. Consultation and coordination with tribes (as identified in section 10.4) occurred during scoping (section 1.4.2), draft EIS review (section 1.4.5) and final EIS review (1.4.6)
EO 13186: Responsibilities of Federal Agencies to Protect Migratory Birds	Full compliance	See section 6.4.2. Water management operations in the ACF Basin have little to no discernable effect on terrestrial vegetative communities and wildlife, including migratory birds.

Note:
[a] This EIS and the Record of Decision, when complete, will be compliant with applicable laws and EOs.

Whereas most of the laws listed in Table 6-1 focus on a single or limited number of resource areas, the Coastal Zone Management Act (CZMA), Title 16 of the United States Code (U.S.C.) sections 1451–1464, encompasses a broad range of resource area considerations in coastal areas, as defined in federally approved state coastal zone management programs. The Florida portion of the ACF Basin lies within the purview of the Florida Coastal Management Program (FCMP). The PAA (Alternative 7K [Alt7K]) is subject to review for federal consistency with the enforceable policies of the FCMP, in accordance with the CZMA and pertinent implementing regulations. At the draft stage of the EIS, USACE reviewed the PAA (which at the time was Alt7H) for consistency with the FCMP and determined that it would be consistent with the enforceable policies of the FCMP to the maximum extent practicable. The Florida Department of Environmental Protection (DEP), with the explicit concurrence of the Governor of Florida, issued a finding of inconsistency with the FCMP in a January 29, 2016 letter of comment on the draft EIS. Upon incorporating further revisions to the ACF WCM update process in response to agency and public comments on the draft EIS, including the selection of a new PAA (Alt7K), USACE completed a substantially revised federal consistency determination prior to the review of the final EIS and forwarded it to the Florida DEP by letter dated September 16, 2016 with a request for FCMP consistency review. The PAA for the ACF WCMs complies with the CZMA to the maximum extent practicable. The consistency determination was provided to Florida over 90 days prior to the expected agency decision on

the ACF WCM update and EIS. Florida DEP is expected to render its finding regarding the USACE federal consistency determination prior to the completion of the final EIS review period. The revised determination of consistency at the final EIS stage is included as appendix L.

The USACE Environmental Operating Principles (EOPs), summarized in section 3.2, are applicable to all USACE activities, including the update of the Master Manual. The EOPs were fully considered in development of the PAA and the other alternatives.

6.1 Water Resources

6.1.1 Water Quantity Environmental Consequences

This section describes the expected effects of the water management alternatives/water supply options for the Master Manual update relative to water quantity considerations. It focuses on the extent of physical change in water resource parameters in the ACF Basin that would result from the various alternatives and provides the principal basis for the evaluation of other natural and socioeconomic resource impacts presented in the subsequent sections. The water resource parameters include lake-level conditions, streamflow conditions, conservation storage volumes, drought operation occurrences, navigation flows/channel depth availability, and water surface profiles/water intake structure viability.

Figures included in this section describe and compare the effects of the alternatives. In a number of cases, model outputs for two or more of the plans were nearly identical for a portion of the plot (or curve) or over the entire range. For the set of curves applicable to each parameter (e.g., median daily water surface elevation at a specific reservoir), the nine alternatives evaluated in the EIS are plotted on two figures for easier reading. The curve for the NAA (Alternative 1A [Alt1A]) appears on both figures. The curves for each alternative are plotted in the following order:

- In the first figure
  - NAA
  - Alternative 1L (Alt1L)
  - Alternative 7A (Alt7A)
  - Alternative 7B (Alt7B)
  - Alternative 7H (Alt7H)
- In the second figure
  - NAA
  - Alternative 7I (Alt7I)
  - Alternative 7J (Alt7J)
  - PAA
  - Alternative 7L (Alt7L)
  - Alternative 7M (Alt7M)

The appearance of fewer curves on a figure than is indicated in the legend means that the data for one or more of the alternatives are identical or nearly identical to another. If two or more plots are identical or nearly identical, the last curve plotted is the one that appears on the figure. The text associated with each figure provides clarification as necessary.

Note that all elevation data in section 6 of the EIS addressing USACE project structures, reservoir water surface elevations, and other pertinent elevation information are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

6.1.1.1 Lake Levels and Conservation Storage

As described in section 2.1.1.1.6, the guide curve for each lake with conservation storage (excluding run-of-river projects) depicts the desired operating level for the top of the conservation pool at any point during the year. The actual level for the top of conservation pool at any point in time depends on the amount of rainfall and associated basin inflow (BI), evaporation from the lake, and releases from the dams to meet project purposes. The USACE reservoirs in the ACF Basin with conservation storage also have action zones within the conservation pool, also described in section 2.1.1.1.6. The action zones prescribe progressively more restrictive guidelines for management of downstream releases to conserve storage as rainfall and BIs decrease during periods of drought and as lake levels decline.

This section summarizes the effects of the alternative plans for USACE reservoirs in the ACF Basin. The following analysis focuses on the physical effects of the alternatives on lake-level conditions and conservation storage values over the modeled period of record and compares lake-level conditions under the various alternatives to predetermined performance measures. It describes impact thresholds for recreation facilities, access, and use of the USACE lakes in the ACF Basin under various hydrologic conditions over the modeled period of record. Based on the model results, this section describes the likely impacts of the alternative plans on lake levels and associated conservation storage conditions at pertinent USACE reservoirs. The section addresses the effects of the NAA and the nine alternatives on lake-level conditions in the basin, beginning with the USACE reservoir farthest upstream (Lake Lanier) continuing to the USACE reservoir farthest downstream (Lake Seminole).

To support evaluation of and comparison among the alternatives, figures depicting median lake-level conditions in the basin provide a representative characterization of normal lake-level conditions. The median value represents the point at which 50 percent of the values are higher and 50 percent are lower. In addition, figures depicting the 90-percent exceedance level have been included, meaning that the values presented for each day would be exceeded 90 percent of the time in the simulation over the period of record. The 90-percent exceedance value would be representative of extremely dry conditions in the basin and low BI to the reservoirs. Figures depicting lake levels under wetter conditions for the alternatives under consideration (e.g., 10- or 25-percent exceedance levels) have not been included in this EIS because they generally indicate minor or no differences among the alternatives.

Interpretation of the model results as presented in Table 6.1-1 and other detailed figures and tables in this section provides the basis for the description of effects on lake levels and conservation storage in the ACF Basin. Table 6.1-1 provides a qualitative assessment of the expected effects of the alternatives on lake-level and conservation storage (where applicable) conditions at reservoirs on the mainstem rivers in the ACF Basin. The following paragraphs provide further details regarding the changes associated with the various alternatives compared to the NAA.

Table 6.1-1.
Summary of the Effects on Lake-Level Conditions of the Alternatives from the NAA during the Modeled Period of Record 1939–2011

Reservoir	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Slightly adverse	Slightly beneficial	Beneficial	Slightly adverse	Slightly adverse	Beneficial	Slightly adverse	Slightly beneficial	Slightly adverse
West Point Lake	Baseline	Slightly beneficial	Slightly beneficial	Beneficial	Slightly beneficial	Slightly beneficial	Beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lake	Baseline	Negligible/ No change	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Lake George W. Andrews	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Nonfederal Reservoirs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.

Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

Adverse—Any adverse impact is clearly detectable and would have an appreciable effect.

Beneficial—Any beneficial impact is clearly detectable and would have an appreciable effect.

6.1.1.1.1 Buford Dam and Lake Lanier

Buford Dam and Lake Lanier and their operations are described in section 2.1.1.1.6.1. This section describes the effects of operations under Water Management Alternative 1 and the Proposed Water Management Alternative (Water Management Alternative 7) in combination with water supply options A, B, H, I, J, K, L, and M.

Figure 6.1-1 through Figure 6.1-6 and Table 6.1-2, Table 6.1-3, and Table 6.1-4 present model results for Lake Lanier operations over the simulated period of hydrologic record for the NAA and for proposed revisions to the Master WCM as defined in Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, Alt7K, Alt7L, and Alt7M. The figures and tables present results for median pool levels (daily), 90-percent exceedance pool levels (daily), percent of days exceeded for pool levels, number of years that impact thresholds (recreation) would be reached (annual and summer season), percent of days during the summer season (May–September) that pool levels would be below impact thresholds (recreation), and percent of time that reservoir storage would be in each action zone. In consideration of the number of alternatives and the ease of viewing the information about each alternative, the results for each parameter (e.g., median daily pool level) are presented in two figures with half of the alternatives presented on each figure. Using the results from the figures and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

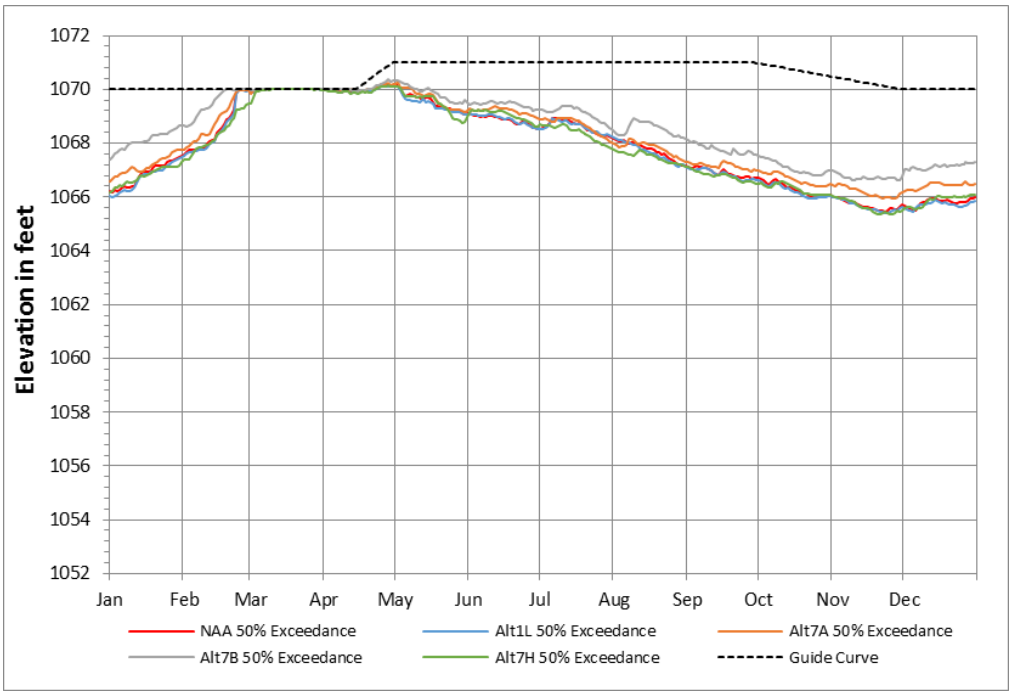


Figure 6.1-1. Lake Lanier Median Daily Water Surface Elevation over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

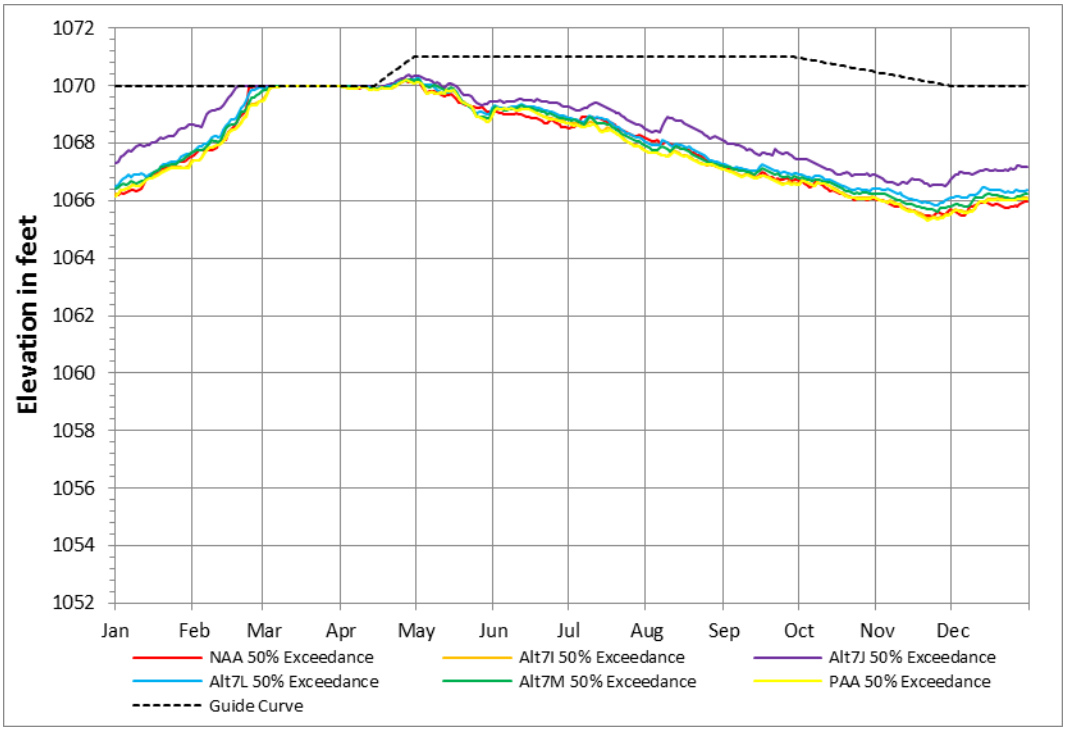


Figure 6.1-2. Lake Lanier Median Daily Water Surface Elevation over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

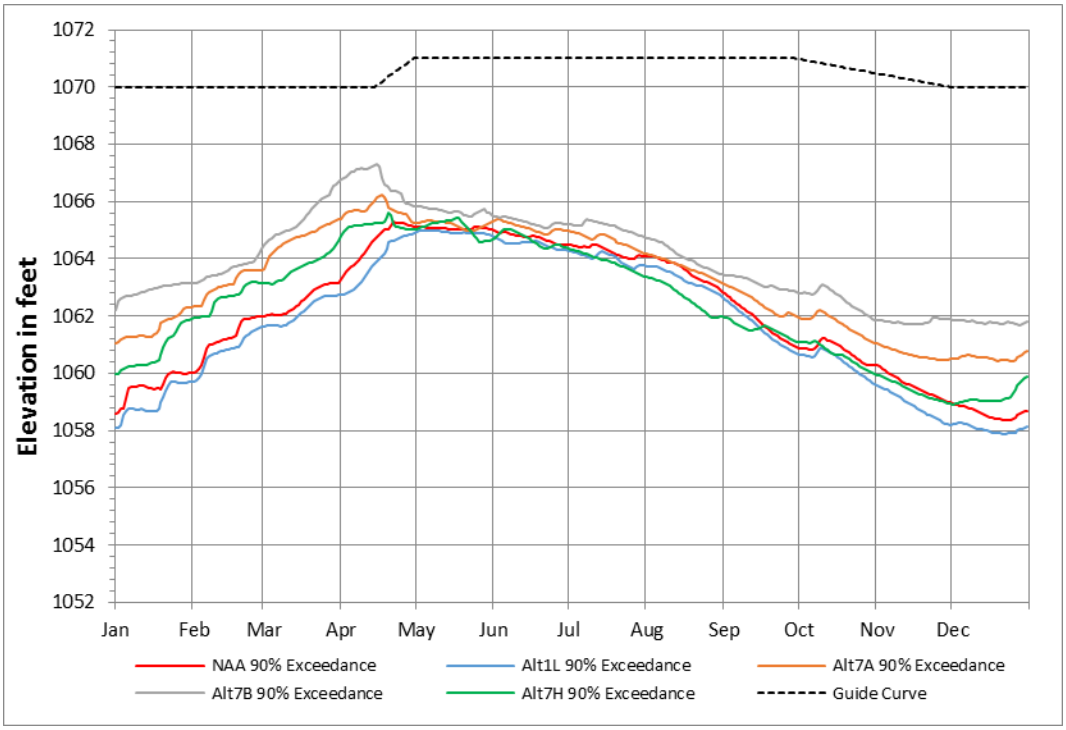


Figure 6.1-3. Lake Lanier Daily Water Surface Elevations—Exceeded 90% of the Time over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

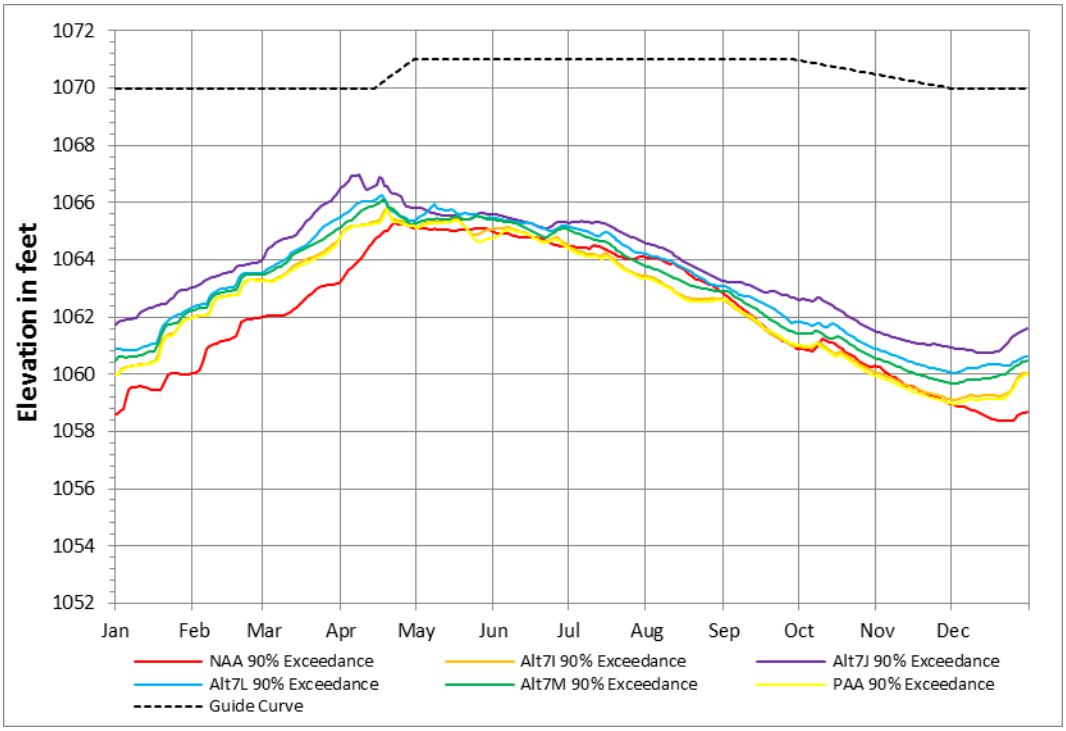


Figure 6.1-4. Lake Lanier Daily Water Surface Elevations—Exceeded 90% of the Time over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

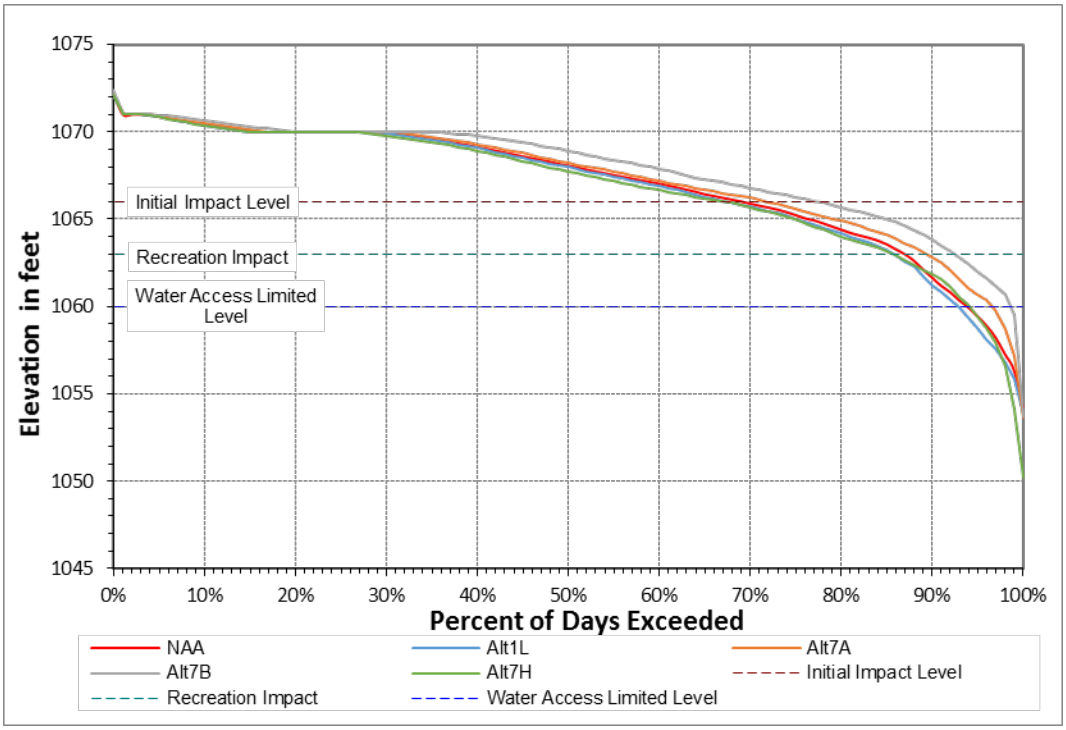


Figure 6.1-5. Lake Lanier Daily Water Surface Elevations—Percent of Days Exceeded over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

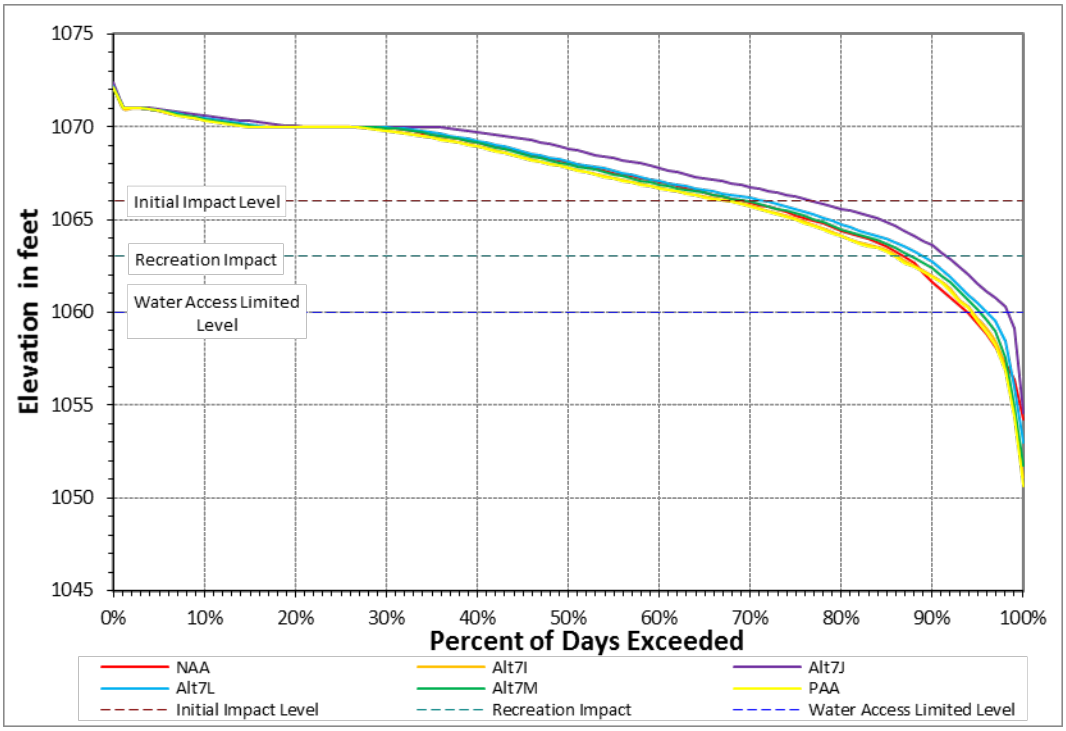


Figure 6.1-6. Lake Lanier Daily Water Surface Elevations—Percent of Days Exceeded over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

Table 6.1-2.
Number of Years Lake Lanier Pool Would Drop below Designated Impact Levels over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M

Alternative	Time Interval Analyzed for Each Year	Initial Impact Level (elev. 1,066 ft)	Recreation Impact Level (elev. 1,063 ft)	Water Access Limited Level (elev. 1,060 ft)
NAA (Alt1A)	Jan–Dec (12 months)	55	24	17
	Summer Season May–Sep (5 months)	32	16	6
Alt1L	Jan–Dec (12 months)	61	25	19
	Summer Season May–Sep (5 months)	32	17	6
Alt7A	Jan–Dec (12 months)	53	23	11
	Summer Season May–Sep (5 months)	32	13	4
Alt7B	Jan–Dec (12 months)	47	19	4
	Summer Season May–Sep (5 months)	27	9	3
Alt7H	Jan–Dec (12 months)	61	29	15
	Summer Season May–Sep (5 months)	36	17	6
Alt7I	Jan–Dec (12 months)	60	29	15
	Summer Season May–Sep (5 months)	36	17	6
Alt7J	Jan–Dec (12 months)	48	20	7
	Summer Season May–Sep (5 months)	27	9	3
PAA (Alt7K)	Jan–Dec (12 months)	60	29	15
	Summer Season May–Sep (5 months)	37	17	6
Alt7L	Jan–Dec (12 months)	53	24	11
	Summer Season May–Sep (5 months)	32	13	4
Alt7M	Jan–Dec (12 months)	55	29	14
	Summer Season May–Sep (5 months)	33	17	5

Note: elev. = elevation

Table 6.1-3.
Lake Lanier—Percent of Days below Impact Thresholds for Recreation Use during Summer Season (May–Sep)

Alternative	Initial Impact Level	Recreation Impact Level	Water Access Limited Level
NAA (Alt1A)	22.6%	8.0%	2.8%
Alt1L	24.5%	9.2%	3.3%
Alt7A	23.5%	7.1%	2.2%
Alt7B	19.2%	5.2%	0.4%
Alt7H	27.3%	9.4%	3.5%
Alt7I	26.8%	9.0%	3.3%
Alt7J	19.3%	5.6%	0.8%
PAA (Alt7K)	27.1%	9.1%	3.4%
Alt7L	23.1%	6.9%	2.6%
Alt7M	25.4%	7.6%	3.0%

Table 6.1-4.
Percent of Time the Lake Lanier Pool Would Be in Revised Action Zone over Modeled Period of Record (1938–2011) for the NAA and Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M

	Lake Lanier Action Zones			
Alternative	Zone 1	Zone 2	Zone 3	Zone 4
NAA (Alt1A)	56%	20%	9%	15%
Alt1L	55%	20%	10%	16%
Alt7A	59%	18%	13%	11%
Alt7B	66%	15%	12%	7%
Alt7H	53%	19%	13%	15%
Alt7I	54%	19%	13%	14%
Alt7J	65%	16%	11%	8%
PAA (Alt7K)	53%	19%	13%	15%
Alt7L	58%	18%	13%	11%
Alt7M	56%	18%	13%	13%

6.1.1.1.1.1 No Action Alternative

As described in section 5.2.1, the NAA represents continuation of current water control operations and current withdrawals and returns in the ACF Basin.

The median daily pool elevation at Lake Lanier over the period of record would range from slightly above 1,066 ft in early January to 1,070 ft (winter guide curve elevation) by late February (Figure 6.1-1). In March and April, the pool elevation would be at or slightly below the guide curve, peaking at about 1,070.1 ft in early May. Thereafter, the pool elevation would gradually decline at a relatively consistent rate to about 1,065.4 ft by the end of November, trending slightly upward to an elevation of 1,066 ft by the end of December. Except for late February through the end of May, the median daily pool elevation would range from about 1 ft to 4.6 ft below the guide curve (Figure 6.1-1).

For the NAA, water surface elevations at the 90-percent exceedance level (indicative of extreme drought conditions in the basin) would likely range from about elevation 1,058.6 ft in January (11.4 ft below the winter guide curve) to about 1,065.1 in early May (about 6 ft below the summer guide curve elevation) (Figure 6.1-3). Thereafter, pool levels would gradually decline at a steady rate through the summer and fall back to about 1,058.6 ft by the end of December.

Figure 6.1-5 provides information on the percentage of days over the modeled period of record that Lake Lanier would be expected to exceed a range of water surface elevations, including elevations that indicate specific levels of potential impact on resources and/or public uses of the lake. Section 2.1.1.2.4.5 discusses three specific impact levels at Lake Lanier and the general effects on public use and water-based recreation activities that would likely occur when the water surface elevation in the lake declines to those levels. They are the Initial Impact Level (IIL), Recreation Impact Level (RIL), and Water Access Limited Level (WAL). Corresponding impact levels also have been defined for West Point Lake and Walter F. George Lake. For the NAA, Lake Lanier water surface elevations would equal or exceed the winter guide curve elevation (1,070 ft) 27 percent of the time. Lake levels would be expected to exceed the IIL (1,066 ft) 70 percent of the time, the RIL (1,063 ft) 87 percent of the time, and the WAL (1,060 ft) 94 percent of the time. Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach would be 1,054.3 ft, about 15.7 ft below the winter guide curve elevation (1,070 ft).

Table 6.1-2 depicts the number of years over the modeled period of record during which Lake Lanier water surface elevations would drop below the three impact levels for public use and recreational activities—at some point during the entire year and at some point during the summer season (May–September). The year is included in the count if, at any time during any year, the model outputs indicate that lake levels would decline below a specific impact level, regardless of the duration. The table summarizes the number of occurrences at the project based on a review of the model outputs over all months of the year and during the summer season at the project. Sustained use of Lake Lanier for boating, fishing, and other activities occurs throughout the year as weather conditions permit. Considering all months of the year, Lake Lanier would be expected to decline below the IIL in 55 of 73 years in the period of record, below the RIL in 24 of 73 years, and below the WAL in 17 of 73 years. Considering only the summer season months, Lake Lanier would be expected to decline below the IIL in 32 of 73 years, below the RIL in 16 of 73 years, and below the WAL in 6 of 73 years.

Table 6.1-3 depicts the percent of days during the summer season (May–September) over the modeled period of record that lake levels would decline below the designated impact thresholds for various recreational uses for the project, as described in section 2.1.1.2.4.5. The period of May through September is when public use of the lake is likely to be its peak, even though various recreational activities might occur year-round. For the NAA, Lake Lanier levels would likely decline below the IIL 22.6 percent of the days in May–September, below the RIL 8.0 percent of the time, and below the WAL 2.8 percent of the time.

As a reflection of conservation storage conditions in Lake Lanier over the period of record, Table 6.1-4 depicts the percent of time that the Lake Lanier pool elevation would be in the respective action zones within the conservation pool. The NAA was modeled using the current action zone configuration. For comparing the model results to alternatives that include revised action zones, however, the model outputs for the NAA are presented in terms of the storage volumes associated with the revised action zones. For the NAA, Lake Lanier would be in revised Zone 1 about 56 percent of the time, in Zone 2 about 20 percent of the time, in Zone 3 about 9 percent of the time, and in Zone 4 about 15 percent of the time.

6.1.1.1.1.2 Alternative 1L

As indicated in section 5.2.2, Alt1L has the same features as the NAA, except that future projected water supply withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek (379 mgd) are included in Alt1L as opposed to current withdrawals (277 mgd) in that reach of the river. Therefore, any noted differences in Lake Lanier pool elevations over the modeled period of record between the NAA and Alt1L would be attributable to increased releases from Buford Dam to support increased future water supply withdrawals from the river.

According to Figure 6.1-1, median daily water surface elevations in Lake Lanier for Alt1L would follow a pattern similar to that of the NAA, except that they would be slightly lower at various times throughout the year (ranging up to about 0.2 ft lower than the NAA). At the 90-percent exceedance level, Alt1L would result in daily water surface elevations that would be slightly lower throughout the year than the NAA (ranging from 0 to about 1 ft lower) (Figure 6.1-3), as increased releases would continue to support increased downstream water supply withdrawals, even under severe drought conditions.

The duration curve for water surface elevations for Alt1L tends to be slightly lower than for the NAA, especially for percent of days exceeded values greater than 90 percent (Figure 6.1-5). Consequently, the percent of days that water surface elevations would likely exceed established impact levels for public use and recreational activities at Lake Lanier would be slightly lower for Alt1L than for the NAA. The differences in the number of years over the period of record that lake levels would drop below the IIL, RIL, and WAL between Alt1L and the NAA are considered minor (Table 6.1-2), with the following exceptions. Lake levels would likely drop below IIL in 61 years over the period of record for Alt1L versus 55 years for the NAA and below the WAL (the most extreme impact level) in 19 years for Alt1L versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September), Alt1L would decline below IIL on 24.5 percent of the days (22.6 percent for the NAA), below RIL on 9.2 percent of the days (8.0 percent for the NAA), and below the WAL on 3.3 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under Alt1L would be 1,053.8 ft, about 16.2 ft below the winter guide curve elevation (compared to 1,054.3 ft for the NAA) (Figure 6.1-5). The percent of time that Lake Lanier conservation storage would be in Zone 1 under Alt1L would slightly decrease compared to the percent of time under the NAA (55 versus 56 percent). The percent of time in conservation storage zones 3 and 4 would each increase slightly under Alt1L compared to the NAA (Table 6.1-4).

Overall, Alt1L would have a slightly adverse effect on lake level and conservation storage conditions compared to the NAA.

6.1.1.1.1.3 Alternative 7A

As indicated in section 5.2.3, Alt7A incorporates the updated set of water management measures in Water Management Alternative 7 (described in section 4.2.7). Alt7A and the NAA use the same water supply withdrawal assumptions for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek (current withdrawal and return rates). Changes in lake level and conservation storage conditions between the NAA and Alt7A would be solely the result of updates to water management operations at the USACE projects in the ACF Basin.

As shown in Figure 6.1-1, median daily water surface elevations in Lake Lanier for Alt7A and for the NAA would be essentially the same during the months of March and April. For the balance of the year, lake levels under Alt7A would generally be higher than under the NAA, ranging up to about 0.6 ft higher. At the 90-percent exceedance level, daily water surface elevations for Alt7A would be higher than for the

NAA throughout the year, notably higher for September–April (ranging about 0.4 ft to about 2.4 ft higher) (Figure 6.1-3).

The duration curve for water surface elevations for Alt7A tends to be higher than for the NAA for the percent of days exceeded values that are greater than 65 percent (Figure 6.1-5). Consequently, the percent of days that water surface elevations would likely exceed established impact levels for public use and recreational activities at Lake Lanier would be higher for Alt7A than for the NAA. For example, Alt7A would exceed the WAL (1,060 ft) on 96 percent of all days over the period of record compared to 93 percent for the NAA. The number of years over the period of record that lake levels would drop below the IIL, RIL, and WAL for Alt7A would be less than for the NAA (Table 6.1-2). For example, lake levels would likely drop below the WAL (the most extreme impact level) in 11 years for Alt7A versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September), Alt7A would decline below IIL on 23.5 percent of the days (22.6 percent for the NAA), below RIL on 7.1 percent of the days (8.0 percent for the NAA), and below the WAL on 2.2 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be 1,053.7 ft, about 16.3 ft below the winter guide curve elevation (Figure 6.1-5). The percent of time that Lake Lanier would be in Zone 1 under Alt7A would slightly increase compared to the percent of time under the NAA (59 versus 56 percent). A noteworthy reduction in the percent of time in Zone 4 would be expected for Alt7A (11 percent) compared to the NAA (15 percent) in exchange for a greater percentage of time in the higher Zone 3 (Table 6.1-4).

Overall, the recommended updates and refinements in water management operations under Alt7A would have a slightly beneficial effect on water surface elevations and conservation storage in Lake Lanier compared to the NAA.

6.1.1.1.1.4 Alternative 7B

As described in section 5.2.4, Alt7B includes the updated water management features in Water Management Alternative 7 (section 4.2.7). Water supply withdrawals for Metro Atlanta would be limited to existing relocation contracts only from Lake Lanier (20 mgd) and limited to current withdrawal levels from the Chattahoochee River between Buford Dam and Peachtree Creek (277 mgd). This alternative reflects only the currently authorized withdrawals from Lake Lanier, not the actual withdrawals from the lake that currently occur.

As shown in Figure 6.1-1, median daily water surface elevations in Lake Lanier for Alt7B and for the NAA would be essentially the same during the months of March and April. For the balance of the year, lake levels for Alt7B would be slightly higher to substantially higher than for the NAA, ranging up to about 1.5 ft higher. At the 90-percent exceedance level, daily water surface elevations for Alt7A would be higher than for the NAA throughout the year, and notably higher for September–April (ranging about 0.5 ft to about 3.5 ft higher) (Figure 6.1-3).

The duration curve for water surface elevations for Alt7B is higher than for the NAA for percent of days exceeded values that are greater than 35 percent (Figure 6.1-5). Consequently, the percent of days that water surface elevations would likely exceed established impact levels for public use and recreational activities at Lake Lanier would be higher for Alt7B than for the NAA. For example, Alt7B would exceed the WAL (1,060 ft) on 98 percent of all days over the period of record compared to 93 percent for the NAA. The number of years over the period of record that lake levels would drop below the IIL, RIL, and WAL would be substantially lower for Alt7B than for the NAA (Table 6.1-2). For example, lake levels would likely drop below the WAL (the most extreme impact level) in 4 years for Alt7B versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September),

Alt7B would decline below IIL on 19.2 percent of the days (22.6 percent for the NAA), below RIL on 5.2 percent of the days (8.0 percent for the NAA), and below the WAL on 0.4 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be 1,053.7 ft, about 16.3 ft below the winter guide curve elevation (Figure 6.1-5). The percent of time that Lake Lanier conservation storage would be in Zone 1 under Alt7B would increase compared to the percen of time under the NAA (66 versus 56 percent). A noteworthy reduction in the percent of time in Zone 4 would be expected for Alt7B (7 percent) compared to the NAA (15 percent) in exchange for a greater percentage of time in the higher Zone 3 (Table 6.1-4).

In summary, the features of Alt7B, which include the recommended updates in water management operations and limiting water withdrawals from Lake Lanier to only those authorized by existing relocation contracts, would have a beneficial effect on water surface elevations and conservation storage in Lake Lanier compared to the NAA.

6.1.1.1.1.5 Alternative 7H

As described in section 5.2.5, Alt7H includes the following features: updated water management measures in Water Management Alternative 7 (section 4.2.7), withdrawals of 185 mgd from Lake Lanier (including 20 mgd for existing relocation contracts), releases from Buford Dam to support downstream withdrawals of the 408 mgd, and withdrawals of 40 mgd from a future Glades Reservoir. Alt7H was generally consistent with a 2013 water supply request from Georgia representing projected 2040 needs, except that proposed withdrawals from Lake Lanier in Alt7H were limited to less than was requested by Georgia at that time. Alt7H was the PAA in the draft EIS, but it is no longer viable because revised water supply needs were provided by the State of Georgia in December 2015, including rescinding the certification of need for Glades Reservoir. Alt7H was retained in the final EIS only to enable comparison to the new alternatives that reflect the revised water supply projections.

As shown in Figure 6.1-1, median daily water surface elevations in Lake Lanier for Alt7H and for the NAA would be about the same throughout the year except that Alt7H would be slightly higher in June (up to about 0.3 ft) and slightly lower in July and August (by up to about 0.4 ft). At the 90-percent exceedance level, daily water surface elevations for Alt7H would be the same or slightly lower than for the NAA between the months of May and September and higher than for the NAA from October through April (by up to 1.9 ft) (Figure 6.1-3).

The duration curves for Alt7H and the NAA are similar, except above the 97-percent exceedance level, where Alt7H would likely result in a substantially lower lake level than would the NAA (Figure 6.1-5). The number of years over the period of record that lake levels would drop below the IIL, RIL, and WAL for Alt7H would be slightly higher than for the NAA (Table 6.1-2). The only noteworthy exception is that lake levels would likely drop below the WAL (the most extreme impact level) in 15 years for Alt7H versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September), Alt7H would decline below IIL on 27.3 percent of the days (22.6 percent for the NAA), below RIL on 9.4 percent of the days (8.0 percent for the NAA), and below the WAL on 3.5 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that Lake Lanier would be likely to reach under Alt7H would be 1,050.2 ft, about 19.8 ft below the winter guide curve (Figure 6.1-5). The percent of time that Lake Lanier conservation storage would be in Zone 1 under Alt7H would decrease compared to the NAA (53 versus 56 percent). The percent of time in Zone 4 would be about the same for Alt7H and for the NAA (15 percent), and Alt7H would have a slightly higher percent of time in Zone 3 (13 versus 9 percent) (Table 6.1-4).

The recommended updates in water management operations included in Alt7H would tend to improve lake level and conservation storage conditions in Lake Lanier compared to the NAA. However, increased withdrawals from Lake Lanier and increased releases to meet future water demands below Buford Dam tend to offset those improvements, resulting in an overall effect on lake level and conservation storage conditions in Lake Lanier under Alt7H that would be slightly adverse compared to the NAA.

6.1.1.1.1.6 Alternative 7I

As described in section 5.2.6, Alt7I incorporates the updated set of water management measures in Water Management Alternative 7 (section 4.2.7). In addition, Alt7I includes assumptions of 225 mgd in future withdrawals from Lake Lanier and 379 mgd in future withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek.

Median daily water surface elevations in Lake Lanier for Alt7I would follow a pattern similar to that for the NAA with the following deviations: Alt71 levels would be slightly higher than for the NAA in February and during July–September (by up to 0.6 ft higher) and slightly lower than for the NAA in December–mid-January and during May–June (by up to 0.3 ft lower) (Figure 6.1-2). At the 90-percent exceedance level, Alt7I would result in lake levels notably higher than those under the NAA for the months of December–April (ranging about 0.1 ft to about 2.0 ft higher) and slightly lower during July and August (by up to 0.5 ft) (Figure 6.1-4).

The duration curve for Alt7I closely matches the curve for the NAA except for lake levels at about 88 percent of days exceeded and greater (Figure 6.1-6). Lake levels would likely exceed the WAL (1,060 ft) on 95 percent of days over the period of record for Alt7I versus 94 percent for the NAA. However, at 98 percent of days exceeded and higher, modeled lake levels for Alt7I would tend to decline more severely than the NAA. As shown in Table 6.1-2, Alt7I would result in lake levels that drop below the IIL, RIL, and WAL in more years over the modeled period of record the the NAA, whether the analysis is based on a full 12-month period of analysis or a summer season period of analysis (May–September). The only exception is that lake levels would likely drop below the WAL (the most extreme impact level) in 15 years for Alt7I versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September), Alt7I would decline below IIL on 26.8 percent of the days (22.6 percent for the NAA), below RIL on 9.0 percent of the days (8.0 percent for the NAA), and below the WAL on 3.3 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach would be 1,051.1 ft, about 3.2 ft below the lowest modeled elevation for the NAA and 18.9 ft below the winter guide curve elevation (Figure 6.1-6). The percent of time that Lake Lanier conservation storage would be in Zone 1 under Alt7I would slightly decrease compared to percent of time under the NAA (54 versus 56 percent). A slight reduction in the percent of time in Zone 4 would be expected for Alt7I (14 percent) compared to NAA (15 percent) in exchange for a greater percentage of time in the higher Zone 3 (Table 6.1-4).

Similarly to Alt7H, the increased water withdrawals from Lake Lanier and increased releases to meet water supply needs downstream of Buford Dam under Alt7I would offset the positive effects of updated water management measures on water surface elevations and conservation storage in Lake Lanier compared to the NAA. Consequently, the effects of Alt7I on Lake Lanier water surface elevations and conservation storage would be slightly adverse compared to the effects of the NAA.

6.1.1.1.1.7 Alternative 7J

As described in section 5.2.7, Alt7J incorporates the updated set of water management measures in Water Management Alternative 7 (section 4.2.7). In addition, with water supply withdrawals would be limited to existing relocation contracts only from Lake Lanier (20 mgd) and 379 mgd in projected future withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek.

Median daily water surface elevations in Lake Lanier for Alt7J would follow a seasonal pattern similar to that for the NAA (Figure 6.1-2). From late February through mid-April, median lake levels would be the same for Alt7J and the NAA (i.e., equal to the winter guide curve at 1,070 ft). For the balance of the year, Alt7J would result in substantially higher median lake levels than under the NAA (mostly in the range of 0.5 to 1.5 ft). At the 90-percent exceedance level, Alt7J would result in lake levels notably higher than those for the NAA for all months of the year (ranging about 0.4 ft to about 3.0 ft higher) (Figure 6.1-4).

The duration curve for Alt7J is notably higher than for the NAA for percent of days exceeded greater than about 30 percent. Consequently, the percent of days that water surface elevations would likely exceed designated impact levels for public use and recreational activities would be substantially higher for Alt7J than for the NAA (Figure 6.1-6). Alt7J would exceed IIL on 77 percent of days (69 percent for the NAA), RIL on 92 percent of days (87 percent for the NAA), and the WAL on 98 percent of days (94 percent for the NAA). With respect to the number of years that lake levels would drop below IIL, RIL, and WAL, Alt7J would represent a substantial improvement over the NAA (Table 6.1-2). For example, the number of years that lake levels would likely drop below the WAL (the most extreme impact level) would decrease from 17 under the NAA to 7 under Alt7J, based on a full 12-month period of analysis, and from 6 years under the NAA to 3 years under Alt7J, based on analysis of the summer season months (May–September). During the summer season, Alt7J would decline below IIL on 19.3 percent of the days (22.6 percent for the NAA), below RIL on 5.6 percent of the days (8.0 percent for the NAA), and below the WAL on 0.8 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be 1,054.6 ft, about 0.3 ft above the lowest modeled elevation for the NAA and 15.4 ft below the winter guide curve elevation (Figure 6.1-6). For Alt7J, the percent of time that Lake Lanier conservation storage would be in Zone 1 would be substantially higher for Alt7J than for the NAA (65 versus 56 percent). A noteworthy reduction in the percent of time in Zone 4 would be expected for Alt7J (8 percent) compared to the NAA (15 percent) (Table 6.1-4).

In summary, the features of Alt7J, which include the recommended updates in water management operations and limiting water withdrawals from Lake Lanier to only those authorized by existing relocation contracts, would have a more beneficial effect on water surface elevations and conservation storage in Lake Lanier than the features of the NAA.

6.1.1.1.1.8 Alternative 7K (PAA)

As described in section 5.2.8, the PAA incorporates the updated set of water management measures in Water Management Alternative 7 (section 4.2.7). In addition, the PAA includes assumptions of 242 mgd in future withdrawals from Lake Lanier and 379 mgd in future withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek. The withdrawals values are the same as those requested by the State of Georgia in its revised 2015 water supply request, as discussed in section (5.1).

Median daily water surface elevations in Lake Lanier for the PAA would follow a seasonal pattern similar to that for the NAA with the following deviations: The PAA levels would be slightly higher than the NAA levels in February and from July through September (by up to 0.6 ft) and slightly lower than the NAA levels in December–mid-January and May–June (by up to 0.3 ft) (Figure 6.1-2). At the 90-percent

exceedance level, the PAA would result in lake levels notably higher than the NAA for the months of December–April (ranging about 0.1 ft to about 2.0 ft higher) and slightly lower during July and August (by up to 0.5 ft) (Figure 6.1-4).

The duration curve for the PAA closely matches the curve for the NAA except for lake levels at about 88 percent of days exceeded and greater (Figure 6.1-6). Lake levels would likely exceed the WAL (1,060 ft) on 95 percent of days over the period of record for the PAA versus 94 percent for the NAA. However, at 98 percent of days exceeded and higher, modeled lake levels for the PAA would tend to decline more severely than for the NAA. As shown in Table 6.1-2, the PAA would result in lake levels that drop below the IIL, RIL, and WAL in more years over the modeled period of record than under the NAA, based on either a full 12-month period of analysis or a summer season period of analysis (May–September). The only noteworthy exception is that lake levels would likely drop below the WAL (the most extreme impact level) in 15 years for the PAA versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September), the PAA would decline below IIL on 27.1 percent of the days (22.6 percent for the NAA), below RIL on 9.1 percent of the days (8.0 percent for the NAA), and below the WAL on 3.4 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be 1,050.7 ft, about 3.6 ft below the lowest modeled elevation for the NAA and 19.3 ft below the winter guide curve elevation (Figure 6.1-6). The percent of time that Lake Lanier conservation storage would be in Zone 1 under the PAA would slightly decrease compared to the NAA (53 versus 56 percent). The percent of time in Zone 4 would be about the same for the PAA and the NAA (15 percent), with a slightly greater percent of time for the PAA in the higher Zone 3 than for the NAA (13 versus 9 percent) (Table 6.1-4).

Similarly to Alt7H and Alt7I, the increased water withdrawals from Lake Lanier and increased releases to meet water supply needs downstream of Buford Dam under the PAA would offset the positive effects of updated water management measures on water surface elevations and conservation storage in Lake Lanier compared to the NAA. Consequently, the effects of the PAA on Lake Lanier water surface elevation and conservation storage would be slightly adverse compared to effects of the NAA.

6.1.1.1.1.9 Alternative 7L

As described in section 5.2.9, Alt7L incorporates the updated set of water management measures in Water Management Alternative 7 (section 4.2.7). In addition, Alt7L includes the following water supply assumptions: current withdrawals from Lake Lanier (128 mgd) and 379 mgd in future withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek.

Median daily water surface elevations in Lake Lanier for Alt7L would closely match those for the NAA from mid-February through May and from July through mid-September (Figure 6.1-2). During the remaining times of the year, Alt7L would result in higher median lake levels (0.1 to 0.5 ft higher than under the NAA). At the 90-percent exceedance level, Alt7L would result in lake levels notably higher than for the NAA for the months of September–April (ranging about 0.4 ft to about 2.4 ft higher) (Figure 6.1-4).

The duration curve for Alt7L is notably higher than for the NAA for percent of days exceeded greater than about 65 percent. Consequently, the percent of days that water surface elevations would likely exceed designated impact levels for public use and recreational activities would be higher for Alt7L than for the NAA. Alt7L would exceed IIL on 71 percent of days (69 percent for the NAA), RIL on 89 percent of days (87 percent for the NAA), and the WAL on 96 percent of days (94 percent for the NAA) (Figure 6.1-6). As shown in Table 6.1-2, Alt7L would result in lake levels that drop below the IIL, RIL, and WAL

in fewer years over the modeled period of record than the NAA, based on either a full 12-month period of analysis or a summer season period of analysis (May–September). The most notable decrease is that lake levels would likely drop below the WAL (the most extreme impact level) in 11 years for Alt7L versus 17 years for the NAA, based on a full 12-month period of analysis. During the summer season (May–September), Alt7L would decline below IIL on 23.1 percent of the days (22.6 percent for the NAA), below RIL on 6.9 percent of the days (8.0 percent for the NAA), and below the WAL on 2.6 percent of the days (2.8 percent for the NAA) (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be 1,053.0 ft, about 1.3 ft below the lowest modeled elevation for the NAA and 17.0 ft below the winter guide curve elevation (Figure 6.1-6). The percent of time that Lake Lanier conservation storage would be in Zone 1 under Alt7L would slightly increase compared to the percent of time under the NAA (58 versus 56 percent). A noteworthy reduction in the percent of time in Zone 4 would be expected for Alt7L (11 percent) compared to NAA (15 percent) in exchange for a slightly greater percent of time in the higher Zone 3 (Table 6.1-4).

Overall, the recommended updates to water management operations included in Alt7L would have a slightly beneficial effect on water surface elevations and conservation storage in Lake Lanier compared to the NAA. The effects on Lake Lanier from Alt7L are nearly the same as the effects of Alt7A. the only difference being the increase in releases to meet water withdrawal needs downstream of Buford Dam: 277 mgd (current) and 379 mgd (projected future needs). Based on the HEC-ResSim model outputs, that increase would have little effect on Lake Lanier.

6.1.1.1.1.10 Alternative 7M

As described in section 5.2.10, Alt7M incorporates the updated set of water management measures in Water Management Alternative 7 (section 4.2.7). In addition, Alt7M includes assumptions of 185 mgd in future withdrawals from Lake Lanier and 379 mgd in future withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek.

Median daily water surface elevations in Lake Lanier for Alt7M and water surface elevation at the 90-percent exceedance level would closely match those described for Alt7I (Figure 6.1-2 and Figure 6.1-4, respectively). Because of the slightly reduced withdrawal levels from Lake Lanier assumed for Alt7M compared to Alt7I, Lake Lanier water surface elevations at the median and 90-percent exceeded levels would be marginally higher for Alt7M.

The duration curve for Alt7M closely matches the curve as described for Alt7I in comparison to the NAA (Figure 6.1-6). The number of years that lake levels for Alt7M would drop below IIL, RIL, and WAL compared to the NAA is similar to the number of years for Alt7I (Table 6.1-2), as is the percent of days during the summer season (May–September) that lake levels for Alt7M would decline below the IIL, RIL, and WAL (Table 6.1-3).

Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be 1,051.7 ft, about 2.6 ft below the NAA and 18.3 ft below the winter guide curve elevation (Figure 6.1-6). The percent of time that Lake Lanier conservation storage would be in zones 1 through 4 under Alt7M would be about the same as for Alt7I when compared to the NAA (Table 6.1-4).

As described for Alt7I, Alt7M would have a slightly adverse effect on water surface elevations and conservation storage in Lake Lanier. The reduced Lake Lanier water withdrawal assumption included in Alt7M compared to Alt7I (185 mgd versus 225 mgd) results in only a marginal difference in lake conditions when compared to the NAA.

6.1.1.1.2 West Point Dam and Lake

West Point Dam and Lake and its operations are described in detail in section 2.1.1.1.6.3. This section describes the effects of operations under Water Management Alternative 1 and the Proposed Water Management Alternative (Water Management Alternative 7) combined with water supply options A, B, H, I, J, K, L, and M.

Figure 6.1-7 through Figure 6.1-12, Table 6.1-5, and Table 6.1-6 present model outputs for West Point Lake operations over the modeled period of hydrologic record for existing conditions (or the NAA) along with the results for proposed revisions to the Master Manual as defined by Alt1B, Alt1J, Alt1L, Alt7A, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M. The figures and tables present results for median pool levels (daily), 90-percent exceedance pool levels (daily), percent of days exceeded for pool levels, number of years that impact thresholds (recreation) would be reached (annual and summer season), and the percent of days during the summer season (May–September) that pools levels would be below impact thresholds (recreation). The results for each parameter (e.g., median daily pool level) are presented in two figures with half of the alternatives presented on each figure. Using the results from these figures and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

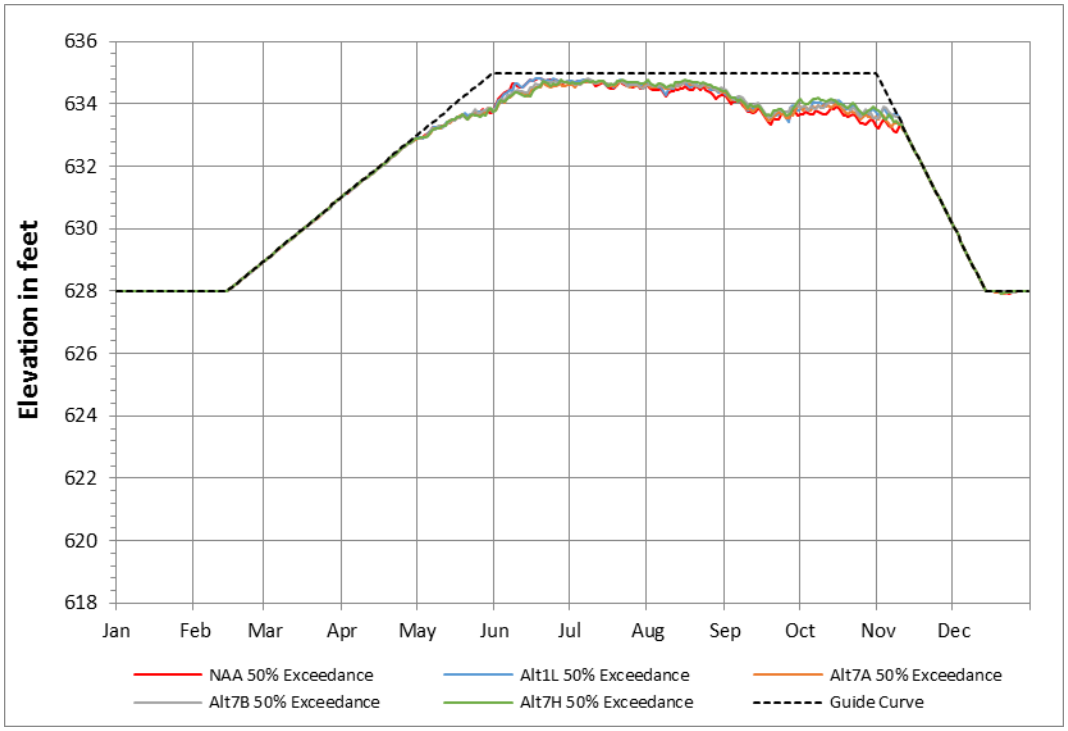


Figure 6.1-7. West Point Lake Median Daily Water Surface Elevation over Modeled Period of Record (1939–2011) for NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

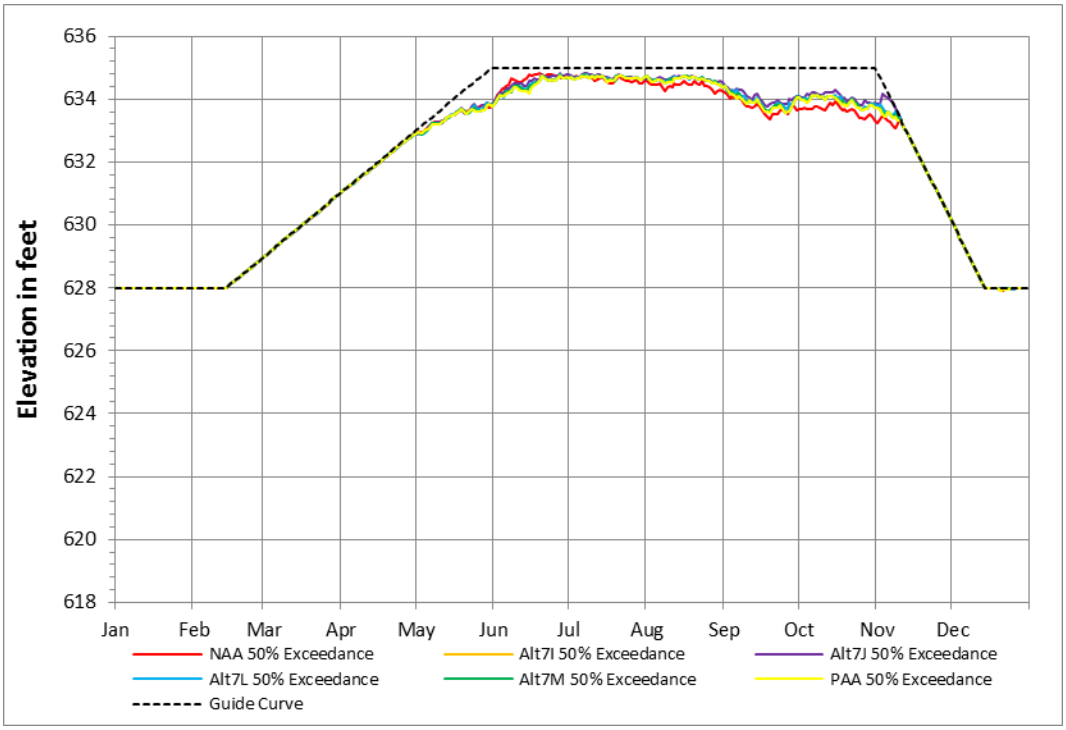


Figure 6.1-8. West Point Lake Median Daily Water Surface Elevation over Modeled Period of Record (1939–2011) for NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

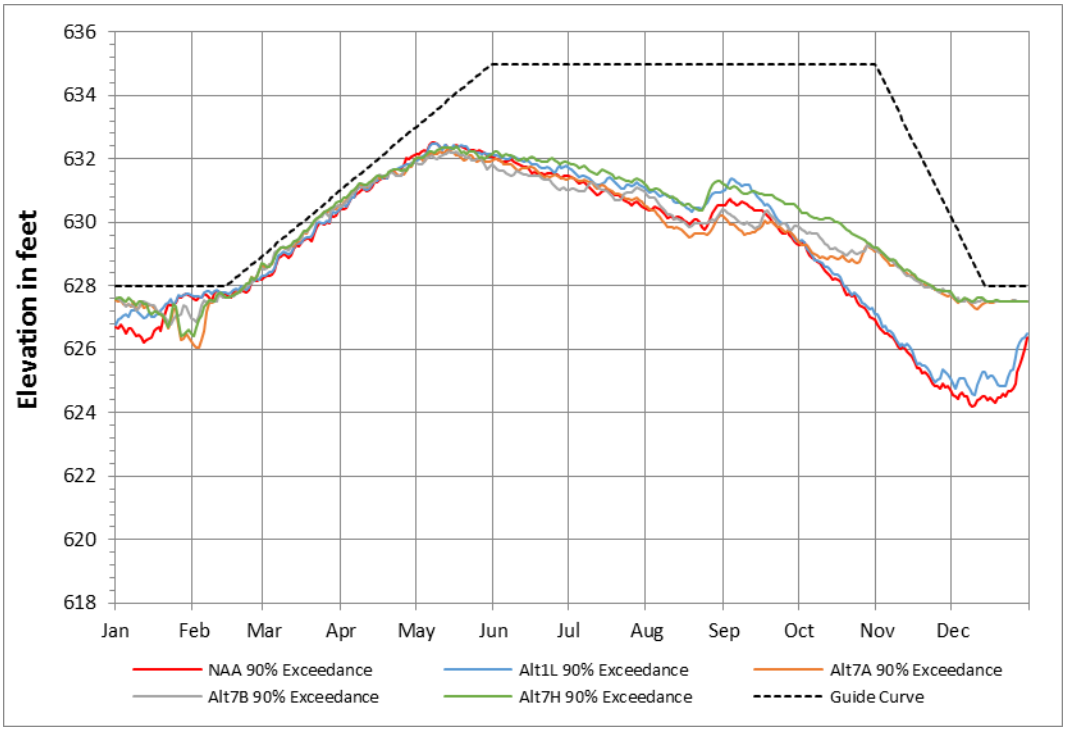


Figure 6.1-9. West Point Lake Daily Water Surface Elevations that Would Be Exceeded 90 Percent of the Time over Modeled Period of Record (1939–2011) for NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

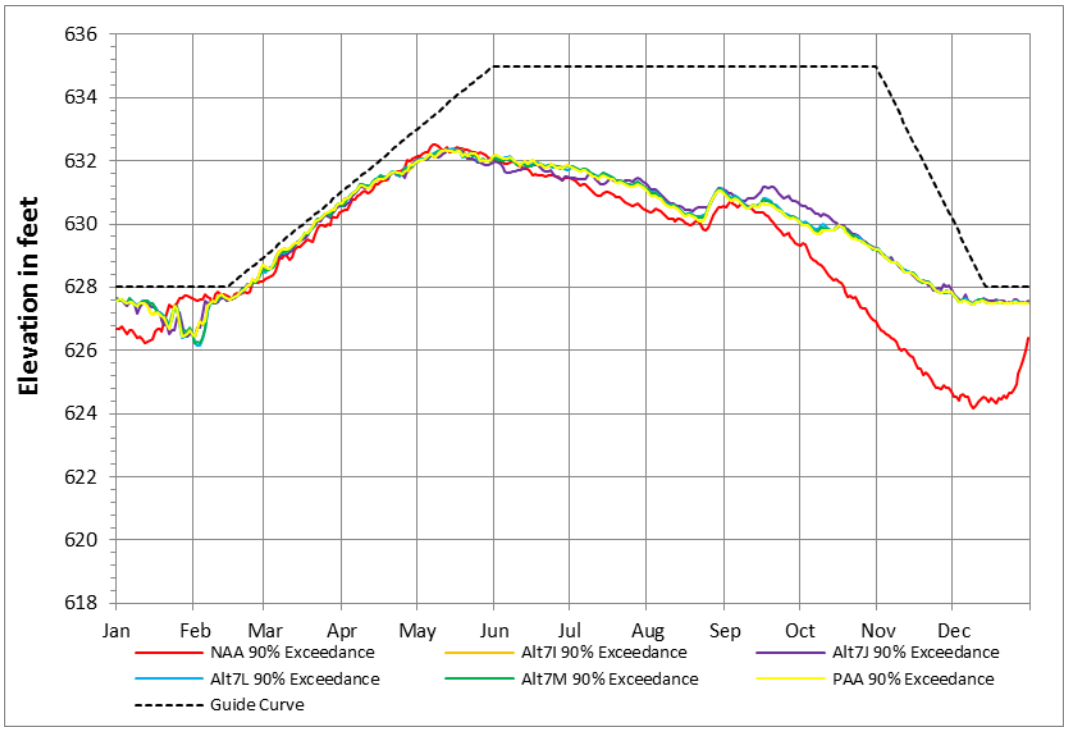


Figure 6.1-10. West Point Lake, Daily Water Surface Elevations that Would Be Exceeded 90 Percent of the Time over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

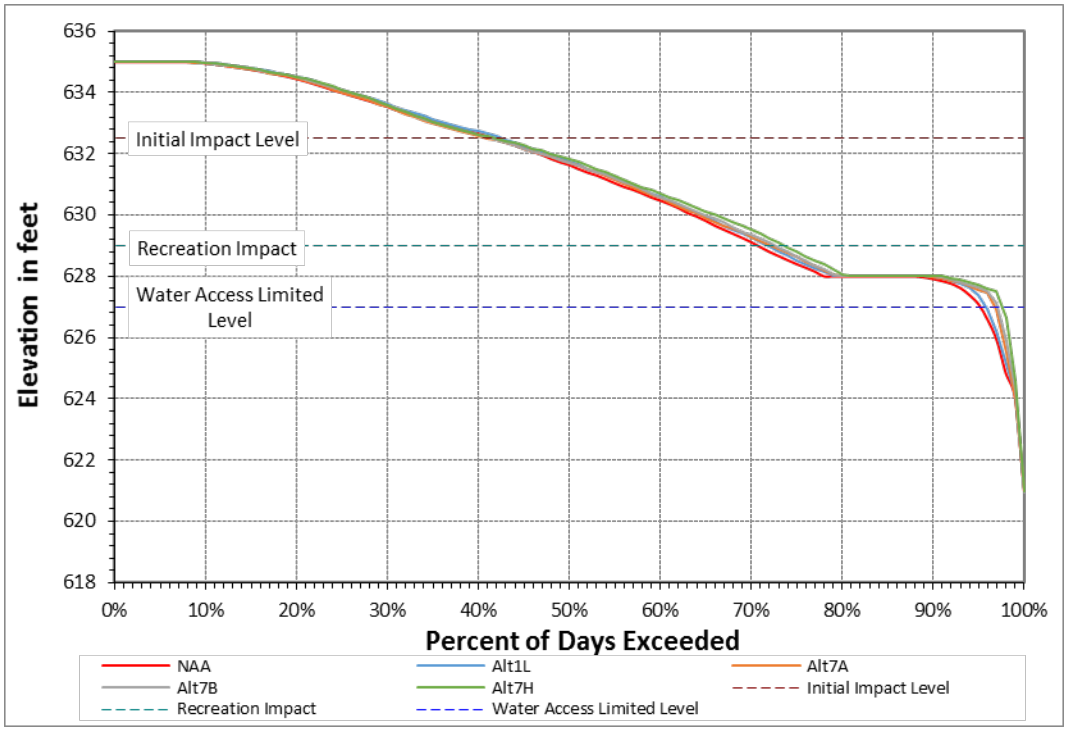


Figure 6.1-11. West Point Lake Daily Water Surface Elevations—Percent of Days Exceeded over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

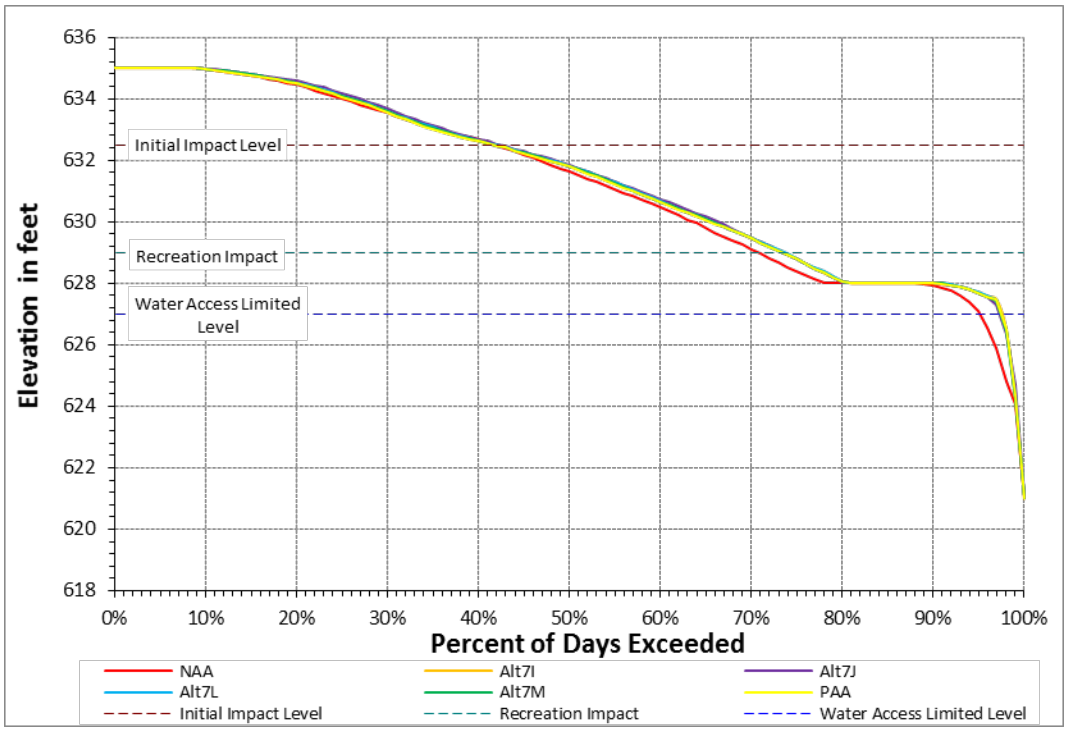


Figure 6.1-12. West Point Lake Daily Water Surface Elevations—Percent of Days Exceeded over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

Table 6.1-5.
Number of Years West Point Lake Water Surface Elevation Would Drop below Impact Thresholds for Recreation Use during the Modeled Period of Record (1939–2011)

Alternative	Time Interval Analyzed for Each Year	Initial Impact Level (elev. 632.5 ft)	Recreation Impact Level (elev. 629 ft)	Water Access Limited Level (elev. 627 ft)
NAA (Alt1A)	Jan–Dec (12 months)	73	73	25
	Summer Season May–Sep (5 months)	40	8	5
Alt1L	Jan–Dec (12 months)	73	73	20
	Summer Season May–Sep (5 months)	37	5	3
Alt7A	Jan–Dec (12 months)	73	73	17
	Summer Season May–Sep (5 months)	44	8	4
Alt7B	Jan–Dec (12 months)	73	73	15
	Summer Season May–Sep (5 months)	39	8	3
Alt7H	Jan–Dec (12 months)	73	73	11
	Summer Season May–Sep (5 months)	44	4	2
Alt7I	Jan–Dec (12 months)	73	73	14
	Summer Season May–Sep (5 months)	45	4	2

Alternative	Time Interval Analyzed for Each Year	Initial Impact Level (elev. 632.5 ft)	Recreation Impact Level (elev. 629 ft)	Water Access Limited Level (elev. 627 ft)
Alt7J	Jan–Dec (12 months)	73	73	14
	Summer Season May–Sep (5 months)	38	4	3
PAA (Alt7K)	Jan–Dec (12 months)	73	73	14
	Summer Season May–Sep (5 months)	44	4	2
Alt7L	Jan–Dec (12 months)	73	73	14
	Summer Season May–Sep (5 months)	42	4	2
Alt7M	Jan–Dec (12 months)	73	73	14
	Summer Season May–Sep (5 months)	42	4	2

Note: elev. = elevation

Table 6.1-6.
West Point Lake–Percent of Days Below Impact Thresholds for Recreation Use during the Summer Season (May–Sep)

Alternative	IIL	RIL	WAL
NAA (Alt1A)	21.9%	3.4%	1.0%
Alt1L	20.6%	2.2%	0.9%
Alt7A	23.0%	3.7%	0.8%
Alt7B	23.4%	3.3%	0.7%
Alt7H	21.7%	2.1%	0.4%
Alt7I	21.9%	2.2%	0.8%
Alt7J	21.5%	2.3%	0.6%
PAA (Alt7K)	22.1%	2.2%	0.4%
Alt7L	21.4%	2.1%	0.4%
Alt7M	22.1%	2.1%	0.4%

6.1.1.1.2.1 No Action Alternative

The median daily pool elevation at West Point Lake over the period of record would closely follow the guide curve (top of conservation pool) from the months of January–April, thereafter increasing to a peak median pool elevation of 634.8 ft in mid-June (slightly below the guide curve elevation of 635 ft) (Figure 6.1-7). From mid-June, the median daily water elevation would gradually decline through the summer months and into the early fall by as much as about 1.4 ft below the guide curve. By early November, the median water surface elevation under the NAA would intersect the guide curve during the fall drawdown period. The water surface elevation would gradually continue to decline through November and December, generally consistent with the fall drawdown and winter guide curve levels.

For the NAA, water surface elevations at the 90-percent exceedance level would likely range from 0.15 ft to 2.9 ft below the guide curve for the months of January–May. From June through December, the water surface elevations would gradually decline from an elevation of about 632 ft in early June to about 624.5 ft in early December. For the NAA, elevations at the 90-percent exceedance level would be over

4 ft below the guide curve elevation from August through early September, about 5.7 ft below the guide curve elevation on October 1, and about 8 ft below the guide curve elevation on November 1 (Figure 6.1-9).

Figure 6.1-11 provides information on the percentage of days over the modeled period of record that West Point Lake would likely exceed a range of water surface elevations that define specific levels of impact on public uses of the lake. For the NAA, West Point Lake water surface elevations would likely exceed the IIL (632.5 ft) on about 42 percent of the days, exceed the RIL (629 ft) on 71 percent of the days, and exceed the WAL (627 ft) on 95 percent of the days. Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach would be 621 ft, about 7 ft below the winter guide curve elevation (628 ft).

Table 6.1-5 depicts the number of years over the modeled period of record during which West Point Lake water surface elevations would drop below the three designated impact levels at some point during the entire year and during the summer recreation season (May–September). The year is included in the count if, at any time during any year, the model outputs indicate that lake levels would decline below a specific impact level, regardless of the duration. Considering all months of the year, West Point Lake would likely decline below the IIL and the RIL in all 73 of 73 years, and below the WAL in 25 of 73 years. Since the winter guide curve elevation (628 ft) is lower than the IIL (632.5 ft) and the RIL (629 ft), it is clear why pool levels analyzed over all months of the year would be expected to decline below the IIL and RIL in all years over the period of record. However, if only the months of the summer season are considered (May–September), West Point Lake would be expected to decline below the IIL in 40 of 73 years, below the RIL in 8 of 73 years, and below the WAL in 5 of 73 years. During the summer season (May–September), the NAA would decline below IIL on 21.9 percent of the days, below RIL on 3.4 percent of the days, and below the WAL on 1.0 percent of the days (Table 6.1-6).

6.1.1.1.2.2 Alternative 1L

Median daily water surface elevations in West Point Lake for Alt1L would follow a seasonal pattern similar to and would be a close match to those of the NAA, except that lake levels from August through mid-November would be slightly higher (ranging from about 0.1 ft up to 0.5 ft) (Figure 6.1-7). At the 90-percent exceedance level, Alt1L would result in daily water surface elevations closely matching those of the NAA, except that the levels would be slightly higher during June–September and December–January (ranging from about 0.1 ft up to 0.5 ft) (Figure 6.1-9).

The duration curve for water surface elevations for Alt1L tends to be slightly higher than for the NAA for percent of days exceeded values greater than 90 percent (Figure 6.1-11). Consequently, the percent of days that water surface elevations would likely exceed established impact levels for public use and recreational activities at West Point Lake would be slightly higher for Alt1L (by about 1 percentage point each for the IIL, RIL, and WAL) than for the NAA. According to Table 6.1-5, there are notable differences between Alt1L and the NAA in the number of years over the period of record that lake levels would likely drop below the IIL, RIL, and WAL. Based on a full 12-month period of analysis, the lake levels would decline below the WAL in 20 years for Alt1L versus 25 years for the NAA. During the summer season, lake levels would likely drop below the IIL in 37 years for Alt1L (40 for the NAA), below the RIL in 5 years (8 for the NAA), and below the WAL in 3 years (5 for the NAA). During the summer season, Alt1L would decline below IIL on 20.6 percent of the days (21.9 percent for the NAA), below RIL on 2.2 percent of the days (3.4 percent for the NAA), and below the WAL on 0.9 percent of the days (1.0 percent for the NAA) (Table 6.1-6).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under Alt1L would be 621.0 ft, the same as under the NAA and about 7.0 ft below the winter guide curve elevation at West Point Lake (Figure 6.1-11).

Overall, Alt1L would have a slightly beneficial effect on lake-level conditions at West Point Lake compared to the NAA. Even though gross withdrawals for Alt1L downstream of Buford Dam to meet future water supply needs (379 mgd) would exceed gross withdrawals for the NAA (277 mgd), net withdrawals for Alt1L from Buford Dam to Whitesburg would be smaller than for the NAA based on larger return flows in Alt1L as a percentage of withdrawals (see section 5.1.4.1.2). Thus, inflow to West Point Lake from the Chattahoochee River for Alt1L would be slightly larger than for the NAA.

6.1.1.1.2.3 Alternative 7A

Figure 6.1-7 indicates that median daily water surface elevations in West Point Lake for Alt7A would be nearly the same as for the NAA, except for slight variations in June, August, and October (varying by no more than 0.4 ft). At the 90-percent exceedance level (representing extreme drought conditions), Alt7A would be a close match to the NAA from early February through August. In late January and in August through early September, Alt7A would drop to a level slightly lower than the NAA. From October through mid-January, Alt7A would represent a substantial improvement in lake levels during extreme drought conditions over the NAA, ranging from a minor increase up to about 3 ft higher (Figure 6.1-9).

The duration curve for water surface elevations for Alt7A tends to be slightly higher than for the NAA for percent of days exceeded values greater than 65 percent (Figure 6.1-11). Consequently, the percent of days that water surface elevations would likely exceed established impact levels for public use and recreational activities at West Point Lake would be slightly higher for Alt1L than for the NAA (63 percent versus 61 percent for the RIL and 97 percent versus 95 percent for the WAL). According to Table 6.1-5, there are notable differences between Alt7A and the NAA in the number of years over the period of record that lake levels would likely drop below the IIL, RIL, and WAL. Based on a full 12-month period of analysis, the lake levels would decline below the WAL in 17 years for Alt7A versus 25 years for the NAA. During the summer season, lake levels would likely drop below the IIL in 44 years for Alt7A (40 for the NAA), below the RIL in 8 years (same as for the NAA), and below the WAL in 4 years (5 for the NAA). During the summer season, Alt1L would decline below IIL on 23.0 percent of the days (21.9 percent for the NAA), below RIL on 3.7 percent of the days (3.4 percent for the NAA), and below the WAL on 0.8 percent of the days (1.0 percent for the NAA) (Table 6.1-6).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under Alt7A would be 621.0 ft, the same as under the NAA and about 7.0 ft below the winter guide curve elevation at West Point Lake (Figure 6.1-11).

Alt7A would have a slightly beneficial effect on lake-level conditions in West Point Lake compared to the NAA. The beneficial effect would be more substantial under extreme drought conditions as shown in the plot of daily elevations at the 90-percent exceeded level (Figure 6.1-9). These improved conditions would be attributable to the inclusion of updated water management features that are part of Water Management Alternative 7.

6.1.1.1.2.4 Alternative 7B

Median daily water surface elevations in West Point Lake for Alt7B in comparison to the NAA would be nearly the same throughout the year as described for Alt7A in section 6.1.1.1.2.3 (see Figure 6.1-7). For October through early November, median daily levels for Alt7B would be marginally higher than for Alt7A. At the 90-percent exceeded level (representing extreme drought conditions), daily water surface elevations for Alt7B would closely match those described for Alt7A throughout the year in comparison to the NAA. From October through mid-January, Alt7B would represent a substantial improvement in lake levels during extreme drought conditions over the NAA, ranging from a minor increase up to about 3 ft higher (Figure 6.1-9).

The duration curve for water surface elevation at West Point Lake for Alt7B is nearly identical to that described for Alt7A in comparison to the NAA (Figure 6.1-11). According to Table 6.1-5, there are some notable differences between Alt7B and the NAA in the number of years over the period of record that lake levels would likely drop below the IIL, RIL, and WAL. Based on a full 12-month period of analysis, the lake levels would decline below the WAL (the most severe impact level) in 15 years for Alt7B versus 25 years for the NAA. During the summer season, lake levels would likely drop below the IIL in 39 years for Alt7B (40 for the NAA), below the RIL in 8 years (same as for the NAA), and below the WAL in 3 years (5 for the NAA). During the summer season, Alt7B would decline below IIL on 23.4 percent of the days (21.9 percent for the NAA), below RIL on 3.3 percent of the days (3.4 percent for the NAA), and below the WAL on 0.7 percent of the days (1.0 percent for the NAA) (Table 6.1-6).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under Alt7B would be 620.9 ft, 0.1 ft below the NAA and about 7.1 ft below the winter guide curve elevation at West Point Lake (Figure 6.1-11).

Alt7B would have a beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that are part of Alt7and an assumed water withdrawal level from Lake Lanier (20 mgd—relocation contracts only) that is substantially smaller than from current water supply withdrawals from the lake.

6.1.1.1.2.5 Alternative 7H

As indicated in Figure 6.1-7, median daily water surface elevations in West Point Lake for Alt7H would be the same as for the NAA between mid-November and early May, both curves matching the project guide curve during that period. Median lake levels in June for Alt7H would be slightly lower (by up to about 0.4 ft) than for the NAA. Between July and October, Alt7H would provide a slight improvement in water surface elevations (about 0.1 to 0.5 ft) compared to the NAA. Alt7H would provide for median lake-level conditions similar to those described for Alt7A (section 6.1.1.1.2.3).

At the 90-percent exceedance level (representing extreme drought conditions), water surface elevations at West Point Lake for Alt7H would be higher than for the NAA throughout the year except for late January–mid-February and the month of May. From June through early September, improvements in water surface elevations for Alt7H would be slight compared to those for the NAA (ranging from 0.1 ft to 0.9 ft). From October through mid-January, Alt7H would provide for substantial improvement in lake-level conditions compared to the NAA, ranging from about 0.9 ft up to about 3.2 ft higher (Figure 6.1-9).

West Point Lake water surface elevations for Alt7H would exceed IIL on 42 percent of the days over the period of record (41 percent for the NAA), exceed RIL on 73 percent of days (70 percent for the NAA), and exceed the WAL on 98 percent of days (95 percent for the NAA) (Figure 6.1-11). For Alt7H, water surface elevations would decline to the lower levels less often than for the NAA (Table 6.1-5). Based on a full 12-month period of analysis, the lake levels would decline below the WAL (the most severe impact level) in 11 years for Alt7H versus 25 years for the NAA. During the summer season, lake levels would likely drop below the IIL in 44 years for Alt7H (40 for the NAA), below the RIL in 4 years (8 for the NAA), and below the WAL in 2 years (5 for the NAA). During the summer season, Alt7H would decline below IIL on 21.7 percent of the days (21.9 percent for the NAA), below RIL on 2.1 percent of the days (3.4 percent for the NAA), and below the WAL on 0.4 percent of the days (1.0 percent for the NAA) (Table 6.1-6).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under Alt7H would be 621.0 ft, the same as under the NAA and about 7.0 ft below the winter guide curve elevation at West Point Lake (Figure 6.1-11).

Alt7H would have a slightly beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that are part of Water Management Alternative 7. As described in section 5.2.5.1, Alt7H was the PAA in the draft EIS and was retained in the final EIS only to enable comparison to the revised the PAA and the other alternatives.

6.1.1.1.2.6 Alternative 7I

As indicated in Figure 6.1-8, median daily water surface elevations in West Point Lake for Alt7I would be the same as for the NAA between mid-November and early May, both curves matching the project guide curve during that period. Median lake levels in June for Alt7I would be slightly lower (by up to about 0.4 ft) than for the NAA. Between July and October, Alt7I would provide a slight improvement in water surface elevations (about 0.1 to 0.5 ft) over the NAA. Alt7I would provide for median lake-level conditions similar to those described for Alt7A (section 6.1.1.1.2.3).

At the 90-percent exceedance level (representing extreme drought conditions), water surface elevations at West Point Lake for Alt7I would be higher than for the NAA throughout the year except for late January–mid-February and the month of May. From June through early September, improvements in water surface elevations for Alt7I would be slight compared to those for the NAA (ranging from 0.1 ft to 0.9 ft). From October through mid-January, Alt7I would provide for substantial improvement in lake-level conditions over the NAA, ranging from about 0.9 ft up to about 3.2 ft higher (Figure 6.1-10).

West Point Lake water surface elevations for Alt7I would exceed IIL on 41 percent of the days over the period of record (same as for the NAA), exceed RIL on 73 percent of days (70 percent for the NAA), and exceed the WAL on 97 percent of days (95 percent for the NAA) (Figure 6.1-12). For Alt7I, water surface elevations would decline to the lower levels less often than for the NAA (Table 6.1-5). Based on a full 12-month period of analysis, the lake levels would decline below the WAL (the most severe impact level) in 14 years for Alt7I versus 25 years for the NAA. During the summer season, lake levels would likely drop below the IIL in 45 years for Alt7I (40 for the NAA), below the RIL in 4 years (8 for the NAA), and below the WAL in 2 years (5 for the NAA). During the summer season, Alt7I would decline below IIL on 21.9 percent of the days (same as for the NAA), below RIL on 2.2 percent of the days (3.4 percent for the NAA), and below the WAL on 0.8 percent of the days (1.0 percent for the NAA) (Table 6.1-6).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under Alt7I would be 621.0 ft, the same as under the NAA and about 7.0 ft below the winter guide curve elevation at West Point Lake (Figure 6.1-12).

Alt7I would have a slightly beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that are part of Water Management Alternative 7. The effects of Alt7I on water surface elevations in West Point Lake compared to the NAA would be nearly the same as those described for Alt7H and for the PAA (see section 6.1.1.1.2.8).

6.1.1.1.2.7 Alternative 7J

As indicated in Figure 6.1-8, Figure 6.1-10, Figure 6.1-12, Table 6.1-5, and Table 6.1-6, the effects of Alt7J on water surface elevations in West Point Lake compared to the NAA would be nearly the same as described for Alt7I. The only exceptions would be that median daily water surface elevations and 90-percent exceeded water surface elevations for Alt7J would be marginally higher than for Alt7I in the months of August–October. While there would be minor seasonal deviations in the model results, the differences in the effects between Alt7J and Alt7I on West Point Lake water surface elevations would be discountable.

Alt7J would have an overall beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that are part of Water Management Alternative 7. The only differences between Alt7J and Alt7I are the water supply withdrawal and return flow assumptions associated with Lake Lanier: 20 mgd for Alt7J and 225 mgd for Alt7I. Withdrawal and return flow assumptions downstream of Buford Dam are the same for both alternatives. Therefore, modeled water surface elevations at West Point Lake are not appreciably sensitive to variations in water supply withdrawal values at Lake Lanier within the range of the two alternatives.

6.1.1.1.2.8 Alternative 7K (PAA)

As indicated in Figure 6.1-8, median daily water surface elevations in West Point Lake for the PAA would be the same as for the NAA between mid-November and early May, both curves matching the project guide curve during that period. Median lake levels in June for the PAA would be slightly lower (by up to about 0.4 ft) than for the NAA. From July through October, the PAA would provide a slight improvement in water surface elevations (about 0.1 to 0.5 ft) over the NAA. The PAA would provide for median lake-level conditions similar to those described for Alt7H and Alt7I in earlier sections.

At the 90-percent exceedance level (representing extreme drought conditions), water surface elevations at West Point Lake for the PAA would be higher than for the NAA throughout the year except for late January–mid-February and the month of May. From June through early September, improvements in water surface elevations for the PAA would be slight compared to those for the NAA (ranging from 0.1 ft to 0.6 ft). From October through mid-January, the PAA would provide for substantial improvement in lake-level conditions over the NAA, ranging from about 0.9 ft up to about 3.2 ft higher (Figure 6.1-10).

West Point Lake water surface elevations for the PAA would exceed IIL on 41 percent of the days over the period of record (same as for the NAA), exceed RIL on 73 percent of days (70 percent for the NAA), and exceed the WAL on 97 percent of days (95 percent for the NAA) (Figure 6.1-12). Water surface elevations would decline to the lower levels less often than for the NAA (Table 6.1-5). Based on a full 12-month period of analysis, the lake levels would decline below the WAL (the most severe impact level) in 14 years for the PAA versus 25 years for the NAA. During the summer season, lake levels would likely drop below the IIL in 44 years for the PAA (40 for the NAA), below the RIL in 4 years (8 for the NAA), and below the WAL in 2 years (5 for the NAA). During the summer season, the PAA would decline below IIL on 22.1 percent of the days (21.9 percent for the NAA), below RIL on 2.2 percent of the days (3.4 percent for the NAA), and below the WAL on 0.4 percent of the days (1.0 percent for the NAA) (Table 6.1-6).

Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach under the PAA would be 621.0 ft, the same as under the NAA and about 7.0 ft below the winter guide curve elevation at West Point Lake (Figure 6.1-12).

The PAA would have a slightly beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that are part of Water Management Alternative 7. Compared to the NAA, the PAA would have essentially the same effects on water surface elevations in West Point Lake over the modeled period of record as Alt7H and Alt7I. The only differences between the PAA and Alt7I are the water supply withdrawal and return flow assumptions associated with Lake Lanier: 242 mgd (43 percent returns) for the PAA and 225 mgd (40.4 percent returns) for Alt7I. Withdrawal and return flow assumptions downstream of Buford Dam are the same for both alternatives. Therefore, modeled water surface elevations at West Point Lake are not appreciably sensitive to variations in water supply withdrawal values for Lake Lanier between these alternatives.

6.1.1.1.2.9 Alternative 7L

As indicated in Figure 6.1-8, Figure 6.1-10, Figure 6.1-12, Table 6.1-5, and Table 6.1-6, the effects of Alt7L on water surface elevations in West Point Lake compared to the NAA would be nearly identical to those described for Alt7I. Any minor differences in the effects of the two alternatives on lake levels, based on the model outputs, are negligible.

Alt7L would have a slightly beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that were part of Alt7. The only differences between Alt7L and Alt7I are the water supply withdrawal and return flow assumptions associated with Lake Lanier: 128 mgd (29 percent returns) for Alt7L and 225 mgd (40.4 percent returns) for Alt7I. Withdrawal and return flow assumptions below Buford Dam are the same for both alternatives. Therefore, modeled water surface elevations at West Point Lake are not appreciably sensitive to variations in water supply withdrawal values for Lake Lanier between these alternatives.

6.1.1.1.2.10 Alternative 7M

As indicated in Figure 6.1-8, Figure 6.1-10, Figure 6.1-12, Table 6.1-5, and Table 6.1-6, the effects of Alt7M on water surface elevations in West Point Lake compared to the NAA would be nearly identical to those described for Alt7I. Any minor differences in the effects of these two alternatives, based on the model outputs, are negligible.

Alt7M would have a slightly beneficial effect on lake-level conditions in West Point Lake compared to the NAA. These improved conditions, especially during extreme drought periods, would be attributable to the inclusion of updated water management features that were part of Water Management Alternative 7. The only differences between Alt7M and Alt7I are the water supply withdrawal and return flow assumptions associated with Lake Lanier: 185 mgd (40.4 percent returns) for Alt7M and 225 mgd (40.4 percent returns) for Alt7I. Withdrawal and return flow assumptions downstream of Buford Dam are the same for both alternatives. Therefore, modeled water surface elevations at West Point Lake are not appreciably sensitive to variations in water supply withdrawal values for Lake Lanier between these alternatives.

6.1.1.1.3 Walter F. George Lock and Dam and Lake

Walter F. George Lake (locally known in Alabama as Lake Eufaula) and its operations are described in detail in section 2.1.1.1.6.5. The lake was formed by the multipurpose Walter F. George Lock and Dam project on the Chattahoochee River. This section describes the effects of operations under Water Management Alternative 1 and the Proposed Water Management Alternative (Water Management Alternative 7) combined with water supply options A, B, H, I, J, K, L, and M.

Figure 6.1-13 through Figure 6.1-18, and Table 6.1-7 present model outputs for Walter F. George Lake operations over the modeled period of hydrologic record for existing conditions (reflected in the NAA) along with the results for proposed revisions to the Master Manual as defined in Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M. The figures and tables present results for median pool levels (daily), 90-percent exceedance pool levels (daily), percent of days exceeded for pool levels, number of years that impact thresholds (recreation) would be reached (annual and summer season), and the percent of days during the summer season (May–September) that pools levels would be below impact thresholds (recreation). The results for each parameter (e.g., median daily pool level) are presented in two figures with half of the alternatives presented on each figure. Using the results from the figures and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

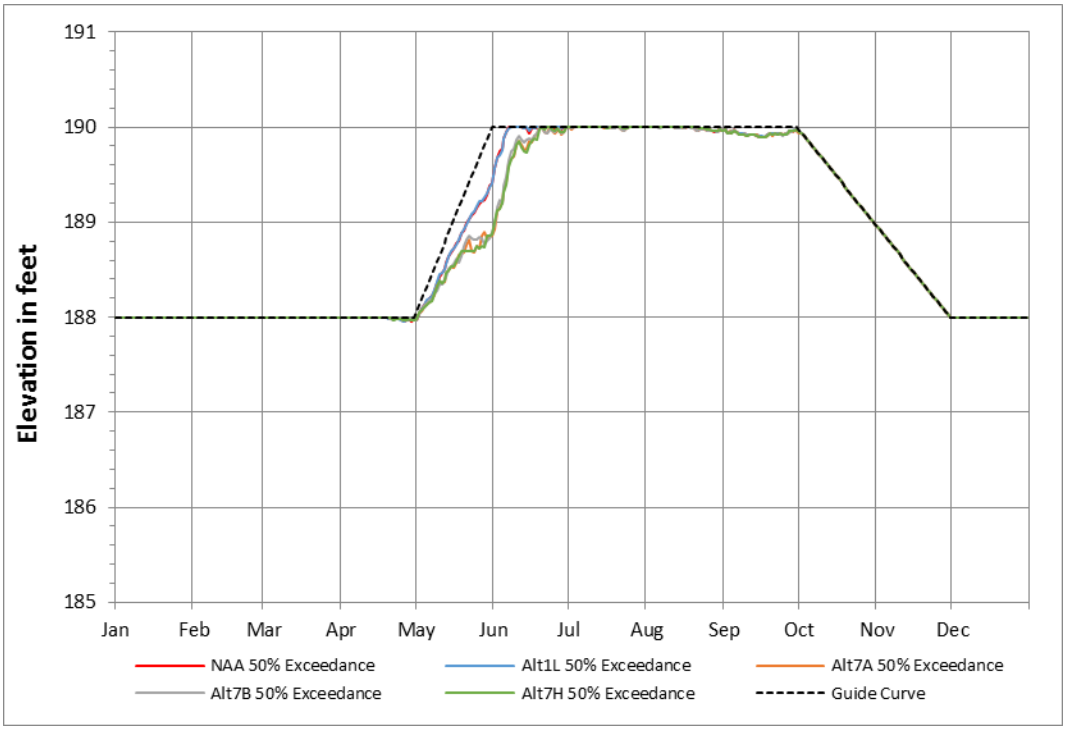


Figure 6.1-13. Walter F. George Lake Median Daily Water Surface Elevation over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

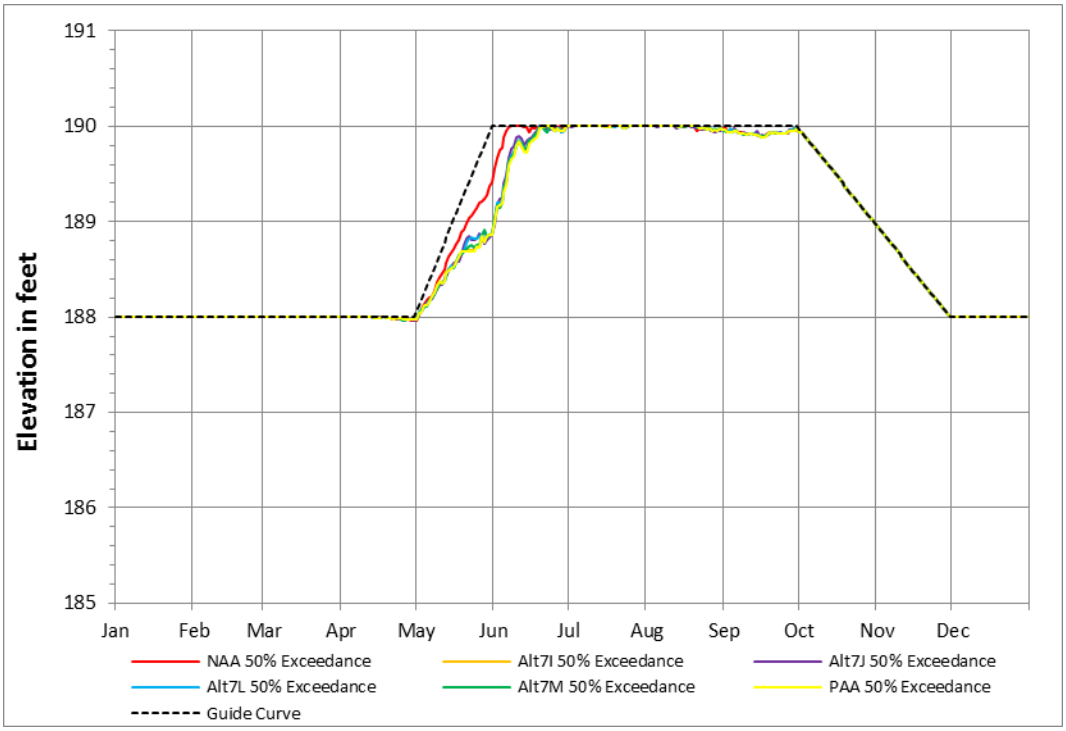


Figure 6.1-14. Walter F. George Lake Median Daily Water Surface Elevation over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

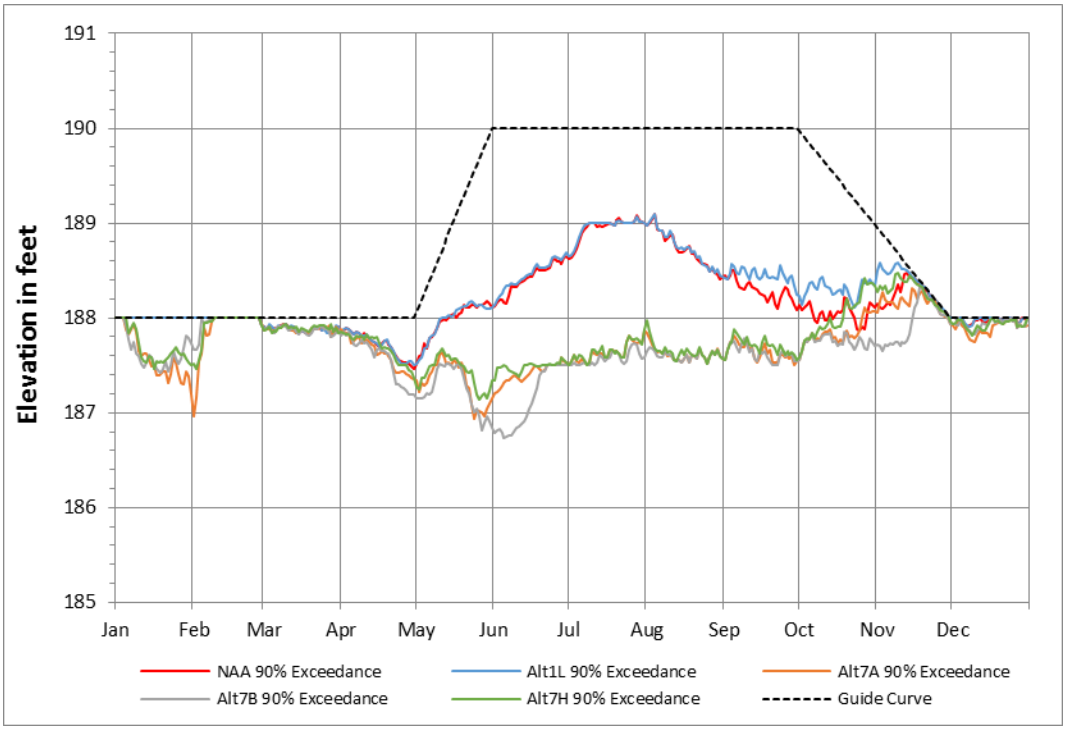


Figure 6.1-15. Walter F. George Lake Daily Water Surface Elevations that Would Be Exceeded 90 Percent of the Time over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

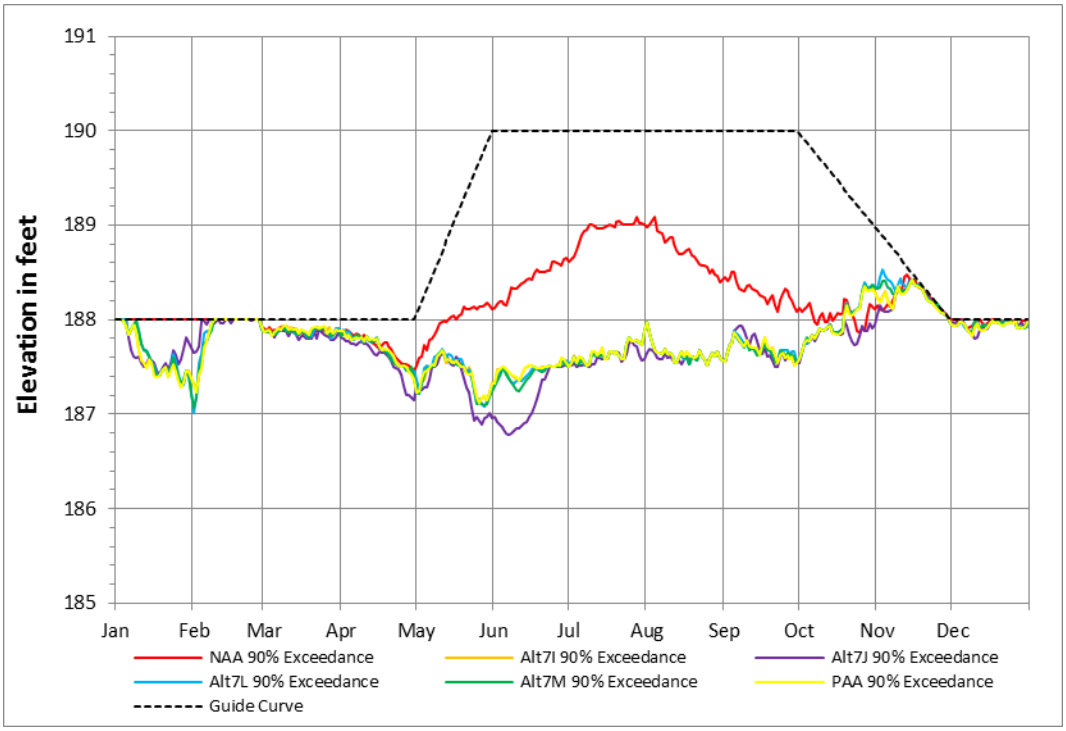


Figure 6.1-16. Walter F. George Lake Daily Water Surface Elevations that Would Be Exceeded 90 Percent of the Time over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

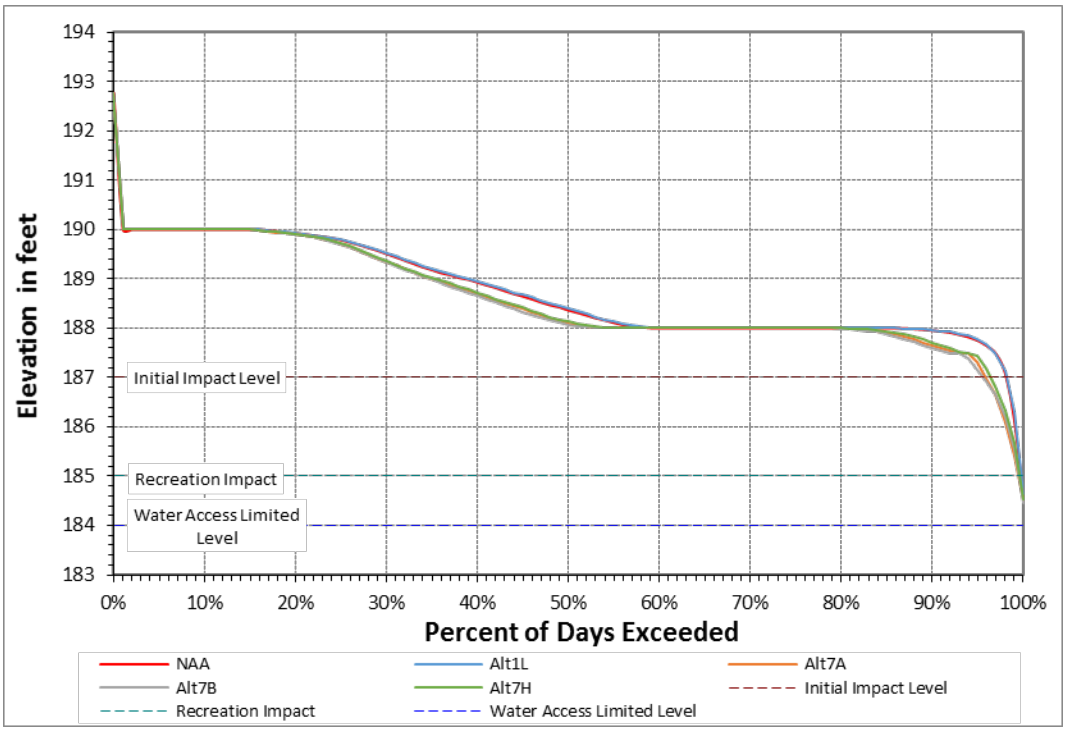


Figure 6.1-17. Walter F. George Lake Daily Water Surface Elevations—Percent of Days Exceeded over Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

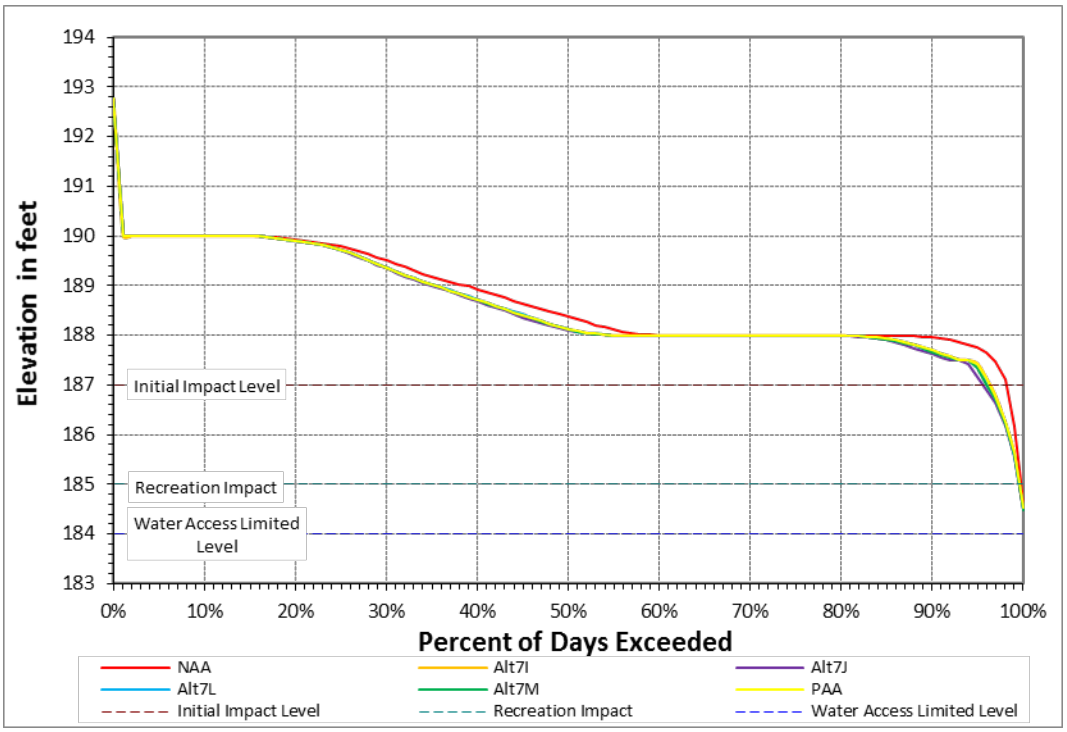


Figure 6.1-18. Walter F. George Lake Daily Water Surface Elevations—Percent of Days Exceeded over Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

Table 6.1-7 summarizes the number of years over the 73-year modeled period of record that Walter F. George Lake levels would drop below each of the three established impact thresholds for public use of the lake.

Table 6.1-7.
Number of Years Walter F. George Lake Water Surface Elevation Would Drop below Impact Thresholds for Recreation Use during 73-year Modeled Period of Record (1939–2011)

Alternative	Time Interval Analyzed for Each Year	Initial Impact Level (elev. 187 ft)	Recreation Impact Level (elev. 185 ft)	Water Access Limited Level (elev. 184 ft)
NAA (Alt1A)	Jan–Dec (12 months)	5	1	0
	Summer Season May–Sep (5 months)	4	0	0
Alt1L	Jan–Dec (12 months)	5	1	0
	Summer Season May–Sep (5 months)	4	0	0
Alt7A	Jan–Dec (12 months)	20	2	0
	Summer Season May–Sep (5 months)	14	2	0
Alt7B	Jan–Dec (12 months)	19	2	0
	Summer Season May–Sep (5 months)	14	1	0
Alt7H	Jan–Dec (12 months)	20	2	0
	Summer Season May–Sep (5 months)	13	1	0
Alt7I	Jan–Dec (12 months)	20	2	0
	Summer Season May–Sep (5 months)	5	2	0
Alt7J	Jan–Dec (12 months)	18	2	0
	Summer Season May–Sep (5 months)	5	2	0
PAA (Alt7K)	Jan–Dec (12 months)	19	2	0
	Summer Season May–Sep (5 months)	5	2	0
Alt7L	Jan–Dec (12 months)	19	2	0
	Summer Season May–Sep (5 months)	5	2	0
Alt7M	Jan–Dec (12 months)	20	2	0
	Summer Season May–Sep (5 months)	5	2	0

Note: elev. = elevation

6.1.1.1.3.1 No Action Alternative

The median daily pool elevation at Walter F. George Lake over the modeled period of record would follow the guide curve from January through April. Beginning in early May, the median daily elevation would gradually increase at a rate slightly less than the guide curve elevation, essentially reaching the summer guide curve elevation (190 ft) by about mid-June. For the balance of the year (mid-June–December), the median water surface elevation would remain at, or just below, the guide curve elevation (Figure 6.1-13).

For the NAA, water surface elevations at the 90-percent exceedance level would be essentially the same as the guide curve from January through February, declining to about elevation 187.5 (0.5 ft below the guide curve) by early May. From June through about mid-November, the 90-percent exceedance water surface elevations would fluctuate from about 1 to 2 ft below the guide curve, peaking at about elevation 189 ft in July. From mid-November through December, the 90-percent exceedance water surface elevations would match the guide curve (Figure 6.1-15).

For the NAA, Walter F. George Lake water surface elevations would likely exceed the IIL (187 ft) about 98 percent of the time and exceed the RIL (185 ft) over 99 percent of the time. Lake levels for the NAA would not drop to the WAL (184 ft). Over the modeled period of record, the lowest water surface elevation that the lake would be expected to reach would be elevation 184.6 ft, about 3.4 ft below the winter guide curve elevation (188 ft) (Figure 6.1-17).

Table 6.1-7 depicts the number of years over the 73-year modeled period of record during which Walter F. George Lake water surface elevations would drop below IIL, RIL, and WAL. Considering all months of the year, Walter F. George Lake would likely decline below the IIL in 5 years, below the RIL in 1 year, and never below the WAL. Considering only the months of the summer season (May–September), Walter F. George Lake would likely decline below the IIL in 4 years and not drop below the RIL or the WAL over the period of record. During the summer season (May–September), the NAA would decline below IIL on 2.6 percent of the days. Over the period of record, lake levels would not decline below the RIL or WAL (Table 6.1-8).

Table 6.1-8.
Walter F. George Lake–Percent of Days below Impact Thresholds for Recreation Use during the Summer Season (May–Sep)

Alternative	IIL	RIL	WAL
NAA (Alt1A)	2.6%	0.0%	0.0%
Alt1L	2.6%	0.0%	0.0%
Alt7A	5.3%	0.4%	0.0%
Alt7B	6.1%	0.3%	0.0%
Alt7H	4.5%	0.2%	0.0%
Alt7I	2.5%	0.0%	0.0%
Alt7J	4.5%	0.2%	0.0%
PAA (Alt7K)	4.5%	0.2%	0.0%
Alt7L	3.6%	0.0%	0.0%
Alt7M	4.5%	0.2%	0.0%

6.1.1.1.3.2 Alternative 1L

The median daily water surface elevations for Walter F. George Lake under Alt1L would be almost identical to those described for the NAA (Figure 6.1-13). At the 90-percent exceedance level (representing extreme drought conditions), daily water surface elevations for Alt1L would closely match those for the NAA, except that Alt1L water surface elevations would be slightly higher (from 0.1 to about 0.4 ft) than those for the NAA between September and mid-November (Figure 6.1-15).

For Alt1L, Walter F. George Lake water surface elevations would likely exceed the IIL about 98 percent of the time, the RIL over 99 percent of the time, and the WAL at all times (same as for the NAA). Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be elevation 184.6 ft, the same level as for the NAA and about 3.4 ft below the winter guide curve (188 ft) (Figure 6.1-17).

For all 12 months of the year over the 73-year modeled period of record, Walter F. George Lake would be expected to decline below the IIL in 5 years, below the RIL in 1 year, and below the WAL in no years (same results as for the NAA) (Table 6.1-7). Based upon only the months of the summer recreation season (May–September), Walter F. George Lake would likely decline below the IIL in 4 years and below the RIL and WAL in no years (same as for the NAA) (Table 6.1-7). During the summer season, Alt1L would decline below IIL on 2.6 percent of the days with no occurrences below the RIL and WAL (same as for the NAA) (Table 6.1-8).

Overall, Alt1L would result in a negligible change to water surface elevation conditions in Walter F. George Lake compared to the NAA. A small deviation was noted for Alt1L water surface elevations at the 90-percent exceedance level (representing extreme drought conditions). The only differences between Alt1L and the NAA are the water withdrawal and return flow assumptions for the reach of the Chattahoochee River downstream of Buford Dam: current withdrawals (277 mgd with a return ratio of 82 percent) for the NAA and future (2050) projected withdrawals (379 mgd with a return ratio of 95 percent) for Alt1L. Inclusion of the larger releases under Alt1L over time to meet future water supply demands, coupled with a higher return ratio, would be largely responsible for this slight deviation in Walter F. George Lake during the fall months compared to the NAA.

6.1.1.1.3.3 Alternative 7A

The median daily water surface elevations for Walter F. George Lake under Alt7A would closely match those under the NAA, except during the transition period (May–mid-June) from the winter to summer guide curve elevations. During that period, Alt7A levels would be lower than for the NAA by variable amounts, ranging from minimal up to about 1.0 ft (Figure 6.1-13).

At the 90-percent exceedance level, water surface elevations under Alt7A would likely decline below the NAA in January and early February (from 0.1 up to about 1.0 ft), and thereafter be nearly the same as under the NAA through April. From May through October, daily water surface elevations at the 90-percent exceedance level for Alt7A would range slightly above or below elevation 187.5 ft and would be from about 0.3 to 1.5 ft below the NAA during that period. During the months of November and December, the 90-percent exceedance elevations for Alt7A and the NAA would be about the same (Figure 6.1-15). Under extreme drought conditions, Alt7A would represent a notable adverse change in Walter F. George Lake water surface elevation conditions compared to the NAA.

For Alt7A, Walter F. George Lake water surface elevations would be expected to exceed the IIL about 96 percent of the time (98 percent for the NAA), exceed the RIL about 99 percent of the time (same as for the NAA), and exceed the WAL at all times (same as for the NAA). This would represent a slight decrease for Alt7A in the percent of time above the IIL compared to the NAA. Over the modeled period

of record, the lowest water surface elevation that the lake would likely reach would be elevation 184.5 ft, about 0.1 ft below the lowest water surface elevation for the NAA and 3.5 ft below the winter guide curve (188 ft) (Figure 6.1-17).

For all 12 months of the year over the 73-year modeled period of record, Walter F. George Lake would be expected to decline under Alt7A below the IIL in 20 years (5 for the NAA), below the RIL in 2 years (1 for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-7). Based upon only the months of the summer recreation season (May–September), Walter F. George Lake would be expected to decline below the IIL in 14 years (4 for the NAA), below the RIL in 2 years (1 for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-7). These results for Alt7A represent a substantial increase in the number of years that lake levels would likely decline below IIL compared to the NAA. During the summer season, Alt7A would decline below the IIL on 5.3 percent of the days (2.6 percent for the NAA), below the RIL on 0.4 percent of the days (none for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-8).

Alt7A would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. That effect would be solely attributable to systemwide water management measures included in the plan from Water Management Alternative 7, including seasonal navigation flows, revised action zones, and drought operations. The water withdrawal and return assumptions for Lake Lanier and for the Chattahoochee River downstream of Buford Dam, as included in the NAA and Alt7A, are identical.

6.1.1.1.3.4 Alternative 7B

As indicated in Figure 6.1-8, Figure 6.1-10, Figure 6.1-12, Table 6.1-5, and Table 6.1-8, the effects of Alt7B on water surface elevations in Walter F. George Lake compared to the NAA would be nearly the same as those described for Alt7A. The only noteworthy differences appear in the model outputs for water surface elevations at the 90-percent exceedance level (representing extreme drought conditions). For Alt7B (Figure 6.1-10), the 90-percent exceedance lake levels would be slightly lower than for Alt7A in late January–mid-February and slightly higher than for Alt7A in the periods of May–August and mid-October–mid-November. While there would be minor seasonal deviations in the model results at the 90-percent exceedance level, the differences in the effects between Alt7B and Alt7A on Walter F. George Lake water surface elevations would be discountable.

Alt7B would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. That effect would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7. The only differences between the features of Alt7B and Alt7A are the water supply withdrawal and associated return flow assumptions associated with Lake Lanier: 20 mgd for Alt7B and 128 mgd for Alt7A. Withdrawal and return flow assumptions downstream of Buford Dam are the same for both alternatives. These differences in water withdrawal rates at Lake Lanier would have little effect on water surface elevations at Walter F. George Lake except that, under extreme drought conditions, the differences could trigger system drought operations more or less frequently, which could indirectly have a slight effect on operations (and corresponding lake levels) at the Walter F. George project.

6.1.1.1.3.5 Alternative 7H

The median daily water surface elevations for Walter F. George Lake under Alt7H would be nearly identical to those described for Alt7A when compared to the NAA (Figure 6.1-13). At the 90-percent exceedance level, the water surface elevations under Alt7H would closely match those described for Alt7A throughout most of the year. During October and November, 90-percent exceedance levels for Alt7H would be expected to slightly exceed NAA levels from about 0.1 to 0.4 ft (Figure 6.1-15).

For Alt7H, Walter F. George Lake water surface elevations would be expected to exceed the IIL about 96 percent of the time (98 percent for the NAA), exceed the RIL about 99 percent of the time (the same as for the NAA), and exceed the WAL at all times (the same as for the NAA). This would represent a slight decrease for Alt7H in the percent of time above the IIL compared to the NAA. Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be elevation 184.5 ft, about 0.1 ft below the lowest water surface elevation for the NAA and 3.5 ft below the winter guide curve (188 ft) (Figure 6.1-17).

For all 12 months of the year over the 73-year modeled period of record, Walter F. George Lake would be expected to decline under Alt7H below the IIL in 20 years (5 for the NAA), below the RIL in 2 years (1 for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-7). Based upon only the months of the summer recreation season (May–September), Walter F. George Lake would be expected to decline below the IIL in 13 years (4 for the NAA), below the RIL in 1 year (none for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-7). These results for Alt7A represent a substantial increase in the number of years that lake levels would likely decline below IIL compared to the NAA. During the summer season, Alt7H would decline below the IIL on 4.5 percent of the days (2.6 percent for the NAA), below the RIL on 0.2 percent of the days (none for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-8).

Alt7H would have an overall adverse effect on lake-level conditions in Walter F. George Lake. Under extreme drought conditions, the levels for Alt7H would represent a substantial change from the NAA levels. Those effects would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7. Water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River downstream of Buford Dam, as included in Alt7H, would not have an appreciable effect on water surface elevations in Walter F. George Lake. The model results for Alt7H and Alt7A are a close match for comparison to the NAA, yet the water supply withdrawal and return assumptions for those alternatives are substantially different.

6.1.1.1.3.6 Alternative 7I

The median daily water surface elevations for Walter F. George Lake under Alt7I would be nearly identical to those described for Alt7H when compared to the NAA (Figure 6.1-14). At the 90-percent exceedance level, the water surface elevations under Alt7I would closely match those described for Alt7H when compared to the NAA (Figure 6.1-16).

For Alt7I, Walter F. George Lake water surface elevations would be expected to exceed the IIL about 96 percent of the time (98 percent for the NAA), exceed the RIL over 99 percent of the time (the same as for the NAA), and exceed the WAL at all times (the same as for the NAA) over the period of record. This result would represent a slight decrease in the percent of time above the IIL for Alt7I compared to the NAA. Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be elevation 184.6 ft, about the same minimum water surface elevation over the period of record as for the NAA and 3.4 ft below the winter guide curve (188 ft) (Figure 6.1-18).

For all 12 months of the year over the 73-year modeled period of record, Walter F. George Lake under Alt7I would be expected to decline below the IIL in 20 years (5 for the NAA), below the RIL in 2 years (1 for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-7). Based upon only the months of the summer recreation season (May–September), Walter F. George Lake would be expected to decline below the IIL in 5 years (4 for the NAA), below the RIL in 2 years (none for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-7). During the summer season, Alt7I would decline below the IIL on 4.5 percent of the days (2.6 percent for the NAA), below the RIL on 0.2 percent of the days (none for the NAA), and never below the WAL (the same for as NAA) (Table 6.1-8).

Alt7I would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. Under extreme drought conditions, the levels for Alt7I would represent a substantial change from the NAA levels. Those effects would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7. Water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River downstream of Buford Dam, as included in Alt7I, would not have an appreciable effect on water surface elevations in Walter F. George Lake when compared to the effects of other alternatives with substantially different water supply assumptions. For example, the model results for Walter F. George Lake water surface elevations for Alt7I and Alt7H are a close match in comparison to the NAA, yet the water supply withdrawal and return assumptions for those alternatives are substantially different.

6.1.1.1.3.7 Alternative 7J

The median daily water surface elevations for Walter F. George Lake under Alt7J would be nearly identical to those described for Alt7I above when compared to the NAA (Figure 6.1-14). At the 90-percent exceedance level, the water surface elevations under Alt7J would closely match those described for Alt7I throughout most of the year, except that Alt7J would be up to 0.5 ft higher than Alt7I in late January and would likely be 0.1–0.5 ft lower than Alt7I in late April, late May–mid-June, and late October. These differences between Alt7J and Alt7I at the 90-percent exceedance level are minor when both are compared to the NAA.

Alt7J would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. Under extreme drought conditions, the levels for Alt7J would represent a substantial change from the NAA levels. Those effects would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7. Water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River downstream of Buford Dam, as included in Alt7J, would not have an appreciable effect on water surface elevations in Walter F. George Lake when compared to the effects of other alternatives with substantially different water supply assumptions. The slight deviations in water surface elevations at the 90-percent exceedance level between Alt7J and Alt7I at Walter F. George Lake is a function of the exceptionally small water withdrawal assumption for Lake Lanier included in Alt7J (i.e., 20 mgd for relocation contracts only). This small withdrawal amount at Lake Lanier could have a slight effect on the duration and extent of drought operations and releases for navigation that could result in slight deviations at the 90-percent exceedance lavel as far downstream as Walter F. George Lake.

6.1.1.1.3.8 Alternative 7K (PAA)

The median daily water surface elevations for Walter F. George Lake under the PAA would be nearly the same throughout all months of the year as those described for Alt7H when compared to the NAA (Figure 6.1-14). At the 90-percent exceedance level, the water surface elevations under the PAA would closely match those described for Alt7H throughout the year when compared to the NAA (Figure 6.1-16).

For the PAA, Walter F. George Lake water surface elevations would be expected to exceed the IIL about 96 percent of the time (98 percent for the NAA), exceed the RIL over 99 percent of the time (the same as for the NAA), and exceed the WAL at all times (the same as for the NAA) over the period of record. This would represent a slight decrease in the percent of time above the IIL for the PAA compared to the NAA. Over the modeled period of record, the lowest water surface elevation that the lake would likely reach would be elevation 184.5 ft, about 0.1 ft below the minimum water surface elevation over the period of record for the NAA and 3.5 ft below the winter guide curve (188 ft) (Figure 6.1-18).

For all 12 months of the year over the 73-year modeled period of record, Walter F. George Lake under the PAA would be expected to decline below the IIL in 19 years (5 for the NAA), below the RIL in 2 years (1 for the NAA), and below the WAL in no years (same as the NAA) (Table 6.1-7). Based upon only the months of the summer recreation season (May–September), Walter F. George Lake would be expected to decline below the IIL in 5 years (4 for the NAA), below the RIL in 2 years (none for the NAA), and below the WAL in no years (the same as for the NAA) (Table 6.1-7). During the summer season, the PAA would decline below the IIL on 4.5 percent of the days (2.6 percent for the NAA), below the RIL on 0.2 percent of the days (none for the NAA), and never below the WAL (the same as for the NAA) (Table 6.1-8).

The PAA would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. Under extreme drought conditions, the levels for the PAA would represent a substantial change from the NAA levels. Those effects would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7, including seasonal navigation flows, revised action zones, and drought operations. Water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River downstream of Buford Dam, as included in the PAA, would not have an appreciable effect on water surface elevations in Walter F. George Lake when compared to the effects of other alternatives with substantially different water supply assumptions. For example, the model results for Walter F. George Lake water surface elevations for the PAA, Alt7I, and Alt7H are a close match in comparison to the NAA, yet the water supply withdrawal and return assumptions for those alternatives are substantially different.

6.1.1.1.3.9 Alternative 7L

As indicated in Figure 6.1-14, Figure 6.1-16, Figure 6.1-18, Table 6.1-7, and Table 6.1-8, the effects of Alt7L on water surface elevations in Walter F. George Lake compared to the NAA would be nearly identical to those described for Alt7I. Any minor differences in the effects of these two alternatives on lake levels, based on the model outputs, are negligible.

Alt7L would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. Under extreme drought conditions, the levels for Alt7L would represent a substantial change from the NAA levels. Those effects would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7. Water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River downstream of Buford Dam, as included in Alt7L, would not have an appreciable effect on water surface elevations in Walter F. George Lake when compared to the effects of other alternatives with substantially different water supply assumptions.

6.1.1.1.3.10 Alternative 7M

As indicated in Figure 6.1-14, Figure 6.1-16, Figure 6.1-18, Table 6.1-7, and Table 6.1-8, the effects of Alt7M on water surface elevations in Walter F. George Lake compared to the NAA would be nearly identical to those described for Alt7I. Any minor differences in the effects of the two alternatives on lake levels, based on the model outputs, are negligible.

Alt7M would have an overall adverse effect on lake-level conditions in Walter F. George Lake compared to the NAA. Under extreme drought conditions, the levels for Alt7M would represent a substantial change from the NAA levels. These effects would be attributable to systemwide water management measures included in the plan from Water Management Alternative 7. Water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River downstream of Buford Dam, as included in Alt7M, would not have an appreciable effect on water surface elevations in Walter F. George Lake when compared to the effects of other alternatives with substantially different water supply assumptions.

6.1.1.1.4 George W. Andrews Lock and Dam and Lake George W. Andrews

The George W. Andrews Lock and Dam and its operations are described in detail in section 2.1.1.1.6.6. It is a run-of-river project, primarily for navigation, that passes releases from Walter F. George Dam and any intervening local inflows into the headwaters of Lake Seminole. Lake George W. Andrews operates at elevation 102 ft, with minor variations. For brief periods during extreme flood conditions, the elevation could be much higher—the highest known flood elevation was 125.8 ft in March 1929 before the lock and dam were built. Lake George W. Andrews has no conservation storage.

6.1.1.1.4.1 No Action Alternative

Under the NAA, lake-level conditions would continue at Lake George W. Andrews as described above.

6.1.1.1.4.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Implementing the alternatives would have no incremental effect on lake-level conditions in Lake George W. Andrews compared to the NAA.

6.1.1.1.5 Jim Woodruff Lock and Dam and Lake Seminole

Jim Woodruff Lock and Dam is described in detail in section 2.1.1.1.6.7. The project is essentially a run-of-river project that passes any waters released from George W. Andrews Lock and Dam on the Chattahoochee River, flows entering from the Flint River, and any local inflows to the lake. Lake Seminole normally operates at elevation 77.0 ft. Water surface elevations can vary between elevation 76.0 ft and 77.8 ft, depending on inflow. The lake has no dedicated conservation storage.

6.1.1.1.5.1 No Action Alternative

Under the NAA, lake-level conditions in Lake Seminole would continue as described above.

6.1.1.1.5.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Implementing these alternatives would have no incremental effect on lake-level conditions in Lake Seminole compared to the NAA.

6.1.1.1.6 Nonfederal Reservoirs

Nonfederal reservoirs on the mainstem rivers in the ACF Basin are described in sections 2.1.1.1.6.2, 2.1.1.1.6.4, 2.1.1.1.6.8, and 2.1.1.1.6.9. They include the Georgia Power Company (GPC) reservoirs on the Chattahoochee and Flint rivers and Warwick Dam (Lake Blackshear) operated by the Crisp County Power Commission (CCPC) on the Flint River.

6.1.1.1.6.1 No Action Alternative

Under the NAA, the structures and/or operations of nonfederal (GPC) reservoirs on the mainstem of the Chattahoochee River would not change. Reregulation of Buford Dam releases at Morgan Falls Dam to meet minimum flow requirements at Peachtree Creek would continue as currently conducted in accordance with existing agreements. Appreciable drawdown of Bull Sluice Lake at the Morgan Falls Dam would be expected on many weekends to augment Buford Dam releases and BIs below Buford Dam to meet the minimum flow requirements at Peachtree Creek. The NAA would not affect the structures and operations at the CCPC's Warwick Dam (Lake Blackshear) or at GPC's Lake Worth Dam, both of which are on the mainstem of the Flint River.

6.1.1.1.6.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Implementing any of these alternatives would have no appreciable effect on lake-level conditions at the nonfederal (GPC) reservoirs on the mainstem of the Chattahoochee River compared to the NAA. Morgan Falls Dam would continue to operate to reregulate releases from Buford Dam to ensure that continuous minimum flow requirements at Peachtree Creek are met. These alternatives would not affect lake-level conditions at the reservoir projects on the mainstem of the Flint River.

6.1.1.2 Flow Conditions Downstream of Buford Dam

This section summarizes the effects of alternative water management plans and water supply options for USACE projects in the ACF Basin on streamflow conditions in the basin. Based on HEC-ResSim outputs over the modeled period of record (1939–2011), this section describes the changes in streamflow conditions that would likely occur under Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, Alt7K (PAA), Alt7L, and Alt7M compared to the NAA. The section discusses three specific reaches of the Chattahoochee River—Buford Dam to West Point Lake, West Point Dam to Walter F. George Lake, and Walter F. George Lock and Dam to Jim Woodruff Lock and Dam—and the Apalachicola River downstream of Jim Woodruff Lock and Dam. None of the water management alternatives/water supply options addressed in this EIS would affect streamflow conditions in the Flint River Basin.

The focus of this section is on changes in the quantity and timing of downstream flows as a function of reservoir operations under each of the alternatives. The discussion summarizes the water quantity-related considerations that might, in turn, affect important recreation, infrastructure, and other resources, as well as assesses the extent to which streamflows would meet or exceed established flow requirements and specifically defined, but nonmandatory, flow needs in the ACF Basin. These other resource effects resulting from changes in streamflow conditions are addressed in more detail in other pertinent sections of the EIS. For example, while changes in streamflow conditions under the alternatives would likely affect water quality conditions in the basin, those effects are specifically addressed in section 6.1.2.

Figures depicting median flow conditions in the basin provide a representative characterization of normal conditions for evaluation and comparison among alternatives. The median value represents the point at which 50 percent of the values are higher and 50 percent are lower. Also included are figures depicting the 90-percent exceedance level, which means that the values presented for each day would be exceeded 90 percent of the time over the period of record in the simulation. The 90-percent exceedance value would be representative of extremely dry conditions in the basin and low BI to the reservoirs. Figures depicting flows under wetter conditions for the alternatives under consideration (e.g., 10- or 25-percent exceedance levels) have not been included in this EIS because they generally indicate minor or no differences among the alternatives.

Interpretation of the model results as presented in Figure 6.1-19 through Figure 6.1-56 and the tabulated information in Table 6.1-9 provide the basis for the description of effects on streamflow conditions in the ACF Basin. Table 6.1-9 provides a qualitative assessment of the expected effects of the alternatives on streamflow conditions in the mainstem rivers in the ACF Basin.

Table 6.1-9.
Summary of the Effects on Streamflow Conditions of the Alternatives from the NAA during the Modeled Period of Record from 1939–2011

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Buford Dam to Bull Sluice Lake (Morgan Falls)	Baseline	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Morgan Falls Dam to Peachtree Creek	Baseline	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Peachtree Creek to West Point Lake	Baseline	Slightly beneficial	Slightly adverse	Slightly beneficial	Negligible/ No change	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change	Negligible/ No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lock and Dam to Jim Woodruff Lock and Dam	Baseline	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.
Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

6.1.1.2.1 Mandatory USACE Minimum Flow Requirements and Nonmandatory Flow Targets/Goals Established by Others in the ACF Basin

USACE has established mandatory minimum flow requirements at specific USACE projects in the ACF Basin. In addition, other agencies and entities have identified nonmandatory flow targets or goals at various other points in the basin with respect to USACE project operations. In cooperation with the other entities, USACE generally will operate its project to support the other targets or goals as long as authorized project purposes are not adversely affected. The following paragraphs summarize the flow requirements and targets/goals in the basin. The subsequent assessment of flow conditions under the various alternatives references and further discusses the mandatory flow requirements and nonmandatory flow targets and goals, as appropriate.

Continuous minimum releases of 600 cfs are required from Buford Dam in accordance with the project authorization (see sections 2.1.1.1.6.1 and 2.1.1.2.4.6). A small service generator at the project provides for the releases. If the generator is inoperable, minimum flow releases temporarily occur through the sluice gate. Similarly, a continuous minimum release of 670 cfs is required from West Point Dam in accordance with the project authorization (see sections 2.1.1.1.6.3 and 2.1.1.2.4.6). A small service generator at that project provides a continuous minimum off-peak release of 675 cfs. If that generator becomes inoperable, a spillway gate is opened temporarily to provide the minimum flow releases.

Specific provisions of the Revised Interim Operations Plan (RIOP)—a product of USACE consultation with the USFWS under section 7 of the Endangered Species Act (ESA)—establish release requirements at Jim Woodruff Lock and Dam. Section 2.1.1.2.4.4 discusses the detailed provisions and requirements in the RIOP for releases under various hydrologic conditions. Generally, the minimum flow requirement at Jim Woodruff Lock and Dam is 5,000 cfs. The RIOP contains specific provisions to reduce releases to 4,500 cfs on a temporary basis under Drought Zone operations (formerly referred to as extreme drought operations or EDO).

USACE currently operates Buford Dam under an agreement with GPC and GAEPD to support a minimum flow of 750 cfs in the Chattahoochee River at its juncture with Peachtree Creek in Metro Atlanta (see section 2.1.1.2.4.6). Based upon scoping input from GAEPD, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, Alt7K (the PAA), Alt7L, and Alt7M include provisions for seasonal minimum flows at Peachtree Creek of 750 cfs (May–October) and 650 cfs (November–April).

The four GPC dams on the middle Chattahoochee River downstream of West Point Lake (i.e., Bartletts Ferry, Goat Rock, Oliver, and North Highlands) have established minimum flow targets in their Federal Energy Regulatory Commission (FERC) licenses (see section 2.1.1.1.6.4), hereafter referred to as *FERC targets* or *FERC flow targets*. Below the North Highlands Dam at Columbus, Georgia, the established FERC targets are as follows:

- An instantaneous target minimum flow release of 800 cfs, or inflow, whichever is less;
- A daily average target minimum flow of 1,350 cfs, or inflow, whichever is less; and
- A weekly average target minimum flow of 1,850 cfs, or inflow, whichever is less.

Releases from West Point Lake could influence how and the extent to which the flow targets are met by GPC, but the FERC flow targets place no mandatory requirements on USACE project operations.

During scoping activities for this EIS, the Alabama Office of Water Resources (OWR) and Southern Nuclear Operating Company both identified a daily average flow need of 2,000 cfs at Columbia, Alabama, just downstream of George W. Andrews Lock and Dam that they consider necessary to sustain continuous power generation operations at the Farley Nuclear Plant. While the *Farley flow need*—as it is called—is a nonmandatory flow target with respect to USACE operations, USACE seriously considers the expressed need in conducting its project operations in the basin.

The Chattahoochee River National Recreation Area (CRNRA) is an important recreation resource in the ACF Basin (see sections 2.1.1.2.4.5, 2.4.3, and 2.6.6). Releases from Buford Dam directly affect water-based recreation activities within the CRNRA. Investigations conducted as part of the Metropolitan Atlanta Area Water Resources Management Study (MAAWRMS) in the 1980s and, subsequently, during the ACF Basin Comprehensive Study in the 1990s evaluated flow preferences in the CRNRA for a variety of recreational pursuits, including wade and float fishing, low-power and nonpower boat fishing, wading, rafting, and canoeing. Nestler et al. (1985) developed optimum flow levels for those recreational pursuits in support of the MAAWRMS effort, which are summarized in Table 6.1-10 for the various segments of the CRNRA.

Subsequently, CH2M Hill (2000) developed a recreation flow preference for the NPS. Key findings from that report are summarized in Table 6.1-11. The results were generally consistent with the optimum flows developed by Nestler et al. (1985).

The NPS noted in its January 2010 scoping comments for this EIS and reiterated in its January 2013 re-scoping comments that these earlier studies document the need for *baseline* flows above 1,000 cfs to support basic recreational use of the CRNRA. In addition to recreational impacts, the NPS indicated that flows lower than that threshold could restrict the ability of law enforcement and emergency personnel to use the river for patrol and rescue operations. The NPS also maintains that sustained, low flow conditions that could be encountered during an extended drought period would promote increased exotic vegetation growth in Bull Sluice Lake above Morgan Falls Dam, further affecting recreational uses in that portion of the CRNRA.

Table 6.1-10.
Optimum Flows (in cfs) within the Boundaries of the CRNRA for Various Recreational Activities

Recreation Activity	Chattahoochee River Reach		
	Buford Dam to RM 342.0 (above McGinnis Ferry Road)	RM 342.0 to Morgan Falls Dam	Morgan Falls Dam to Peachtree Creek
Wade fishing	750	750	750
Tube fishing	1,000	1,000	1,000
Boat fishing (nonpower)	1,500	1,500	1,500
Boat fishing (low-power)	2,500	3,500	5,000
Water contact wading (shoal areas)	750	750	750
Rafting (novice)	1,250–5,000	1,500–5,000	1,750–3,500
Rafting (mid-level)	7,000	7,000	7,000
Canoeing (novice)	1,500	1,750	2,000
Canoeing (mid-level)	7,000	7,000	7,000

Source: Nestler et al. 1985
Note: RM = river mile

Table 6.1-11.
Flow Preferences of Expert Recreation User Groups in the CRNRA

Expert User Group	Primary Concerns[a]	Flow Preference[b]
Powerboat fishing (Group 1)	Higher flows allow better river access for motorized boats, but fishing is better at lower flows	1,000 to 1,200 cfs
Wade and tube fishing (Group 2)	Maintaining healthy fish habitat relative to water quality, food base, and releases to scour accumulated sediment; access is better at lower flows	1,000 to 1,200 cfs
Nonmotorized boating (Group 3)		
Shell rowing	Morgan Falls impoundment is only suitable location in CRNRA for shell rowing; medium-to-high flows preferred	1,000 to 1,200 cfs
Kayaking and canoeing	Medium-to-high flows create more challenging hydraulics; preferred section is Powers Ferry (RM 306.5) to U.S. Highway 41 (RM 303.8); Devil's Race Course (RM 305.5) is most popular destination	6,000 cfs

Source: CH2M Hill 2000
Notes:
RM = river mile
[a] As identified in discussions with expert users.
[b] Based on comments and video observation feedback from expert users.

6.1.1.2.2 Buford Dam to West Point Lake

Figure 6.1-19 through Figure 6.1-36 present model outputs for flow conditions at three locations in the Chattahoochee River between Buford Dam and West Point Lake: immediately downstream of Buford Dam (river mile [RM] 348.1), at the river's juncture with Peachtree Creek (RM 300.5), and at Whitesburg, Georgia (RM 259.9). Flow conditions at the three locations were examined to assess changes that would be expected under the water management alternatives/water supply options considered in detail for the ACF Basin—Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, Alt7K (the PAA), Alt7L, and Alt7M—compared to the NAA. The figures present model results for median daily flows, daily flows at the 90-percent exceedance level, and duration curves depicting the percent of days exceeded for the range of daily flow values. In consideration of the number of alternatives and the ease of viewing the

information about each alternative, the results for each parameter (e.g., magnitude of flow conditions) are presented in two figures with half of the alternatives presented on each figure. Using the results from the figures and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

Flow values below Buford Dam over the modeled period of record (1939–2011) are considered representative of conditions from the dam downstream to Bull Sluice Lake, the reservoir formed by the GPC Morgan Falls Dam. Flow values at Peachtree Creek and at Whitesburg are considered representative of flow conditions between Morgan Falls Dam and the headwaters of West Point Lake.

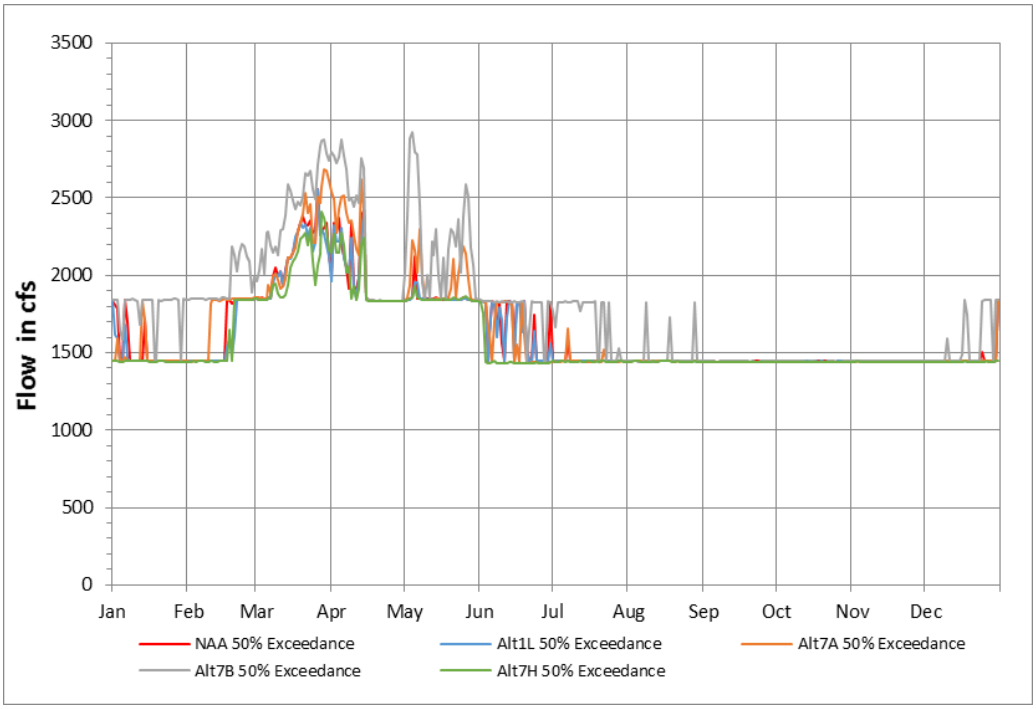


Figure 6.1-19. Chattahoochee River Median Daily Flows below Buford Dam, GA, (RM 348.1) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

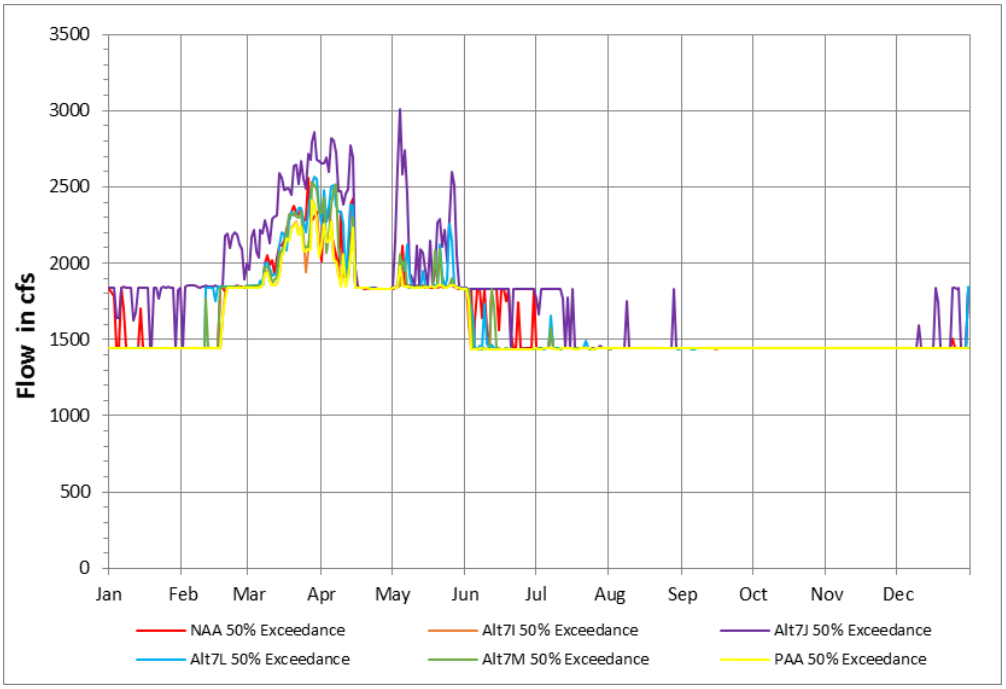


Figure 6.1-20. Chattahoochee River Median Daily Flows below Buford Dam, GA, (RM 348.1) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

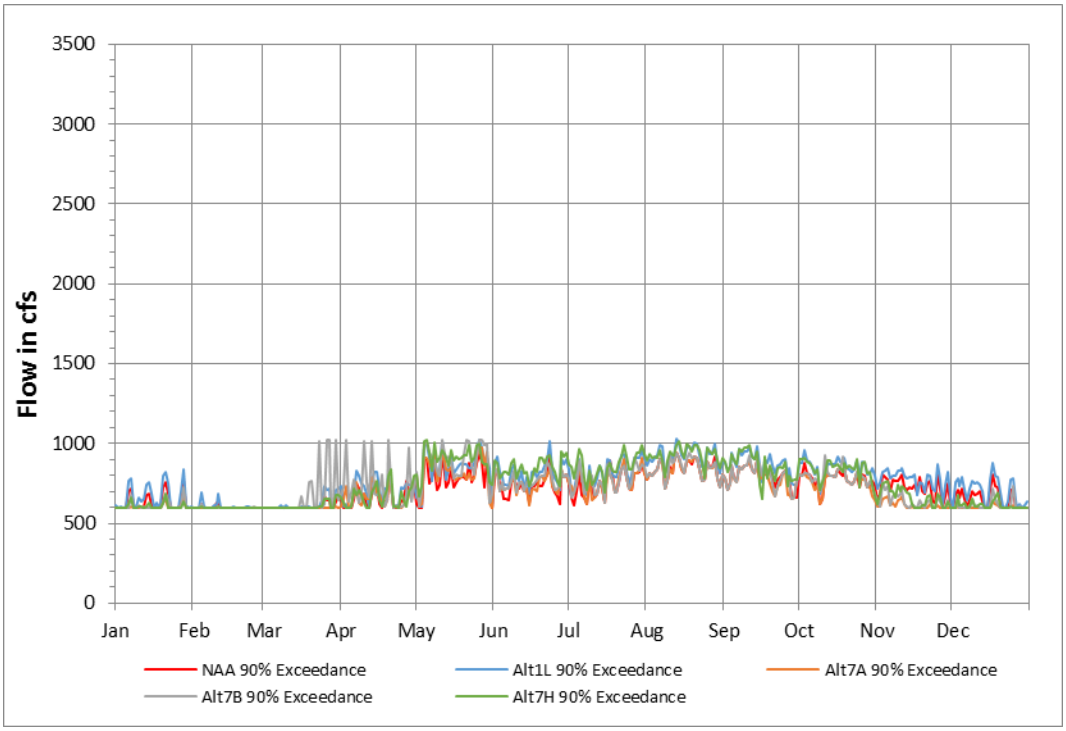


Figure 6.1-21. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level below Buford Dam, GA, (RM 348.1) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

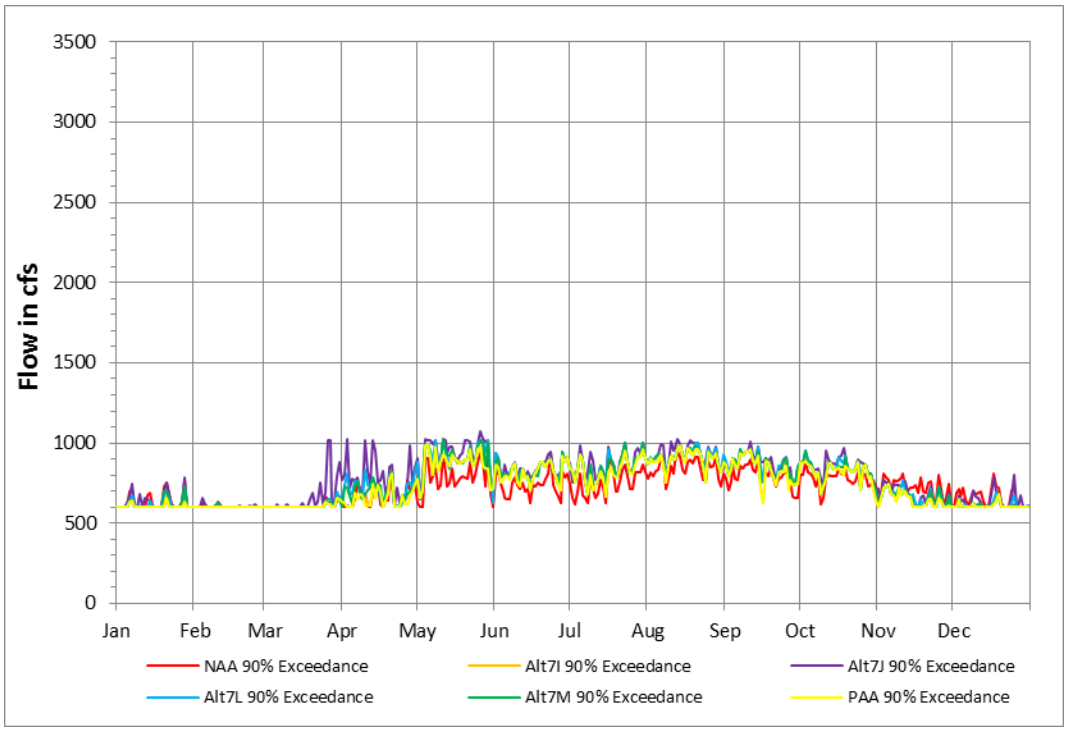


Figure 6.1-22. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level below Buford Dam, GA, (RM 348.1) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

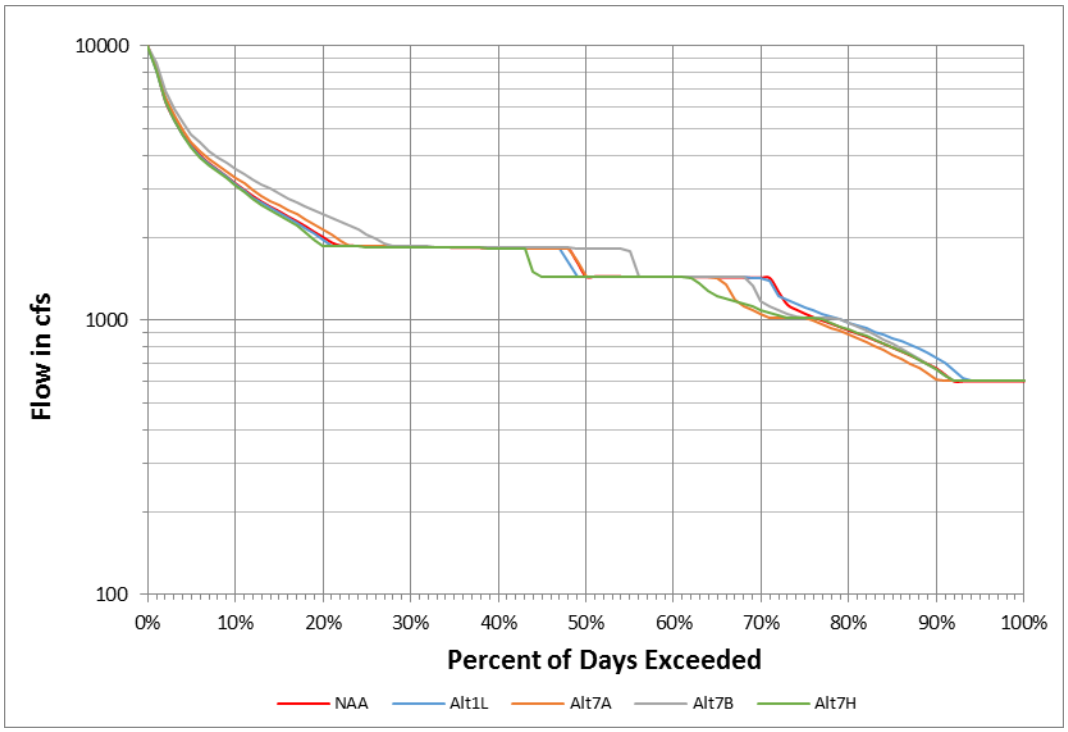


Figure 6.1-23. Chattahoochee River Flows below Buford Dam, Percent of Days Exceeded for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

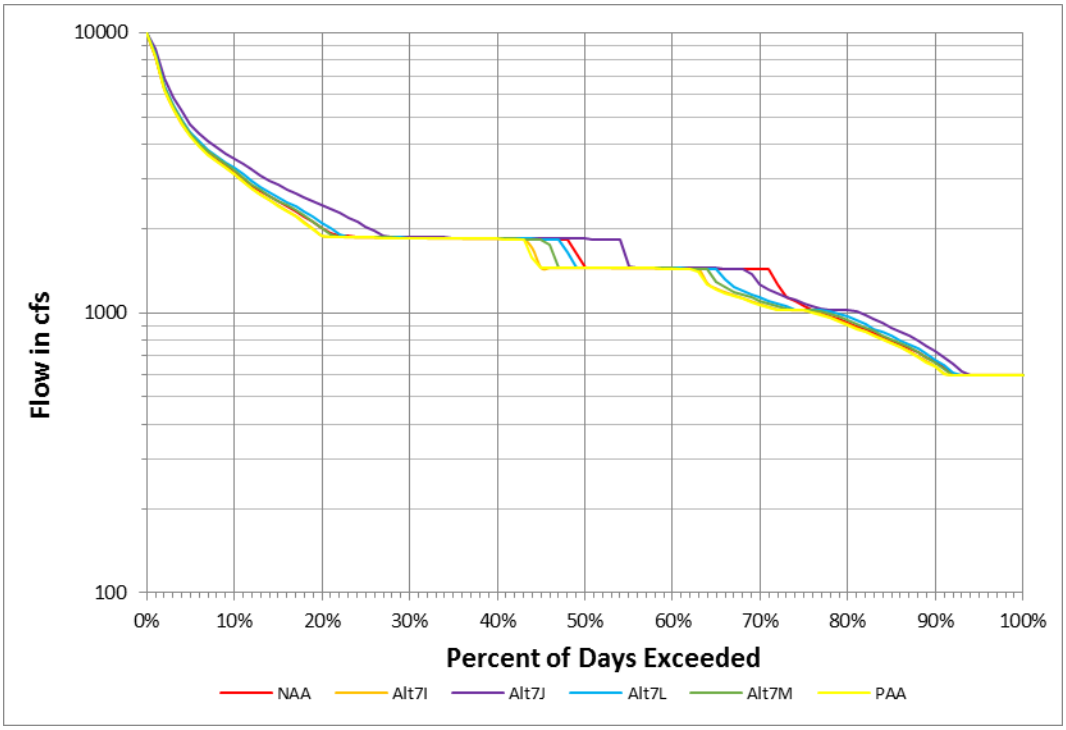


Figure 6.1-24. Chattahoochee River Flows below Buford Dam, Percent of Days Exceeded for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

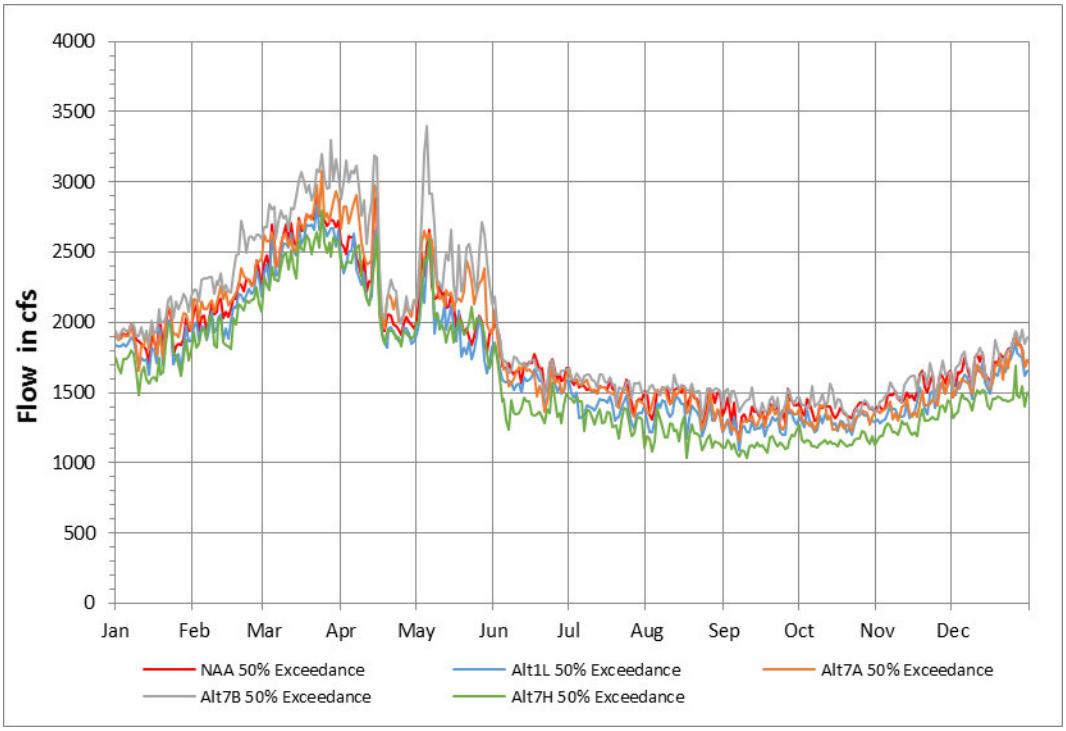


Figure 6.1-25. Chattahoochee River Median Daily Flows at Atlanta (Peachtree Creek), GA, (RM 300.5) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

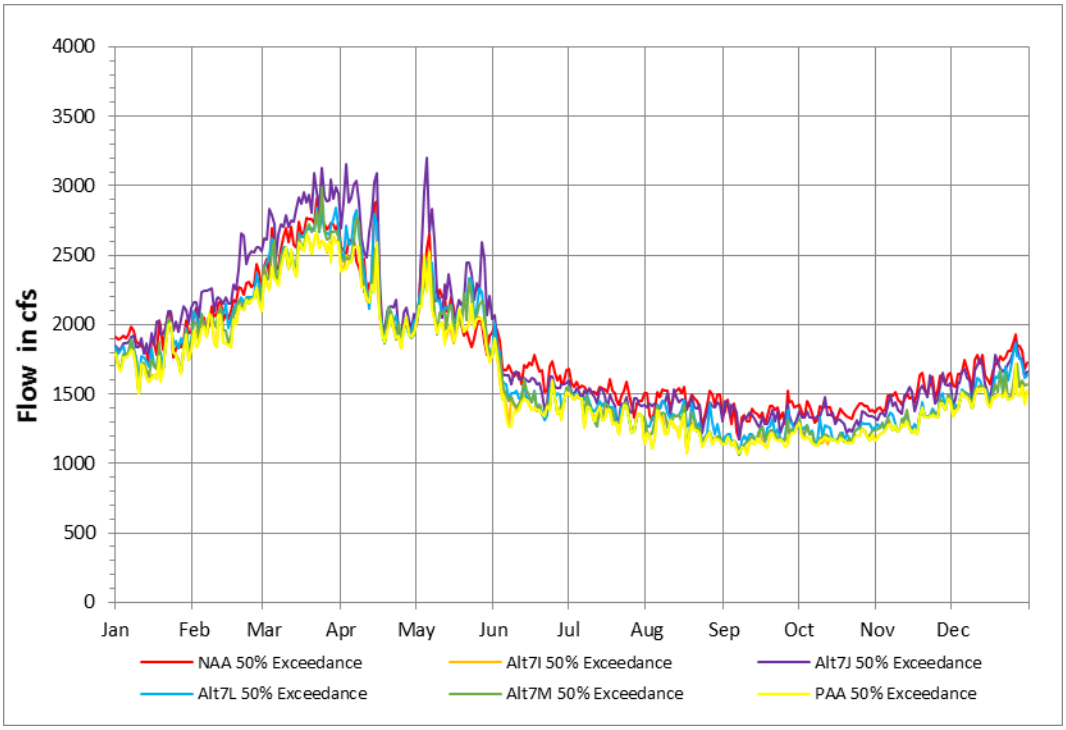


Figure 6.1-26. Chattahoochee River Median Daily Flows at Atlanta (Peachtree Creek), GA, (RM 300.5) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

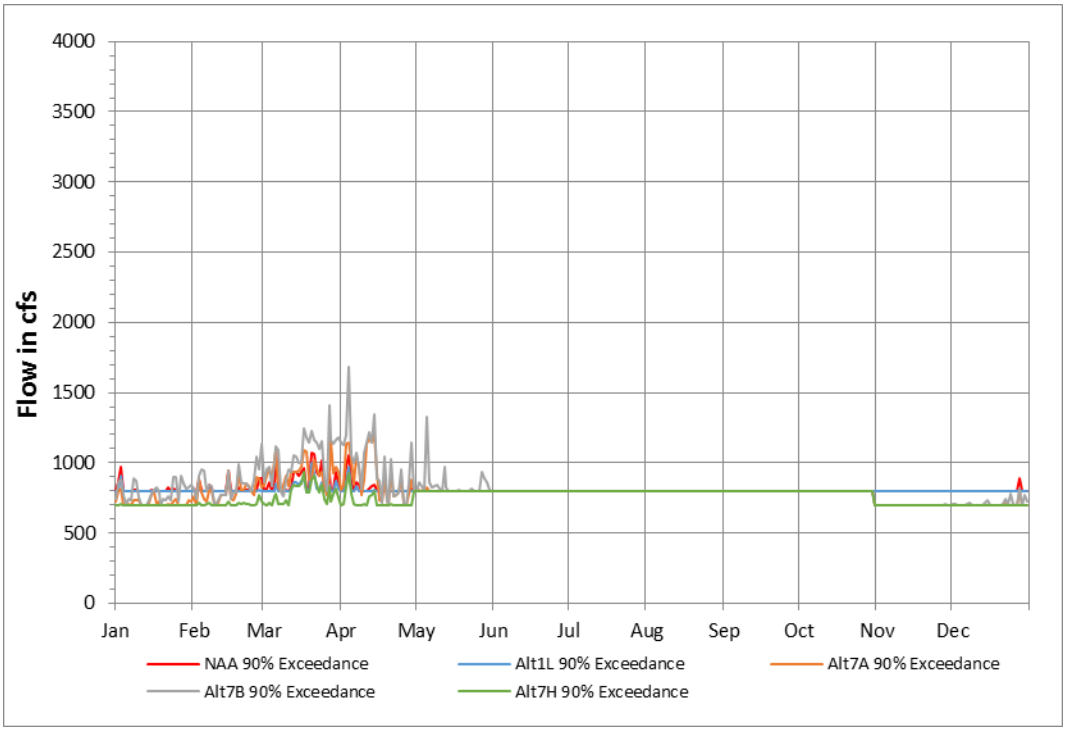


Figure 6.1-27. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level at Atlanta (Peachtree Creek), GA, (RM 300.5) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

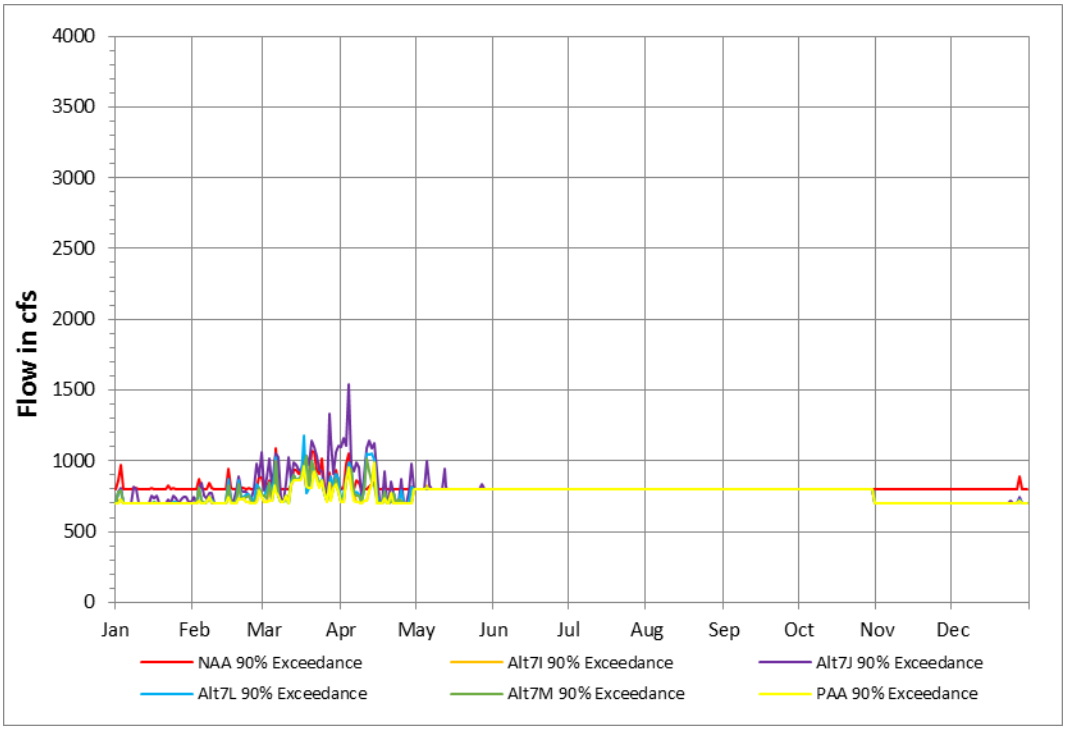


Figure 6.1-28. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level at Atlanta (Peachtree Creek), GA, (RM 300.5) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

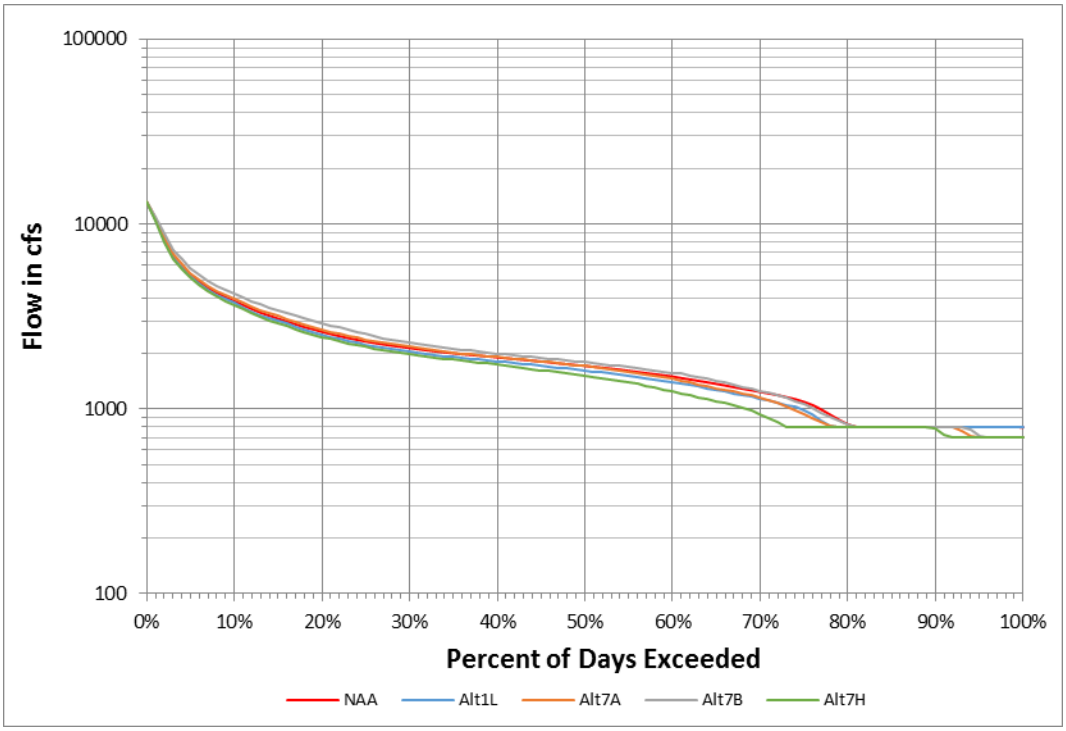


Figure 6.1-29. Chattahoochee River Flows at Atlanta (Peachtree Creek), GA, Percent of Days Exceeded for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

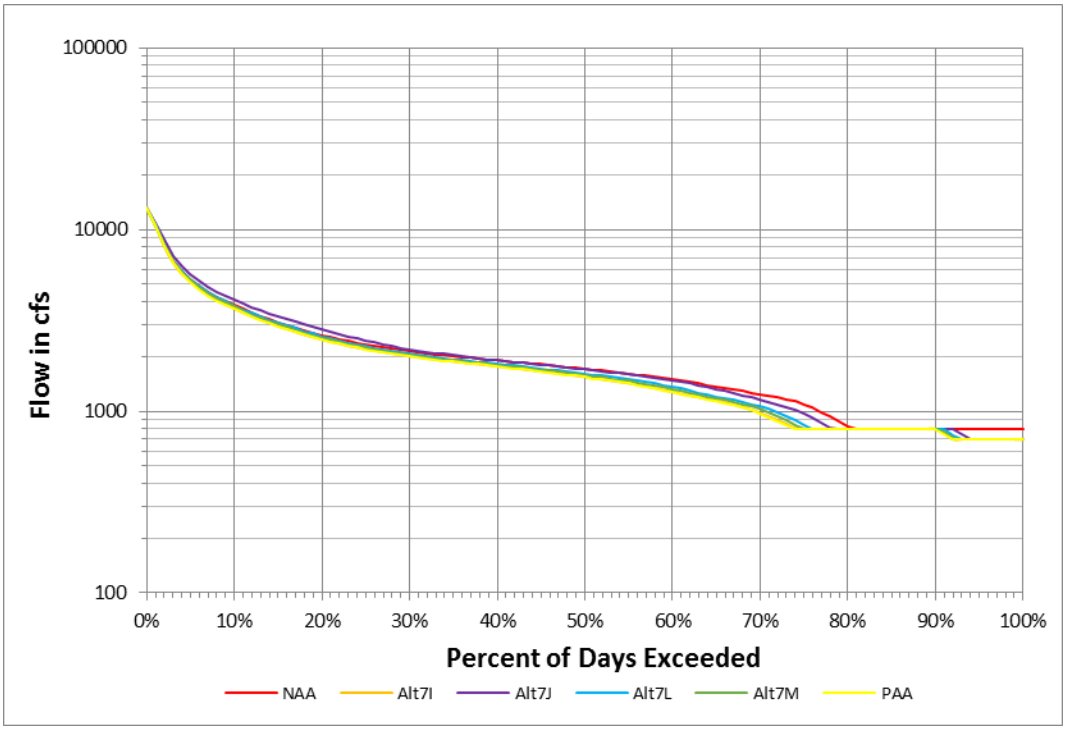


Figure 6.1-30. Chattahoochee River Flows at Atlanta (Peachtree Creek), GA, Percent of Days Exceeded for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

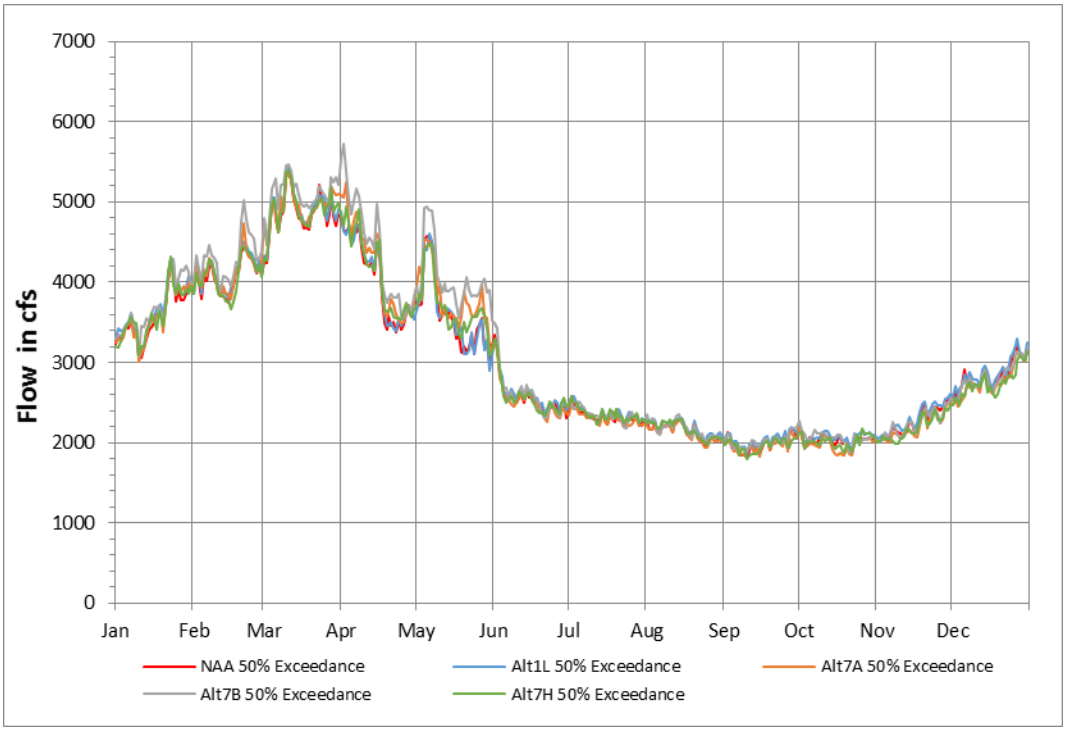


Figure 6.1-31. Chattahoochee River Median Daily Flows at Whitesburg, GA, (RM 259.9) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

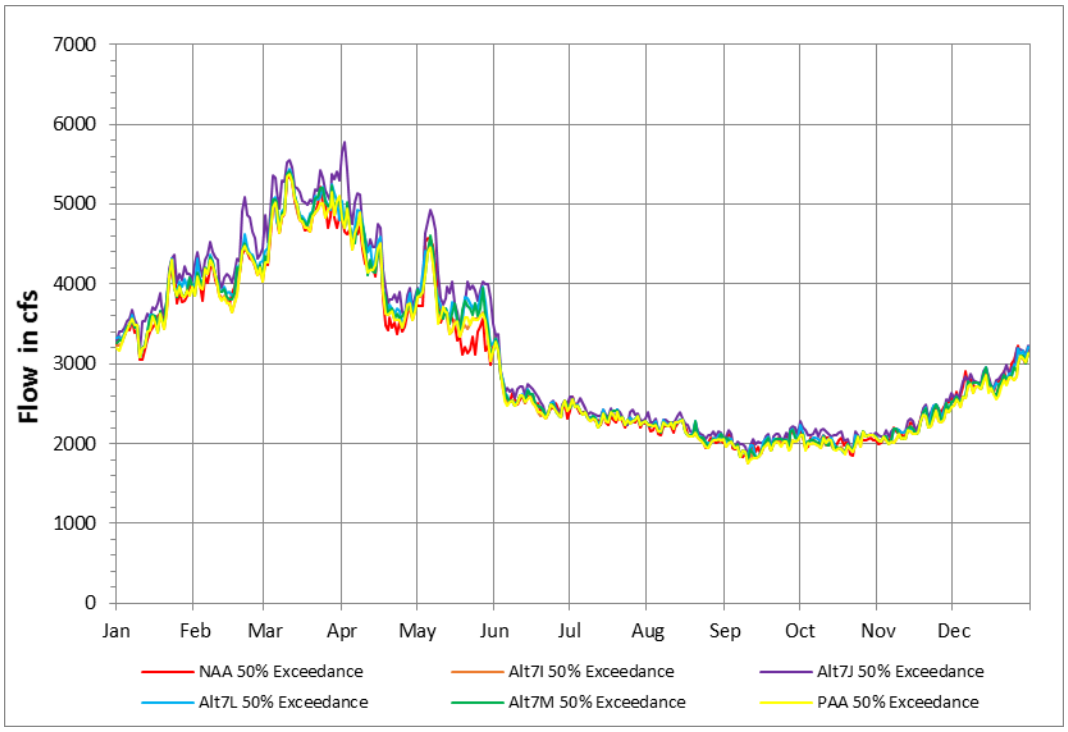


Figure 6.1-32. Chattahoochee River Median Daily Flows at Whitesburg, GA, (RM 259.9) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

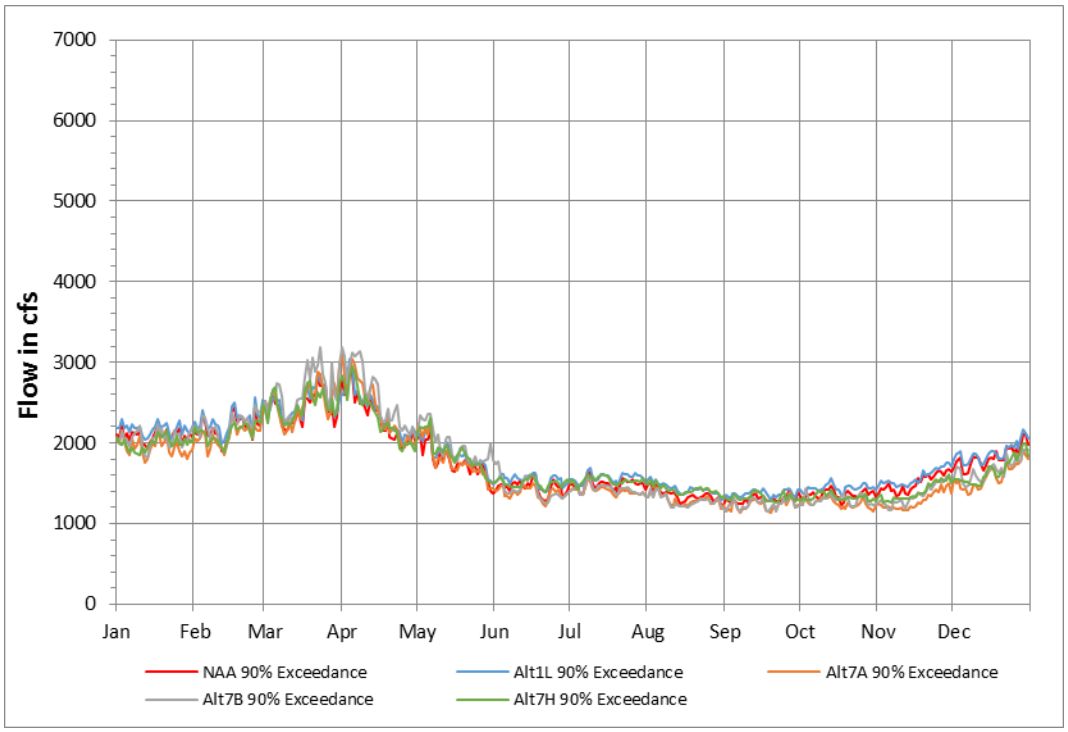


Figure 6.1-33. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level at Whitesburg, GA, (RM 259.9) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

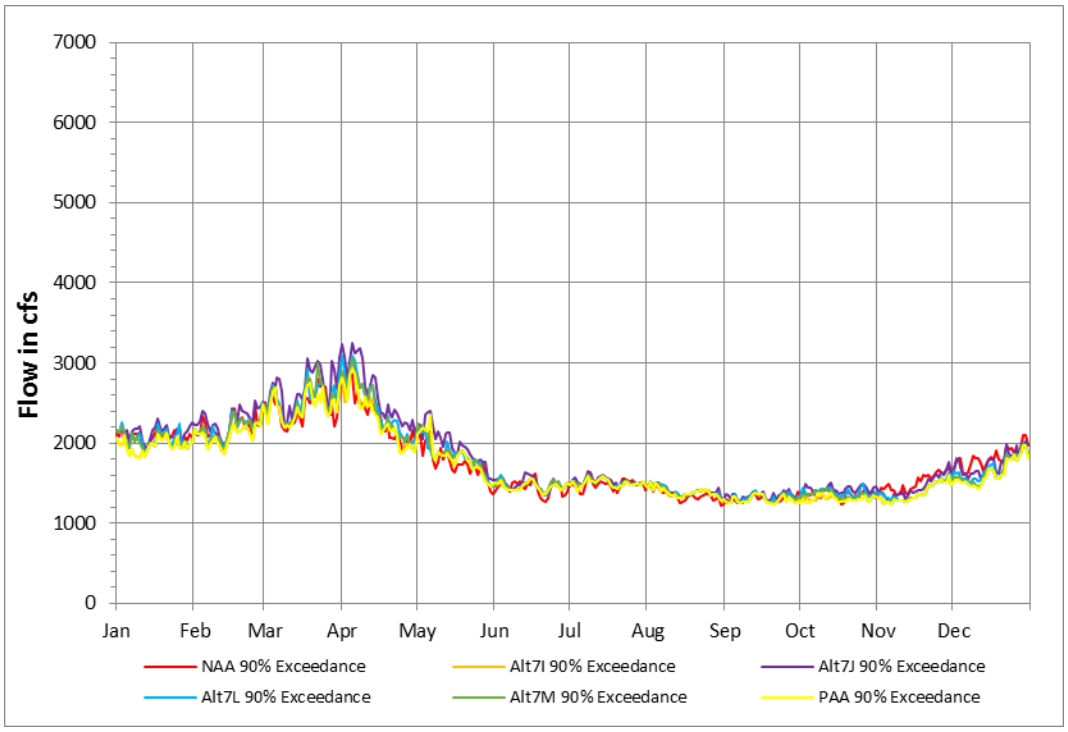


Figure 6.1-34. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level at Whitesburg, GA, (RM 259.9) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

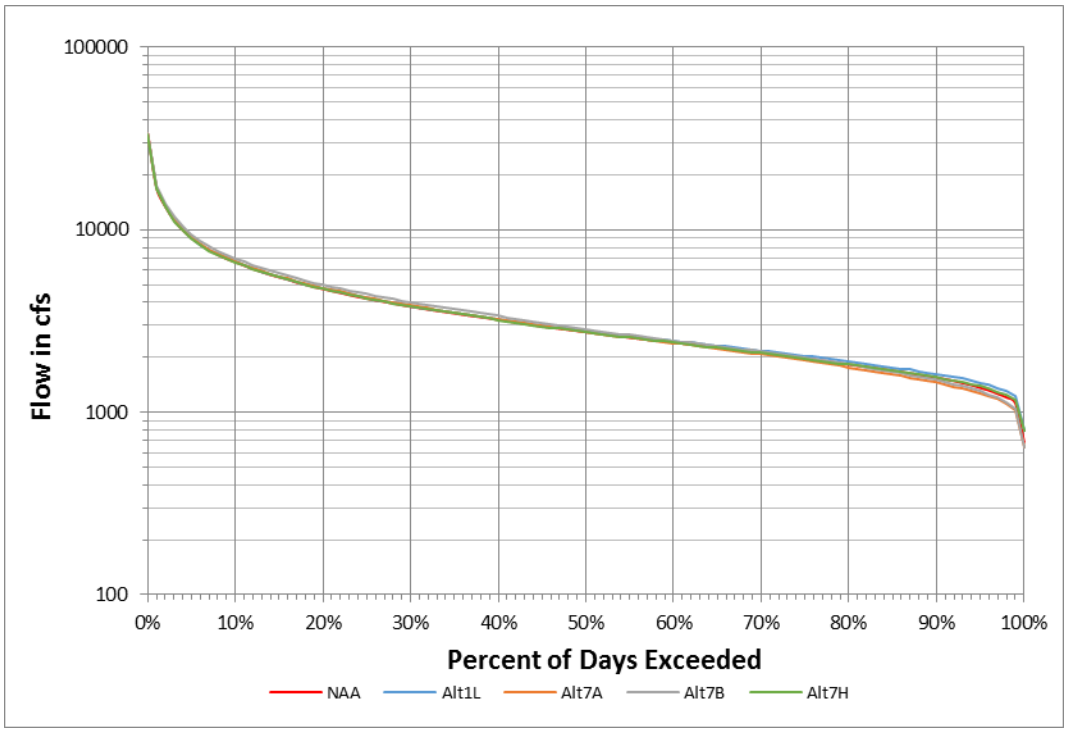


Figure 6.1-35. Chattahoochee River Flows at Whitesburg, GA, Percent of Days Exceeded for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

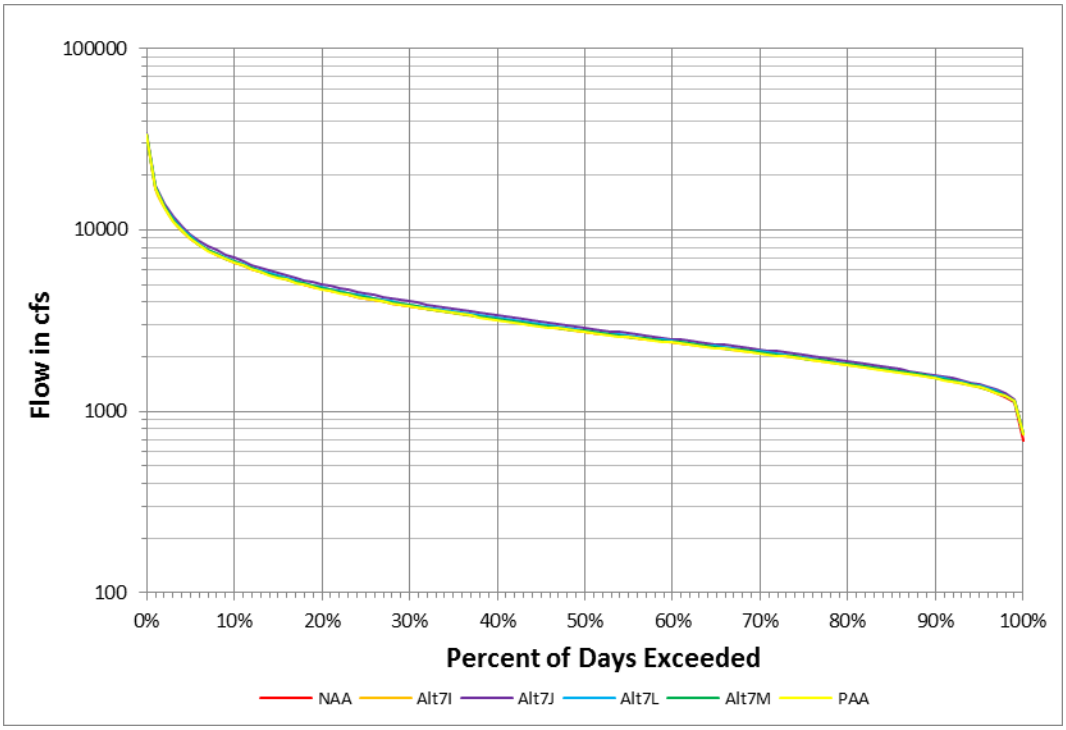


Figure 6.1-36. Chattahoochee River Flows at Whitesburg, GA, Percent of Days Exceeded for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

6.1.1.2.2.1 No Action Alternative

Releases at Buford Dam would generally govern flow conditions in the Chattahoochee River downstream to Bull Sluice Lake (Morgan Falls Dam) in addition to local inflow that occurs over that reach of the river. Under the NAA, minimum releases at Buford Dam would continue to equal or exceed 600 cfs at all times in accordance with the project authorization. Median daily flows between the months of June and mid-February would likely be about 1,450 cfs, occasionally ranging as high as about 1,800 cfs during that period. From mid-February through May, median daily flows would typically be about 1,800 cfs, occasionally ranging as high as 2,500 cfs in March and early April (Figure 6.1-19). Daily flows below Buford Dam at the 90-percent exceedance level (indicative of drought conditions) would typically be at the minimum flow of 600 cfs during January–March and vary between 600 and 900 cfs through the balance of the year (Figure 6.1-21). Daily minimum flows of 600 cfs would occur no more than about 8 percent of the days over the period of record, and daily flows would exceed 1,000 cfs on about 76 percent of the days (Figure 6.1-23).

Under the NAA, flow conditions in the river necessary to pursue water-based recreation activities in the CRNRA downstream to Bull Sluice Lake (based on criteria established in the MAAWRMS and ACF Basin Comprehensive studies) would continue to be available most of the time. The general exception would be for infrequent and relatively brief periods of extreme high flow conditions during major flood events. Conditions below Buford Dam vary widely, even over a 24-hour period, because of the inherent nature of peak hydroelectric power operations. Flows in the Chattahoochee River below Buford Dam can range from less than 1,000 cfs to 10,000 cfs over a short period due to peak power generation. The extreme daily fluctuation (or pulsing effect) in releases from Buford Dam is more noteworthy at the upper end of the CRNRA nearer to Buford Dam. The fluctuation progressively declines as peak flows move downstream and are eventually reregulated, or smoothed out, by operations at Morgan Falls Dam at RM 312.5. Appropriate communication mechanisms and warning systems are in place to accommodate

recreation use in the upper portion of the CRNRA immediately downstream of Buford Dam in a manner that is compatible with the daily fluctuations. Under the NAA, flow conditions between Buford Dam and Morgan Falls Dam are compatible for most recreation activities identified in Table 6.1-10 and, most of the time, are within the general range of optimum flow levels presented in Table 6.1-11.

At Peachtree Creek (RM 300.5), median daily flows under the NAA would be in the range of about 1,800 cfs in January, peaking at about 2,800 cfs in March, and declining to about 2,000 cfs in late April as conservation storage in Lake Lanier is replenished (Figure 6.1-25). Following a brief increase to about 2,500 cfs in early May, median flows would gradually decline to about 1,300 cfs by September and gradually increase again to about 1,700 cfs by the end of December. At the 90-percent exceedance level (reflecting extreme drought conditions), daily flows at Peachtree Creek would consistently occur at the currently established minimum flow level of 750 cfs throughout the year (modeled as 800 cfs in HEC-ResSim), except for intermittent periods from January through April ranging as high as 1,200 cfs (Figure 6.1-27). Per agreement with GPC and GAEPD, USACE makes releases at Buford Dam, with reregulation of those releases as necessary at the GPC Morgan Falls Dam, sufficient to maintain a minimum flow of 750 cfs at Peachtree Creek at all times, including weekends.

Under the NAA, flows at or below 1,000 cfs within the boundary of the CRNRA are more likely to be encountered on weekends when releases for hydroelectric power operations at Buford Dam are limited to those necessary to maintain a minimum flow of 750 cfs in the river at Peachtree Creek. Sustained periods of flow at that level could occur during periods of severe drought when peaking hydroelectric power operations would likely be significantly curtailed, or suspended, under drought operations to conserve storage in Lake Lanier. Daily minimum flows of 750 cfs at Peachtree Creek would occur on no more than about 19 percent of the days over the period of record, and daily flows would exceed 1,000 cfs on about 76 percent of the days (Figure 6.1-29). According to the NPS, a daily average flow of 1,000 cfs would provide a baseline level of flow to support most water-based recreational uses in the lower portion of the CRNRA below Morgan Falls Dam (see section 6.1.1.2.1).

At Whitesburg (RM 259.9), median daily flows under the NAA would follow a seasonal pattern similar to flows upstream at Peachtree Creek (Figure 6.1-31). Flows would be in the range of about 3,200 cfs in January, peaking at about 5,000 cfs in March, and declining to about 3,400 cfs in late April. Following a brief increase to about 4,600 cfs in early May, median daily flows would gradually decline to about 2,000 cfs by September and gradually increase again to about 3,200 cfs by the end of December. For the NAA at the 90-percent exceedance level, daily flows would range from about 2,200 cfs in January to a peak of about 3,000 cfs in early April, thereafter gradually declining to about 1,300 cfs in August–October before returning to 3,000 cfs by the end of December (Figure 6.1-33). The flow-duration curve for Whitesburg indicates that flows would be expected to exceed 1,123 cfs on 99 percent of the days over the period of record, and the lowest modeled flow expected over the period of record would be 686 cfs (Figure 6.1-35).

6.1.1.2.2.2 Alternative 1L

For Alt1L, median daily flow conditions just below Buford Dam would be nearly the same as for the NAA, except for a few days from mid-February through early April when NAA flows would likely be slightly higher (by about 100–300 cfs) (Figure 6.1-19). Daily flows for Atl1L at the 90-percent exceedance level would consistently be higher than the NAA throughout most of the year by about 100–200 cfs. From mid-February through late March, flows for both Alt1L and the NAA at the 90-percent exceedance level would be at about 600 cfs (Figure 6.1-21). For Alt1L, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 6 percent of the days over the entire period of record (8 percent for the NAA), and daily flows would exceed 1,000 cfs on about 79 percent of the days (76 percent for the NAA) (Figure 6.1-23).

Overall, Alt1L would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA. Releases would be increased to ensure that the 2050 M&I water supply withdrawal needs downstream of Buford Dam would be met (379 cfs) compared to current needs (277 mgd). The first major water intake structure on the river below Buford Dam (Atlanta-Fulton County) is located about 19 miles (mi) downstream of the dam. Therefore, the flows for Atl1L would tend to be slightly higher in this reach of the river, especially under drought conditions because of the increased downstream demand. Those minor improvements in flow conditions could have a slightly beneficial effect on recreational use in the CRNRA between Buford Dam and Bull Sluice Lake.

Median daily flows in the Chattahoochee River at Peachtree Creek would be slightly lower than for the NAA (by about 100–200 cfs) throughout the year (Figure 6.1-25). Daily flows at the 90-percent exceedance level for Alt1L and the NAA would equal the minimum flow of 750 cfs most of the time (Figure 6.1-27). In March and early April, Alt1L flows would be higher than the minimum flow but slightly lower than NAA flows. Releases from Buford Dam would occur as necessary, coupled with local inflow downstream of the dam and reregulation of flows at Morgan Falls Dam, to maintain a minimum flow of 750 cfs at Peachtree Creek throughout the year. Over the period of record, flows in the Chattahoochee River at Peachtree Creek would equal the minimum flow of 750 cfs about 21 percent of the time (compared to 19 percent of the time for the NAA). Daily flows would exceed 1,000 cfs on about 74 percent of the days (76 percent for the NAA) (Figure 6.1-29).

Alt1L would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek. In comparison to the NAA, the changes in modeled flow conditions for Alt1L could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt1L would be nearly identical to NAA flows throughout the year (Figure 6.1-31). Daily flows at the 90-percent exceedance level for Alt1L would be slightly higher than NAA flows throughout the year (typically in the range of 0–100 cfs higher) (Figure 6.1-33). The flow-duration curve for Whitesburg indicates that flows would be expected to exceed 1,223 cfs on 99 percent of the days over the period of record (1,123 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 787 cfs (686 for the NAA) (Figure 6.1-35).

Alt1L would likely have a slightly beneficial effect on flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake. The slightly increased flows at the 90-percent exceedance level at Whitesburg (reflecting extreme drought conditions) would be caused principally by increased releases from Buford Dam to meet future water withdrawal needs from the Chattahoochee River as well as a more favorable future ratio of water returned to water withdrawn from the river (current—82 percent; future—95 percent).

6.1.1.2.2.3 Alternative 7A

For Alt7A, median daily flow conditions just below Buford Dam would be nearly the same as under the NAA, except for short intermittent periods from mid-February through May, when Alt7A flows would likely be as much as 300–500 cfs higher (Figure 6.1-19). Daily flows at the 90-percent exceedance level would nearly be the same for Alt7A and the NAA, except that Alt7A flows would be slightly higher in April and May and slightly lower in November and December (Figure 6.1-21). For Alt7A, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 10 percent of the days over the period of record (8 percent for the NAA), and daily flows would exceed 1,000 cfs on about 75 percent of the days (76 percent for the NAA) (Figure 6.1-23).

Overall, Alt7A would have a slightly adverse effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA, because slightly lower flow conditions would be likely at certain times of the year under extreme drought conditions. Since assumed withdrawal levels from Lake Lanier and downstream of Buford Dam are the same for Alt7A and the NAA, changes to flow conditions immediately downstream of Buford Dam would be attributable to reservoir water management changes at Buford Dam/Lake Lanier associated with Water Management Alternative 7. Those changes include revised action zones, updated drought operations, revised minimum flow criteria at Peachtree Creek from 750 cfs to 650 cfs from November through April, and other updates discussed in section 4.2.7.1.

In the Chattahoochee River at Peachtree Creek, median daily flows for Alt7A would follow a seasonal pattern with similar values to the NAA throughout the year (Figure 6.1-25). Alt7A flows would likely be slightly higher than NAA flows from January through May, with the differences slightly more pronounced during April and May (briefly as much as 400 cfs higher during that period). During June–September, Alt7A and NAA flows would be a close match. From October through December, Alt7A flows would be slightly lower than for the NAA. Daily flows at the 90-percent exceedance level for Alt7A would be about 100 cfs lower than for the NAA from November through mid-February because of the change in the prescribed minimum flow at Peachtree Creek included in Water Management Alternative 7 from 750 to 650 cfs during that portion of the year (Figure 6.1-27). During mid-February–mid-April, Alt7A flows would be slightly higher than for the NAA. Daily minimum flows of 650 cfs would occur on about 6 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 15 percent of the time. Thus, about 21 percent of the time flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 73 percent of the days (76 percent for the NAA) (Figure 6.1-29).

Alt7A would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. This effect would be caused principally by lower median daily flow values in October–December and lower flows at the 90-percent exceedance level from October through mid-February. These results are due to revisions to water management measures included in Water Management Alternative 7, principally seasonal minimum flows at Peachtree Creek. The minor changes in modeled flow conditions could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt7A would be nearly identical to NAA flows throughout the year (Figure 6.1-31), except that Alt7A flows would be slightly higher than for the NAA in April and May. Daily flows at the 90-percent exceedance level for Alt7A would be slightly higher than NAA flows in April and May (typically in the range of 0–200 cfs higher) and slightly lower than NAA flows over the balance of the year (Figure 6.1-33). The flow-duration curve for Whitesburg indicates that flows would be expected to exceed 1,223 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA) (Figure 6.1-35), and the lowest modeled flow expected over the period of record would be 643 cfs (686 for the NAA).

Alt7A would likely have a slightly adverse effect on flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake. The deviations between the Alt7A and NAA flow conditions at Whitesburg are the result of revised water management measures included in Water Management Alternative 7, such as increased releases, as needed, to support downstream navigation from January through May. Lower flows at the 90-percent exceedance level in November–February most likely reflect the results of reducing the minimum flow criteria at Peachtree Creek from 750 cfs to 650 cfs from October through April.

6.1.1.2.2.4 Alternative 7B

For Alt7B, median daily flow conditions just below Buford Dam would be nearly the same as under the NAA from August through December (at about 1,450 cfs). From January though July, Alt7B daily median flows would consistently be higher (typically by about 400 cfs and intermittently by up to 1,000 cfs) (Figure 6.1-19). Daily flows at the 90-percent exceedance level would be nerly the same (at about 600 cfs) from January through mid-March. From mid-March through October, Alt7B flows would be slightly higher (from a marginal increase up to about 300 cfs higher). In November and December, Alt7B flows would be slightly lower than NAA flows (Figure 6.1-21). For Alt7B, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 9 percent of the days over the period of record (8 percent for the NAA), and daily flows would likely exceed 1,000 cfs on 79 percent of the days (76 percent for the NAA) (Figure 6.1-23).

Overall, Alt7B would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA, because median daily flows and daily flows at the 90-percent exceedance levels would tend to be slightly higher most of the time throughout the year. Changes to flow conditions between Alt7B and the NAA immediately downstream of Buford Dam would be attributable to a combination of water management measures included in Water Management Alternative 7 and water supply withdrawal assumptions for Lake Lanier because the assumed withdrawal levels from the Chattahoochee River downstream of Buford Dam are the same for both Alt7B and the NAA.

In the Chattahoochee River at Peachtree Creek, median daily flows for Alt7B would follow a seasonal pattern similar to that for the NAA throughout the year (Figure 6.1-25). Alt7B flows would likely be slightly higher than NAA flows from January through May (generally from 100 to about 500 cfs higher), with the differences slightly more pronounced during April and May. During June–December, Alt7B and NAA flows would be a close match, with Alt7B flows marginally higher most of the time. Daily flows at the 90-percent exceedance level for Alt7B would be about 100 cfs lower than for the NAA from November through most of January because of the change in the prescribed minimum flow at Peachtree Creek included in Water Management Alternative 7 from 750 to 650 cfs during that portion of the year (Figure 6.1-27). During February–April, Alt7B flows would be higher most of the time than NAA flows (ranging from marginally higher to about 400 cfs higher). Daily minimum flows of 650 cfs would occur on about 4 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 15 percent of the time. Thus, about 19 percent of the time flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 76 percent of the days (the same as for the NAA) (Figure 6.1-29).

Alt7B would likely have a slightly beneficial effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. This effect would be the result principally of slightly higher median daily flow values throughout the year, even though flows at the 90-percent exceedance level from October through January would be slightly lower than for the NAA. These results are due to revisions to water management measures included in Water Management Alternative 7, principally seasonal minimum flows at Peachtree Creek. Additionally, limiting water supply withdrawals in Lake Lanier for Alt7B to 20 mgd (existing relocation contracts only) would make more water available for hydropower generation during the year, thus slightly increasing median daily flows in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. In comparison to the NAA, the changes in modeled flow conditions for Alt7B could have a slightly beneficial overall effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area, except under the most extreme drought conditions.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt7B would be nearly identical to NAA flows from June through December (Figure 6.1-31). From January through May, Alt7B flows would be slightly higher than NAA flows (ranging from zero to about 400 cfs higher). Daily flows

at the 90-percent exceedance level for Alt7B would be slightly higher than NAA flows in March–May (typically in the range of 0–500 cfs higher) and marginally lower than NAA flows over the balance of the year (Figure 6.1-33). The flow-duration curve for Whitesburg indicates that flows would be expected to exceed 1,044 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 643 cfs (686 for the NAA) (Figure 6.1-35).

Overall, Alt7B would likely have a slightly beneficial effect on flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake. Median daily flows and flows at the 90-percent exceedance level for Alt7B would be higher during the first half of the year, and flows at the 90-percent exceedance level in the second half of the year would be only marginally lower than for the NAA. The differences in flow conditions between Alt7B and the NAA at Whitesburg in the spring months at the 90-percent exceedance level would be affected by limiting Lake Lanier withdrawals to 20 mgd (making more water available for hydropower generation) and releases to support navigation from January through May. The flow conditions for Alt7B from July through December would be affected by the features of Water Management Alternative 7 aimed at conserving storage in Lake Lanier during extreme drought events and the reduced minimum flow criteria at Peachtree Creek from 750 cfs to 650 cfs between November and April.

6.1.1.2.2.5 Alternative 7H

For Alt7H, median daily flow conditions just below Buford Dam would closely match those for the NAA, except during the period from mid-February through March, when flows would be slightly lower and the month of June when Alt7H flows could be up to 400 cfs lower (Figure 6.1-19). Between July and mid-February, daily median flows for Atl7H and the NAA would consistently be about 1,450 cfs. Daily flows at the 90-percent exceedance level for Alt7H would be similar to those for the NAA, except that Alt7H flows would tend to be slightly higher than for the NAA in May–October (in the range of 100 cfs) and slightly lower in November and December (by 100–200 cfs) (Figure 6.1-21). For Alt7H, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 8 percent of the days over the period of record (the same as for the NAA), and daily flows would exceed 1,000 cfs on about 77 percent of the days (76 percent for the NAA) (Figure 6.1-23).

Overall, Alt7H would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA, because slightly higher flows would be likely during the summer and early fall months under extreme drought conditions. In comparison to the NAA, the following features of Alt7H would affect flow conditions downstream of Buford Dam: (1) updated reservoir operations at Buford Dam associated with Water Management Alternative 7; (2) increased water supply withdrawals from Lake Lanier; and (3) increased releases from Buford Dam to meet future downstream water withdrawal needs.

For Alt7H, median daily flows in the Chattahoochee River at Peachtree Creek would follow a seasonal pattern similar to that for the NAA throughout the year (Figure 6.1-25). However, Alt7H flows would likely be consistently lower than NAA flows throughout the year, with the differences typically about 100–300 cfs lower. Daily flows at the 90-percent exceedance level for Alt7H would be at 750 cfs from May through October (the same as for the NAA) (Figure 6.1-27). From November through April, Alt7H flows would likely be 650 cfs most of time, about 100 cfs lower than NAA flows. For a brief period from March through mid-April, Alt7H flows at the 90-percent exceedance level would increase to as high as 900 cfs, but would remain lower than NAA flows during that period. The primary reason for the lower Alt7H flows would be the change in the prescribed minimum flow at Peachtree Creek included in Water Management Alternative 7 from 750 to 650 cfs during November–April. Daily minimum flows of 650 cfs would occur on about 8 percent of the days over the period of record, and minimum flows of 750 cfs

would occur about 18 percent of the time. Thus, about 26 percent of the time flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 68 percent of the days (76 percent for the NAA) (Figure 6.1-29).

Alt7H would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. That effect would be the result principally of lower median daily flow values throughout the year and slightly lower flows at the 90-percent exceedance level from October through April. These results are due to revisions to water management measures included in Water Management Alternative 7, principally seasonal minimum flows at Peachtree Creek. In addition, the substantially larger water withdrawals from Lake Lanier and the formerly proposed Glades Reservoir in Alt7H compared to the NAA, coupled with water management measures in Water Management Alternative 7, also affect releases from Buford Dam. Increased releases from Buford Dam under Alt7H to meet future downstream water supply needs would be offset in this reach of the river by increased withdrawals by Metro Atlanta water suppliers. A substantial portion of the treated wastewater return flows would occur downstream of Peachtree Creek. In comparison to the NAA, the changes in modeled flow conditions for Alt7H could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt7H would be nearly identical to NAA flows throughout the year (Figure 6.1-31), except for mid-April–May when Alt7H flows would be marginally higher than NAA flows and November–December when Alt7H flows would be marginally lower than for the NAA. Daily flows at the 90-percent exceedance level for Alt7H would be slightly higher than NAA flows in April and May (typically in the range of 0–200 cfs higher) and marginally lower than NAA flows over the balance of the year (Figure 6.1-33). The flow-duration curve for Whitesburg indicates that flows would be expected to exceed 1,175 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 787 cfs (686 for the NAA) (Figure 6.1-35).

Overall, Alt7H would result in no appreciable change to flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake compared to the NAA. The marginal increase in Alt7H flows compared to the NAA at Whitesburg in the spring is the result of revised water management measures in Water Management Alternative 7, including increased releases, as needed, to support downstream navigation from January through May. Compared to the NAA, slightly lower flows in November–February for Alt7H at the 90-percent exceedance level would result from Water Management Alternative 7 features to conserve storage in Lake Lanier during extreme droughts, revised minimum flow criteria at Peachtree Creek (November–April), and substantially increased withdrawals between Buford Dam and Peachtree Creek (408 mgd).

6.1.1.2.2.6 Alternative 7I

For Alt7I, median daily flow conditions just below Buford Dam would closely match those for the NAA, except during the period from mid-March through mid-April when flows would be slightly lower than the NAA and the month of June when Alt7I flows could intermittently be up to 400 cfs lower (Figure 6.1-20). Between July and mid-February, median daily flows for Atl7I and the NAA would consistently be about 1,450 cfs except for early January when NAA flows could be intermittently higher (by up to 400 cfs) than the Alt7I. Daily flows at the 90-percent exceedance level for Alt7I would be similar to those for the NAA, except that Alt7I flows would tend to be slightly higher than NAA flows in May–October (in the range of 100–200 cfs) and slightly lower in November and December (ranging up to 200 cfs lower) (Figure 6.1-22). For Alt7I, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the

minimum level of 600 cfs would occur on about 8 percent of the days over the period of record (the same as for the NAA), and daily flows would exceed 1,000 cfs on about 76 percent of the days (the same as for the NAA) (Figure 6.1-24). Flow conditions below Buford Dam throughout the year would be nearly the same for Alt7I as for Alt7H.

Overall, Alt7I would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA. Median daily flows would not change appreciably, and slightly higher flows would be likely during the summer and early fall months under extreme drought conditions. In comparison to the NAA, the following features of Alt7I would affect flow conditions downstream of Buford Dam: (1) updated reservoir operations at Buford Dam associated with Water Management Alternative 7; (2) increased water supply withdrawals from Lake Lanier; and (3) increased releases from Buford Dam to meet future downstream water withdrawal needs. Model results for flows below Buford Dam for Alt7I are nearly the same as for Alt7H despite different water withdrawal rates in Lake Lanier. Therefore, the differences in withdrawals in Lake Lanier between these alternatives have little incremental effect on streamflow conditions below Buford Dam.

In the Chattahoochee River at Peachtree Creek, median daily flows (Figure 6.1-26) and flows at the 90-percent exceedance level (Figure 6.1-28) for Alt7I would be nearly identical to those described for Alt7H in comparison to the NAA. Daily minimum flows of 650 cfs would occur on about 8 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 18 percent of the time. Thus, about 26 percent of the time flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 69 percent of the days (76 percent for the NAA) (Figure 6.1-30).

Alt7I would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. That effect would be the result principally of lower median daily flow values throughout the year and slightly lower flows at the 90-percent exceedance level from October through April. These results are due to revisions to water management measures included in Water Management Alternative 7, principally seasonal minimum flows at Peachtree Creek. In addition, the substantially larger water withdrawals from Lake Lanier compared to the NAA, coupled with water management measures in Water Management Alternative 7, also could affect releases from Buford Dam. Increased releases from Buford Dam under Alt7I to meet future downstream water supply needs would be offset in this reach of the river by increased withdrawals by Metro Atlanta water suppliers. A substantial portion of the treated wastewater return flows would occur downstream of Peachtree Creek. In comparison to the NAA, the changes in modeled flow conditions for Alt7I could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt7I would be nearly identical to NAA flows throughout the year (Figure 6.1-32). Daily flows at the 90-percent exceedance level for Alt7I would be marginally higher than NAA flows in April and May and marginally lower than NAA flows from November through January (Figure 6.1-34). The flow-duration curve for Whitesburg (Figure 6.1-36) indicates that flows would be expected to exceed 1,141 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 749 cfs (686 for the NAA).

Overall, Alt7I would result in no appreciable change to flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake compared to the NAA. The factors responsible for slight deviations from the NAA in this reach of the river would be the same as those presented for Alt7H.

6.1.1.2.2.7 Alternative 7J

For Alt7J, median daily flows just below Buford Dam would likely be up to about 400 cfs higher than for the NAA from mid-December through mid-April, intermittently higher (from zero to 1,000 cfs) in May, and about 40 cfs higher from mid-May through mid-June (Figure 6.1-20). Daily flows at the 90-percent exceedance level for Alt7J would be similar to NAA flows (about 600 cfs) from January through March, higher than the NAA from April through October (ranging from zero to about 200 cfs), and slightly lower in November and December (from zero to 200 cfs lower) (Figure 6.1-22). For Alt7J, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 6 percent of the days over the period of record (8 percent for the NAA), and daily flows would exceed 1,000 cfs on about 81 percent of the days (76 percent for the NAA) (Figure 6.1-24).

Overall, Alt7J would have a beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA. Median daily flows and flows at the 90-percent exceedance level (representing extreme drought conditions) would be slightly higher over a substantial portion of the year. In comparison to the NAA, the following features of Alt7J would affect flow conditions downstream of Buford Dam: (1) updated reservoir operations at Buford Dam associated with Water Management Alternative 7; (2) increased water supply withdrawals from Lake Lanier; and (3) increased releases from Buford Dam to meet future downstream water withdrawal needs. Model results for flows below Buford Dam for Alt7J are higher than for Alt7I and Alt7H. Releases from the dam would increase if water withdrawal rates in Lake Lanier were limited to that currently authorized (20 mgd, existing relocation contracts only) compared to Lake Lanier withdrawal rates that would accommodate all or most future demands (e.g., Alt7I and Alt7H). The substantial difference between withdrawal rates for these alternatives does have a noteworthy effect on streamflow conditions below Buford Dam.

In the Chattahoochee River at Peachtree Creek, median daily flows (Figure 6.1-26) and flows at the 90-percent exceedance level (Figure 6.1-28) for Alt7J would be nearly the same as those described for Alt7B in comparison to the NAA, except that median daily flows would be marginally higher than Alt7B throughout the year. Daily minimum flows of 650 cfs would occur on about 6 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 15 percent of the time. Thus, about 21 percent of the time, flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 74 percent of the days (76 percent for the NAA) (Figure 6.1-30).

Alt7J would likely have a slightly beneficial effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. That effect would be the result principally of slightly higher median daily flow values throughout the year and slightly higher flows in March and April at the 90-percent exceedance level than for the NAA. These results are due to revisions to water management measures included in Water Management Alternative 7. Limiting water supply withdrawals in Lake Lanier for Alt7J to 20 mgd (existing relocation contracts only) would make more water available for hydropower generation over the year, thus slightly increasing median daily flows in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. In addition, more water would be released from Buford Dam under Alt7J to meet future downstream water supply withdrawals needs (379 mgd versus 277 mgd for the NAA), but much of those additional releases would be offset in the reach between Morgan Falls Dam and Peachtree Creek by the increased withdrawals that would occur. In comparison to the NAA, the changes in modeled flow conditions for Alt7J could have a slightly beneficial overall effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area, except under the most extreme drought conditions.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt7J would parallel NAA flows throughout the year (Figure 6.1-32). The flows would be slightly higher than NAA flows from January through May and closely match NAA flows for the balance of the year. Daily flows at the 90-percent exceedance level for Alt7J would be slightly higher than NAA flows from January through October and slightly lower than NAA flows in November and December (Figure 6.1-34). The flow-duration curve for Whitesburg (Figure 6.1-36) indicates that flows would be expected to exceed 1,164 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 750 cfs (686 for the NAA).

Overall, Alt7J would likely have a slightly beneficial effect on flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake compared to the NAA. Slightly improved flow conditions at Whitesburg for Alt7J compared to the NAA would be attributable to: (1) water supply withdrawals from Lake Lanier limited to existing relocation contracts (20 mgd), which would make more water available for release via hydropower generation; (2) releases to accommodate greater future downstream water supply demand (379 mgd) with a higher return ratio to the river; and (3) releases to support downstream navigation from January through May when sufficient water is available.

6.1.1.2.2.8 Alternative 7K (PAA)

For the PAA, median daily flow conditions just below Buford Dam would closely match the NAA, except during the period from mid-March through mid-April when flows would be slightly higher than the NAA and in the month of June when PAA flows could be up to 400 cfs higher (Figure 6.1-20). Between July and mid-February, median daily flows for the PAA and the NAA would consistently be about 1,450 cfs, except for early January when PAA flows would intermittently be up to 400 cfs higher than the NAA. Daily flows at the 90-percent exceedance level for the PAA would be similar to those for the NAA, except that PAA flows would tend to be slightly higher than the NAA in May–October (in the range of 100–200 cfs) and slightly lower in November and December (ranging up to 200 cfs lower) (Figure 6.1-22). For the PAA, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 8 percent of the days over the period of record (the same as for the NAA), and daily flows would exceed 1,000 cfs on about 76 percent of the days (the same as for the NAA) (Figure 6.1-24). Flow conditions below Buford Dam throughout the year would be nearly the same for the PAA, Alt7I, and Alt7H.

Overall, the PAA would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA. Median daily flows would not change appreciably, and slightly higher flows would be likely during the summer and early fall months under extreme drought conditions. In comparison to the NAA, the following features of the PAA would affect flow conditions downstream of Buford Dam: (1) updated reservoir operations at Buford Dam associated with Water Management Alternative 7; (2) increased water supply withdrawals from Lake Lanier; and (3) increased releases from Buford Dam to meet future downstream water withdrawal needs. Model results for flows below Buford Dam for the PAA are nearly the same as for Alt7I and Alt7H despite varying water withdrawal rates in Lake Lanier. Therefore, the differences in withdrawals in Lake Lanier among these alternatives have little incremental effect on streamflow conditions below Buford Dam.

In the Chattahoochee River at Peachtree Creek, median daily flows for the PAA (Figure 6.1-26) would follow a similar seasonal pattern to the NAA throughout the year. However, PAA flows would likely be consistently lower than NAA flows throughout the year, with the differences typically about 100–300 cfs lower. Daily flows at the 90-percent exceedance level for the PAA (Figure 6.1-28) would be at 750 cfs from May through October (same as for the NAA). From November through April, PAA flows would likely be 650 cfs most of time, about 100 cfs lower than NAA flows. For a brief period from March through mid-April, PAA flows at the 90-percent exceedance level would increase to as high as 900 cfs,

but would remain lower than NAA flows during that period. The primary reason for the lower PAA flows would be the change in the prescribed minimum flow at Peachtree Creek included in Water Management Alternative 7 from 750 to 650 cfs during November–April. Daily minimum flows of 650 cfs would occur on about 8 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 18 percent of the time. Thus, about 26 percent of the time, flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 69 percent of the days (76 percent for the NAA) (Figure 6.1-30). Flow conditions at Peachtree Creek throughout the year would be nearly the same for the PAA as for Alt7I and Alt7H.

The PAA would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. That effect would be the result principally of lower median daily flow values throughout the year and slightly lower flows at the 90-percent exceedance level from October through April. These results are due to revisions to water management measures included in Water Management Alternative 7, principally seasonal minimum flows at Peachtree Creek. In addition, the substantially larger water withdrawals from Lake Lanier under the PAA compared to the NAA, coupled with water management measures in Water Management Alternative 7, also could affect releases from Buford Dam. Increased releases from Buford Dam under the PAA to meet future downstream water supply needs would be offset in this reach of the river by increased withdrawals by Metro Atlanta water suppliers, and a substantial portion of the treated wastewater return flows occur downstream of Peachtree Creek. In comparison to the NAA, the changes in modeled flow conditions for the PAA could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

For the PAA, median daily flows in the Chattahoochee River at Whitesburg, Georgia, would be nearly identical to NAA flows throughout the year (Figure 6.1-32). Daily flows at the 90-percent exceedance level for the PAA would be marginally higher than NAA flows in April and May and marginally lower than NAA flows from November through January (Figure 6.1-34). The flow-duration curve for Whitesburg (Figure 6.1-36) indicates that flows would be expected to exceed 1,143 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 749 cfs (686 for the NAA).

Overall, the PAA would result in no appreciable change to flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake compared to the NAA. The factors responsible for slight deviations from the NAA in this reach of the river would be the same as those presented for Alt7H.

6.1.1.2.2.9 Alternative 7L

For Alt7L, median daily flow conditions just below Buford Dam would be nearly identical to those described for the PAA in comparion to the NAA, except that flows would be about 400 cfs higher than PAA flows for a slightly longer portion of February and slightly higher than PAA flows from mid-March through mid-April (Figure 6.1-20). Daily flows at the 90-percent exceedance level for Alt7L would be nearly the same as those described for the PAA as compared to the the NAA, except that Alt7L flows would tend to be marginally higher than PAA flows between May and November (Figure 6.1-22). For Alt7L, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 7 percent of the days over the period of record (8 percent for the NAA), and daily flows would exceed 1,000 cfs on about 78 percent of the days (76 percent for the NAA) (Figure 6.1-24). Flow conditions below Buford Dam for Alt7L throughout the year would be marginally higher than the PAA, Alt7I, and Alt7H.

Overall, Alt7L would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA. Median daily flows would not appreciably change and slightly higher flows would be likely during the summer and early fall months under extreme drought conditions. In comparison to the NAA, the features of Alt7L that affect flow conditions downstream of Buford Dam are the same as described for the PAA. Model results for flows below Buford Dam for Alt7L are similar to those for the PAA and Alt7I, despite varying water withdrawal rates in Lake Lanier. The Lake Lanier withdrawal rate for Alt7L (128 mgd, equal to current withdrawals) is substantially lower than the assumed rates for the PAA or Alt7I (242 mgd and 225 mgd, respectively). The differences in Lake Lanier withdrawals between Alt7L and the PAA and Alt7I would have only a marginal incremental effect on streamflow conditions below Buford Dam.

In the Chattahoochee River at Peachtree Creek, median daily flows (Figure 6.1-26) and flows at the 90-percent exceedance level (Figure 6.1-28) for Alt7M would be nearly the same as those described for the PAA in comparison to the NAA, except that median daily flows for Alt7L would be marginally higher throughout the year. Daily minimum flows of 650 cfs would occur on about 7 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 19 percent of the time. Thus, about 26 percent of the time flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 71 percent of the days (76 percent for the NAA) (Figure 6.1-30). Flow conditions at Peachtree Creek throughout the year for Alt7L would be nearly the same as those for the PAA, Alt7I, and Alt7H.

Alt7L would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. That effect would be the result principally of lower median daily flow values throughout the year and slightly lower flows at the 90-percent exceedance level from October through April. These results are caused principally by revised water management measures included in Water Management Alternative 7 since Lake Lanier withdrawals would be the same for Alt7L and for the NAA. Increased releases from Buford Dam under Alt7L to meet future downstream water supply needs would be offset in this reach of the river by increased withdrawals by Metro Atlanta water suppliers. A substantial portion of the treated wastewater return flows occur downstream of Peachtree Creek. In comparison to the NAA, the changes in modeled flow conditions for Alt7L could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

For Alt7L, median daily flows in the Chattahoochee River at Whitesburg, Georgia, would be nearly identical to NAA flows throughout the year (Figure 6.1-32). Daily flows at the 90-percent exceedance level for Alt7L would be marginally higher than NAA flows in April and May and marginally lower than NAA flows from November through January (Figure 6.1-34). The flow-duration curve for Whitesburg indicates that flows would be expected to exceed 1,149 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 749 cfs (686 for the NAA) (Figure 6.1-36).

Overall, Alt7L would result in no appreciable change to flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake compared to the NAA. The factors responsible for slight deviations from the NAA in this reach of the river would be the same as those presented for Alt7H.

6.1.1.2.2.10 Alternative 7M

For Alt7M, median daily flow conditions just below Buford Dam would be nearly identical to those described for the PAA in comparion to the NAA, except that flows would be about 400 cfs higher than PAA flows for a slightly longer portion of February and slightly higher than PAA flows from mid-March through mid-April (Figure 6.1-20). Daily flows at the 90-percent exceedance level for Alt7M would be nearly the same as those described for the PAA as compared to the NAA, except that Alt7M flows would

tend to be marginally higher than PAA flows between May and November (Figure 6.1-22). For Alt7M, releases at Buford Dam would equal or exceed 600 cfs continuously. Flows at the minimum level of 600 cfs would occur on about 8 percent of the days over the period of record (the same as for the NAA), and daily flows would exceed 1,000 cfs on about 77 percent of the days (76 percent for the NAA) (Figure 6.1-24). Flow conditions below Buford Dam throughout the year would be nearly the same for Alt7M as for the PAA and Alt7I.

Overall, Alt7M would have a slightly beneficial effect on flow conditions between Buford Dam and Bull Sluice Lake compared to the NAA. Median daily flows would not change appreciably and slightly higher flows would be likely during the summer and early fall months under extreme drought conditions. In comparison to the NAA, the features of Alt7M that affect flow conditions downstream of Buford Dam are the same as described for the PAA. Model results for flows below Buford Dam for Alt7M are nearly the same as for the PAA and Alt7I despite varying water withdrawal rates for Lake Lanier (185 mgd, 242 mgd, and 225 mgd, respectively). Therefore, the differences in withdrawals from Lake Lanier among these alternatives have little incremental effect on streamflow conditions below Buford Dam.

In the Chattahoochee River at Peachtree Creek, median daily flows (Figure 6.1-26) and flows at the 90-percent exceedance level (Figure 6.1-28) for Alt7M would be nearly identical to those described for the PAA in comparison to the NAA. Daily minimum flows of 650 cfs would occur on about 7 percent of the days over the period of record, and minimum flows of 750 cfs would occur about 18 percent of the time. Thus, about 25 percent of the time flows would equal the seasonal minimum flow level (compared to 19 percent of the time at the 750 cfs minimum flow level for the NAA). Daily flows would exceed 1,000 cfs on about 70 percent of the days (76 percent for the NAA) (Figure 6.1-30). Flow conditions at Peachtree Creek throughout the year would be nearly the same for Alt7M as for the PAA and Alt7I.

Alt7M would likely have a slightly adverse effect on flow conditions in the Chattahoochee River between Morgan Falls Dam and Peachtree Creek compared to the NAA. That effect would be the result principally of lower median daily flow values throughout the year and slightly lower flows at the 90-percent exceedance level from October through April. These results are due to revisions to water management measures included in Water Management Alternative 7, principally seasonal minimum flows at Peachtree Creek. In addition, the substantially larger water withdrawals from Lake Lanier in Alt7M, coupled with water management measures in Water Management Alternative 7, also could affect releases from Buford Dam compared to the NAA. Increased releases from Buford Dam under Alt7M to meet future downstream water supply needs would be offset in this reach of the river by increased withdrawals by Metro Atlanta water suppliers. A substantial portion of the treated wastewater return flows occur downstream of Peachtree Creek. In comparison to the NAA, the changes in modeled flow conditions for Alt7M could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

Median daily flows in the Chattahoochee River at Whitesburg, Georgia, for Alt7M would be nearly identical to NAA flows throughout the year (Figure 6.1-32). Daily flows at the 90-percent exceedance level for Alt7M would be marginally higher than NAA flows in April and May and marginally lower than NAA flows from November through January (Figure 6.1-34). The flow-duration curve for Whitesburg (Figure 6.1-36) indicates that flows would be expected to exceed 1,145 cfs on 99 percent of the days over the period of record (1,031 cfs for the NAA), and the lowest modeled flow expected over the period of record would be 749 cfs (686 for the NAA).

Overall, Alt7M would result in no appreciable change to flow conditions in the Chattahoochee River from Peachtree Creek to West Point Lake compared to the NAA. The factors responsible for any slight deviations from the NAA in this reach of the river would be the same as those presented for Alt7H.

6.1.1.2.3 West Point Dam to Walter F. George Lake

Figure 6.1-37 through Figure 6.1-46 present model outputs for flow conditions at two locations in the Chattahoochee River between West Point Dam and Walter F. George Lake: downstream of West Point Dam and at Columbus, Georgia. Flow conditions at those locations are considered representative of conditions that would occur within that reach of the Chattahoochee River. Flows conditions were examined to assess changes that would be expected under the water management alternatives/water supply options considered in detail for the ACF Basin under Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M compared to the NAA. The figures present model results for median daily flows, daily flows at the 90-percent exceedance level, and flow duration. In consideration of the number of alternatives and the ease of viewing the information about each alternative, the results for each parameter (e.g., magnitude of flow conditions) are presented in two figures with half of the alternatives presented on each figure. Using the results from the figures and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

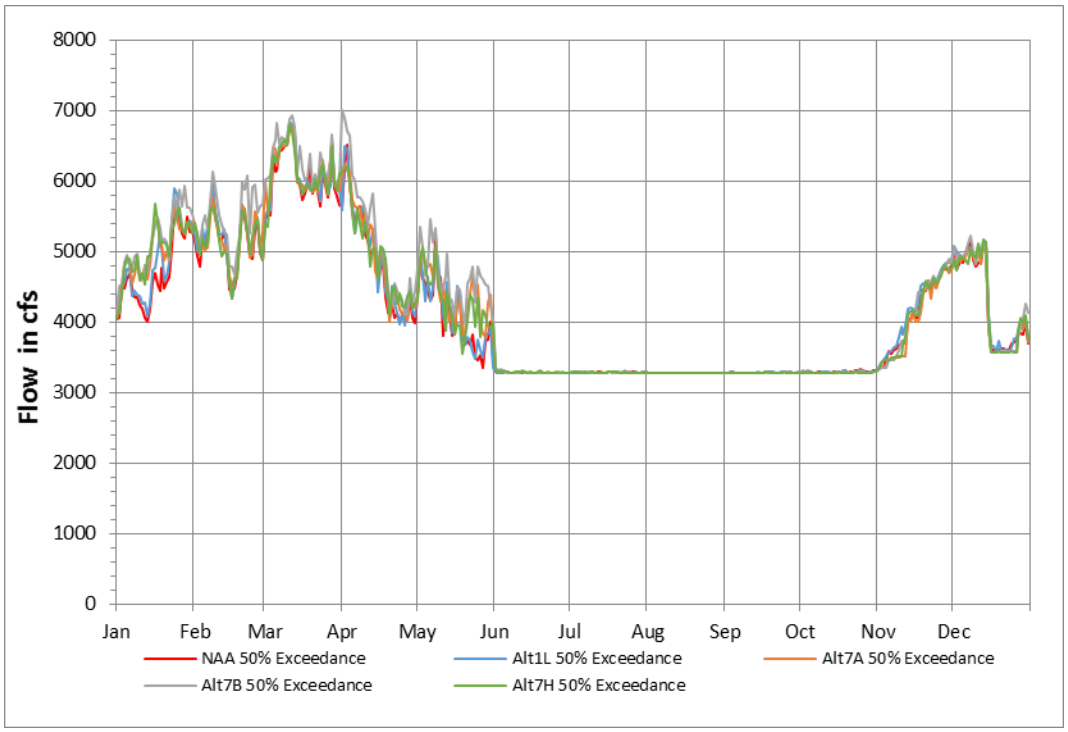


Figure 6.1-37. Chattahoochee River Median Daily Flows below West Point Dam, GA, (RM 201.4) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

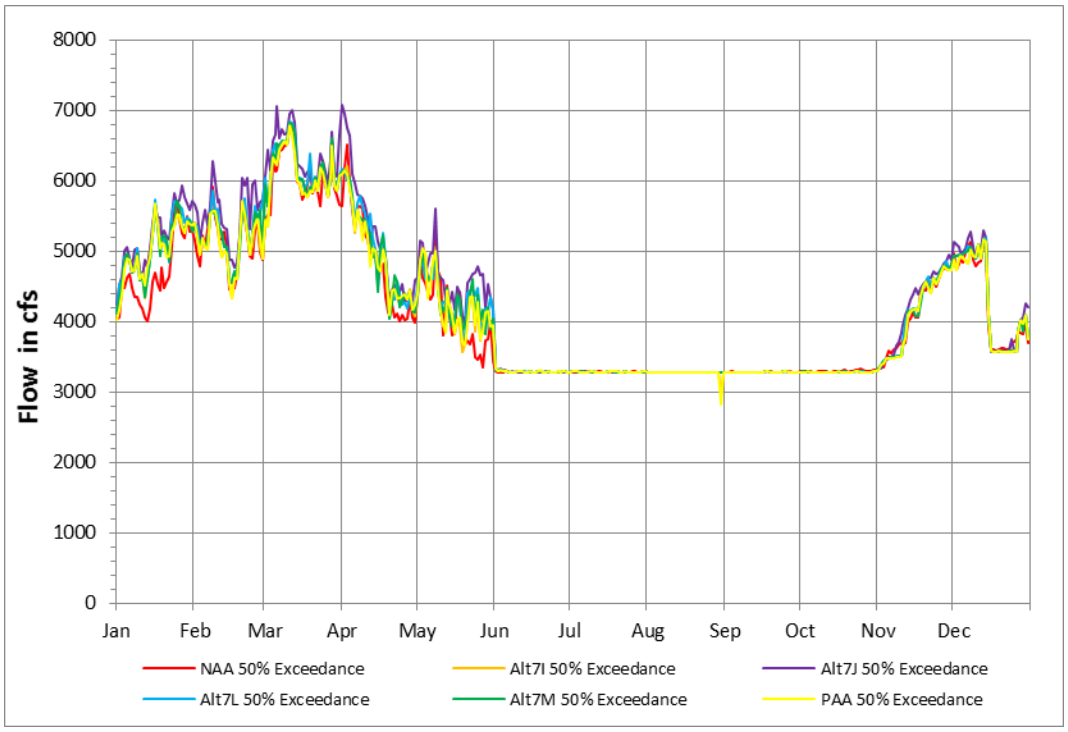


Figure 6.1-38. Chattahoochee River Median Daily Flows below West Point Dam, GA, (RM 201.4) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

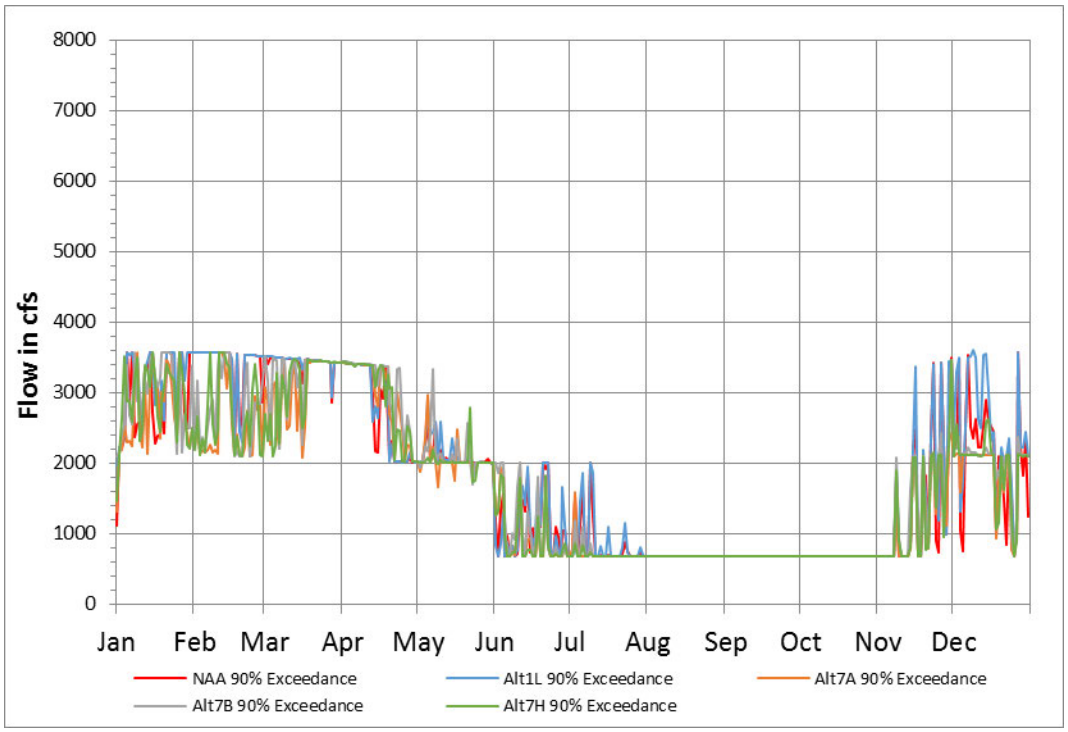


Figure 6.1-39. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level below West Point Dam, GA, (RM 201.4) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

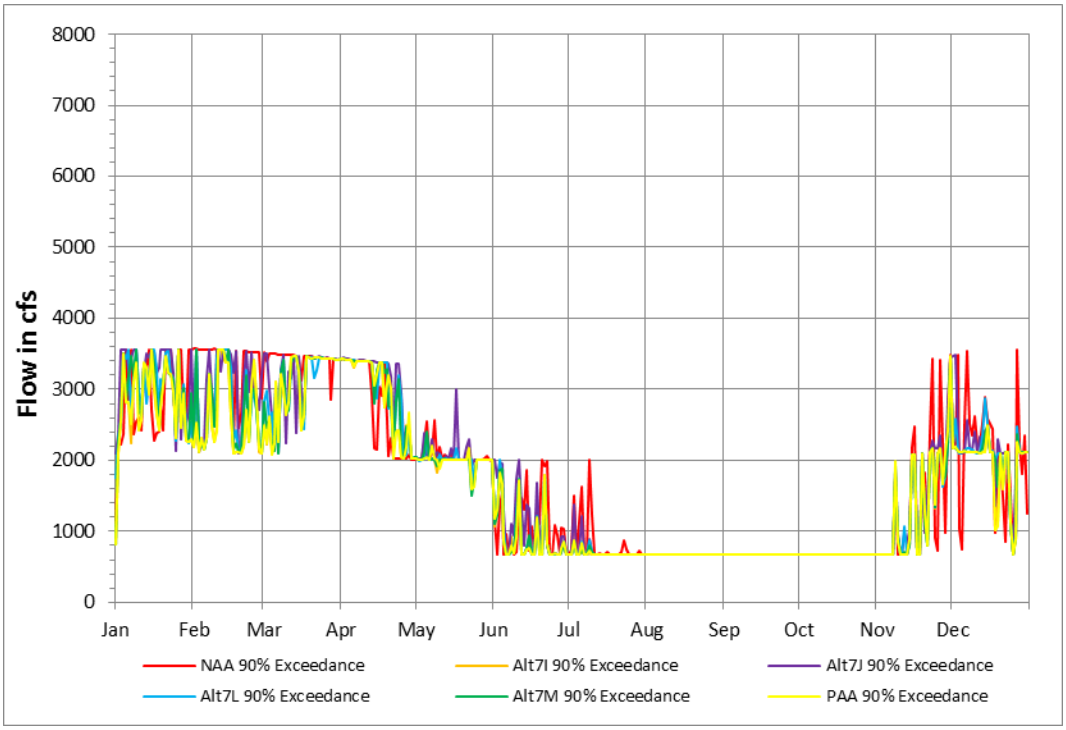


Figure 6.1-40. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level below West Point Dam, GA, (RM 201.4) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

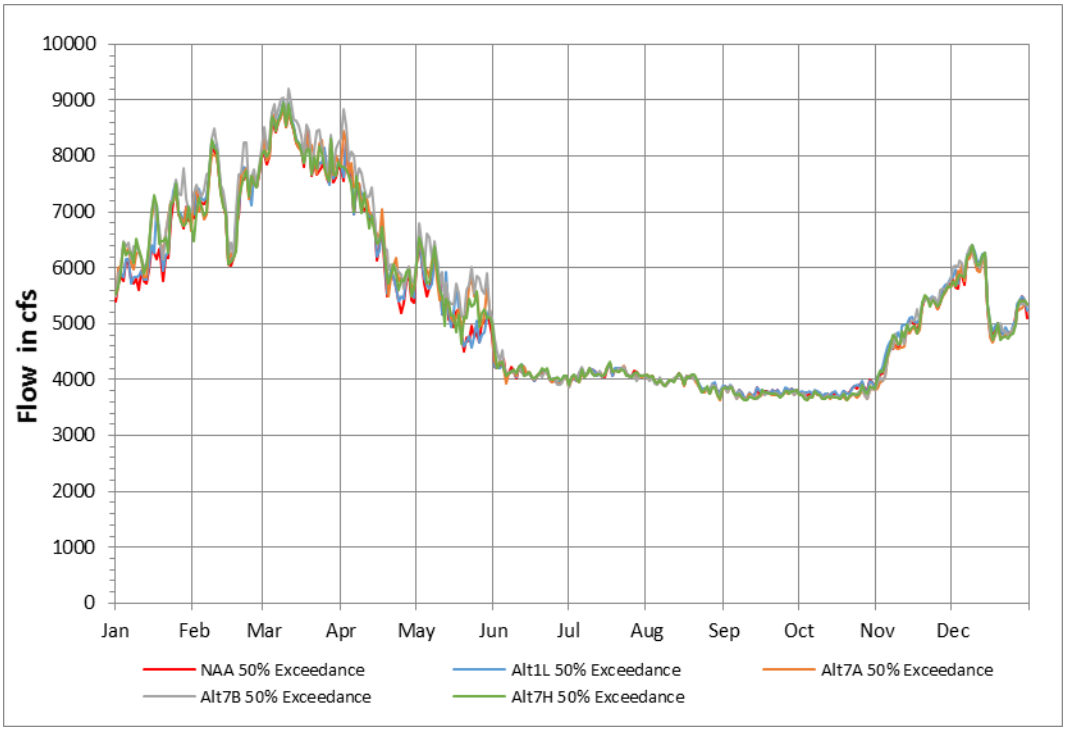


Figure 6.1-41. Chattahoochee River Median Daily Flows at Columbus, GA, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

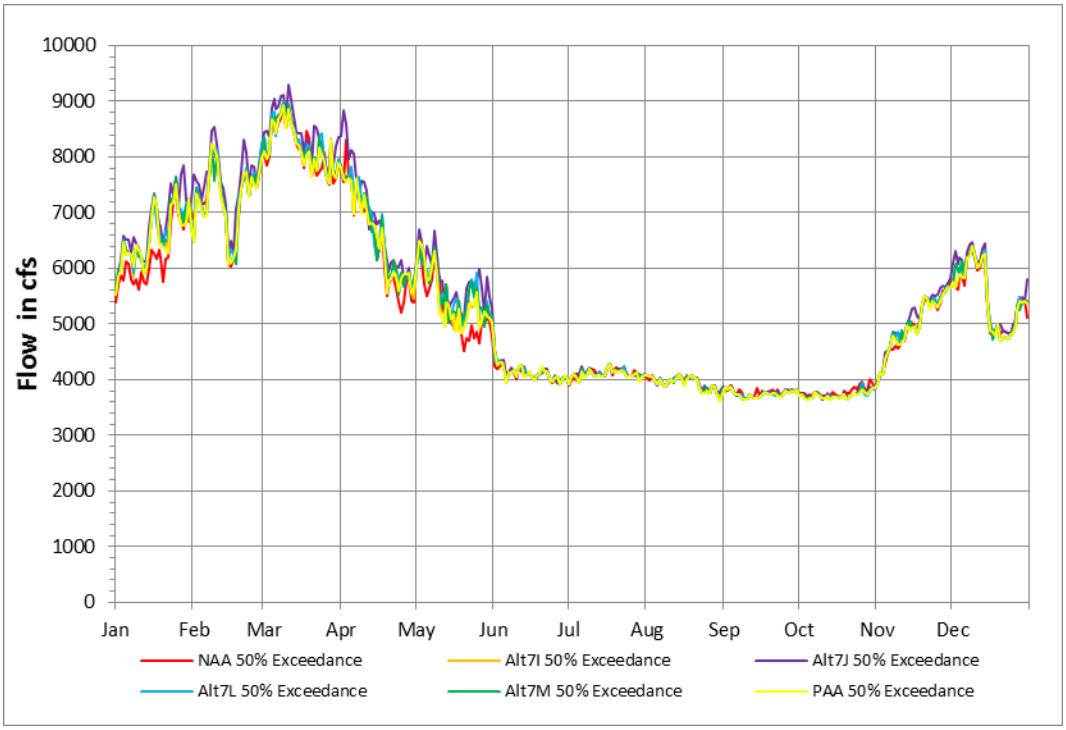


Figure 6.1-42. Chattahoochee River Median Daily Flows at Columbus, GA, for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

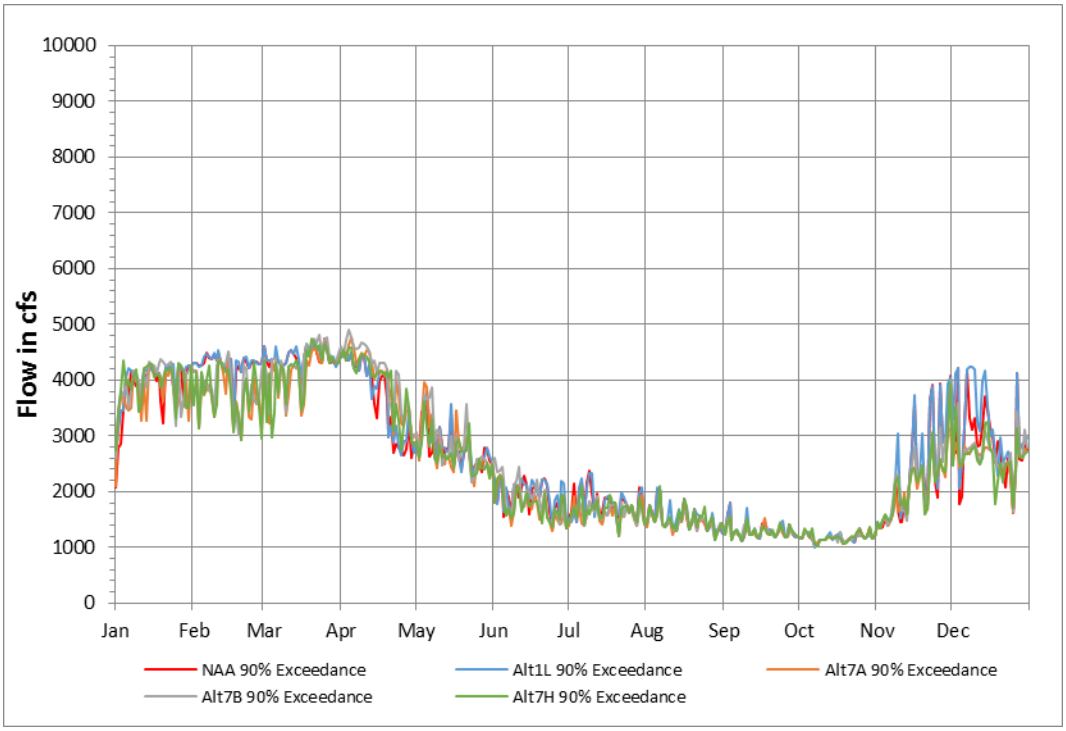


Figure 6.1-43. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level at Columbus, GA, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

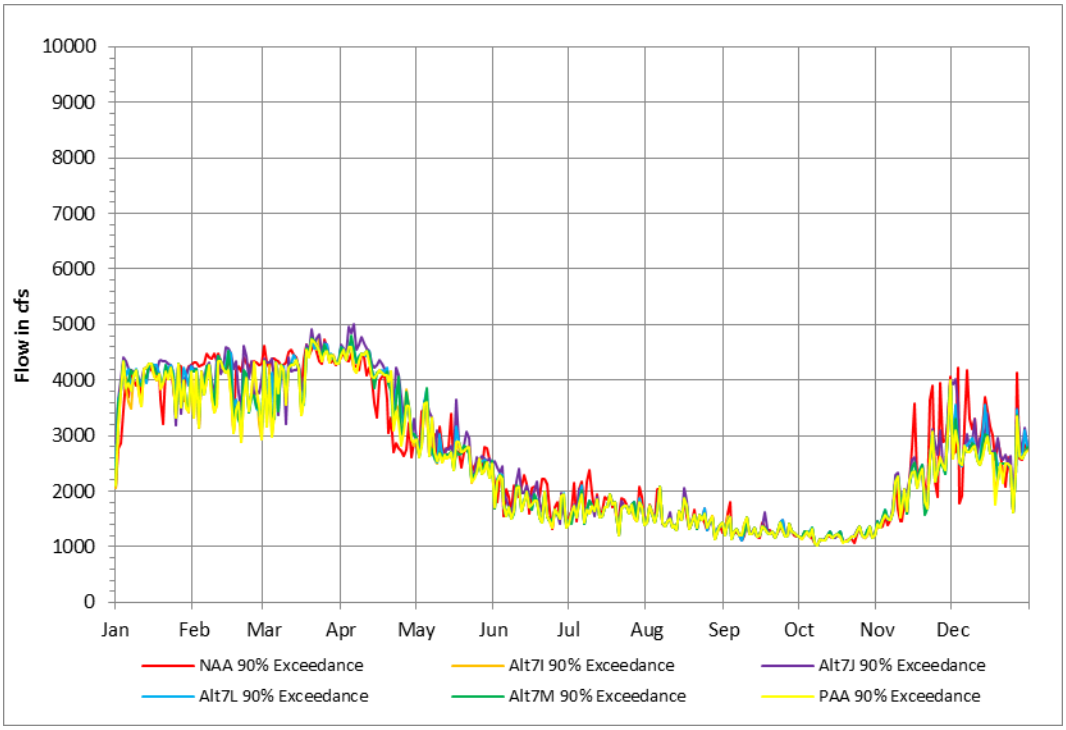


Figure 6.1-44. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level at Columbus, GA, for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

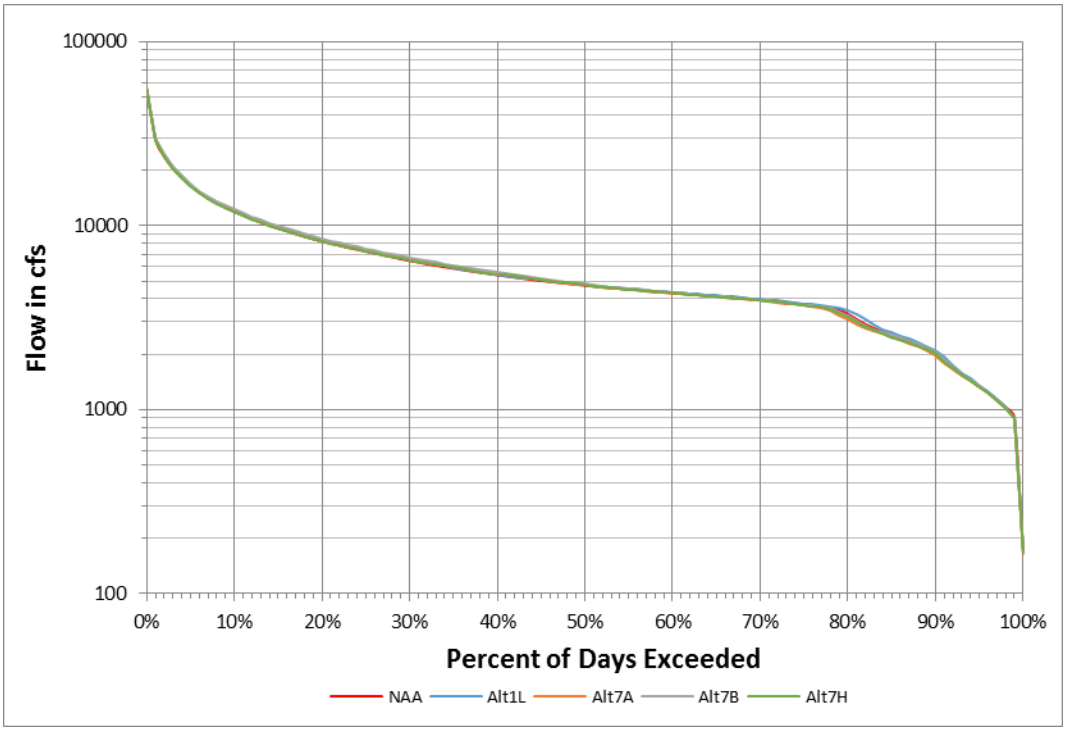


Figure 6.1-45. Chattahoochee River Flows at Columbus, GA, Percent of Days Exceeded for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

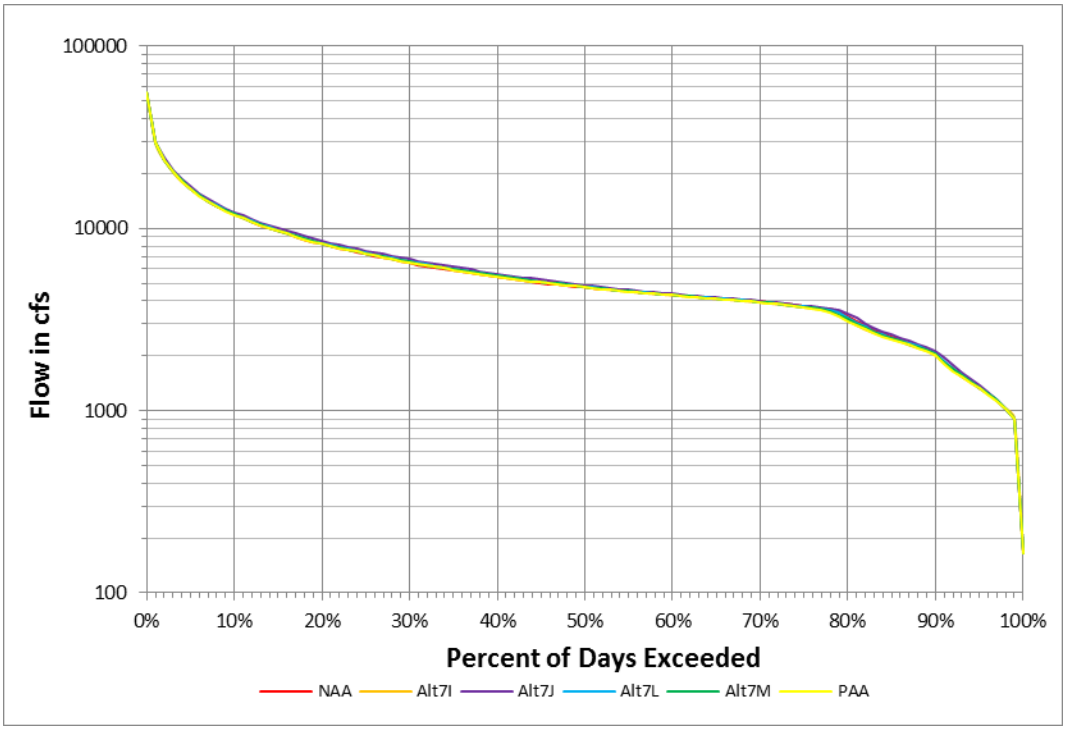


Figure 6.1-46. Chattahoochee River Flows at Columbus, GA, Percent of Days Exceeded for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and PAA.

6.1.1.2.3.1 No Action Alternative

Under the NAA, West Point Dam would continuously release a minimum flow of 675 cfs. Median daily flows downstream of West Point Dam from June through November would consistently be about 3,300 cfs. From December through May, median daily flows would vary from about 3,600 cfs in December up to about 6,900 cfs in March (Figure 6.1-37). Daily flows at the 90-percent exceedance level below West Point Dam (indicative of drought conditions) would typically be at the minimum flow of 675 cfs from July through early November and generally vary between about 2,000 and 3,500 cfs through the balance of the year (Figure 6.1-39). Daily minimum flows of 675 cfs would occur no more than about 10 percent of the days over the period of record.

At Columbus, median daily flows under the NAA would follow a seasonal pattern similar to flows downstream of West Point Dam but of larger magnitude (Figure 6.1-41). The median daily flows would be steady from June through October, ranging from slightly above to slightly below 4,000 cfs. From November through May, median daily flows would vary from about 5,000 cfs in December up to a peak at about 9,000 cfs in March. At the 90-percent exceedance level (reflecting extreme drought conditions), daily flows at Columbus would range between about 1,000 and 2,000 cfs from June through mid-November and between 2,000 and 4,600 cfs during the balance of the year (Figure 6.1-43). Based on a review of HEC-ResSim model outputs over the modeled period of record, the daily average flows would be expected to equal or exceed the established daily average FERC minimum flow target of 1,350 cfs on 94.9 percent of the days over the modeled period of record (Figure 6.1-45). Instances of daily flows below 1,350 cfs would generally be attributable to low BIs that cannot support the FERC flow target (see section 6.1.1.2.1). These instances could occur at any time during the year, depending on hydrologic conditions in the basin, but they would most likely occur for brief periods in the summer or early fall. GPC's ability to meet the FERC flow target at Columbus with releases from the North Highlands Dam is somewhat

dependent upon operations at West Point Dam. Therefore, close coordination of USACE and GPC operations on the Chattahoochee River is required, particularly during periods of low BI.

6.1.1.2.3.2 Alternative 1L

Immediately downstream of West Point Dam, median daily flows under Alt1L would closely match those for the NAA, except that they would be marginally and intermittently higher from January through May (Figure 6.1-37). Daily flows at the 90-percent exceedance level for Alt1L would also closely match those for the NAA, except for intermittent instances January–July and November–December, when Alt1L flows would be slightly higher, with rare instances when the daily flows for Alt1L would be lower than NAA flows (Figure 6.1-39). For Alt1L, daily minimum flows of 675 cfs would occur on no more than 9 percent of the days over the period of record (10 percent for the NAA).

For Alt1L, median daily flows at Columbus would closely match those for the NAA, except that Alt1L flows would be slightly higher than the NAA flows December–May (from zero to 600 cfs) (Figure 6.1-41). Daily flows at the 90-percent exceedance level for Alt1L would be nearly the same as those for the NAA (Figure 6.1-43). HEC-ResSim model outputs indicate that daily flows for Alt1L would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 95.0 percent of the days over the modeled period of record compared to 94.9 percent for the NAA (Figure 6.1-45).

Alt1L would result in no appreciable change in flow conditions between West Point Dam and Walter F. George Lake compared to the NAA. Both Alt1L and the NAA assume current water management practices for the USACE ACF Basin reservoirs and gross withdrawals from Lake Lanier to be at current levels (128 mgd). Therefore, the minimal deviations between daily flows below West Point Dam and Columbus for Alt1L and the NAA at those locations would be attributable to differences in the assumed gross water supply withdrawals downstream of Buford Dam and the ratio of water returned to water withdrawn in that reach of the river. Alt1L assumes gross withdrawals of 379 mgd (projected 2050 need) with a 95-percent return ratio, and the NAA assumes gross withdrawals of 277 mgd (current) with an 82-percent return ratio.

6.1.1.2.3.3 Alternative 7A

Downstream of West Point Dam, median daily flows under Alt7A would be equivalent to the NAA June–December (Figure 6.1-37). From January through May, the flow values for Alt7A would follow a pattern similar to that for the NAA but would tend to range slightly higher than NAA values in January and May (ranging from 100 to about 800 cfs). Daily flows at the 90-percent exceedance level for Alt7A would be nearly equivalent to the NAA from May through November, and they would tend to be intermittently lower than NAA flows by variable amounts from December through mid-March and from mid-June through mid-July (Figure 6.1-39). From mid-April through mid-June, flows for Alt7A would be intermittently higher than for the NAA. However, at the 90-percent exceedance level, these variations do not represent appreciable departures from modeled flows for the NAA. For Alt7A, daily minimum flows equaling but not exceeding 675 cfs would occur on the same percent of the days over the period of record as for the NAA (10 percent).

For Alt7A, median daily flows at Columbus would be nearly equivalent to NAA flows in all months, except that Alt7A flows would be slightly higher in the months of January and April–May (Figure 6.1-41). At the 90-percent exceedance level, daily flows under Alt7A would be nearly equivalent to those under the NAA from June through November, with some instances of slightly lower flows for Alt7A. From December through March, Alt7A flows would be lower than NAA flows, ranging from minimal amounts up to as much as 1,000 cfs intermittently. In April and May, Alt7A flows would be slightly higher than for the NAA (Figure 6.1-43). Again, at the 90-percent exceedance level, these variations do not represent appreciable departures from modeled flows for the NAA. HEC-ResSim model outputs

indicate that daily flows would be expected to equal or exceed the FERC daily average target flow of 1,350 cfs on 94.8 percent of the days over the modeled period of record (versus 94.9 percent for the NAA) (Figure 6.1-45).

Overall, Alt7A would result in no appreciable change over the range of possible flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations experienced principally at the 90-percent exceedance level would be attributable to updates to systemwide water management practices in Water Management Alternative 7, because the upstream water supply withdrawal and return assumptions for Metro Atlanta are the same for Alt7A and the NAA. For Alt7A, slightly higher median flows in January and May between West Point Dam and the headwaters of Walter F. George Lake, compared to the NAA, would reflect the influence of additional upstream releases to support downstream navigation flows during those months. At the 90-percent exceedance level (indicative of severe drought conditions), slightly lower flows in the late winter/early spring months for Alt7A would be the result of other updates to water management practices in Water Management Alternative 7, including revised action zones, seasonal minimum flows at Peachtree Creek, and revised drought operations to conserve storage.

6.1.1.2.3.4 Alternative 7B

Downstream of West Point Dam, median daily flows under Alt7B would be equivalent to the NAA from June through November (Figure 6.1-37). From December through May, the flow values for Alt7B would follow a pattern similar to that for the NAA but would range slightly and consistently higher than the NAA (ranging from 100 to about 800 cfs higher). Daily flows at the 90-percent exceedance level for Alt7B would be nearly equivalent to the NAA from June through November. They would tend to be intermittently and slightly lower than NAA flows from December through mid-March and slightly higher from mid-April through May (Figure 6.1-39). However, these variations at the 90-percent exceedance level do not represent appreciable departures from modeled flows for the NAA. For Alt7B, daily minimum flows equaling but not exceeding 675 cfs would occur on no more than 9 percent of the days over the period of record (10 percent for the NAA).

For Alt7B, median daily flows at Columbus would closely match NAA flows in the months of June–December (Figure 6.1-41). Alt7B flows would be slightly higher than for the NAA in the months of January–May (from 100 up to about 1,000 cfs higher). At the 90-percent exceedance level, daily flows under Alt7B would range from nearly equivalent to slightly lower than the NAA from January through March and slightly higher than the NAA from April through May (Figure 6.1-43). At the 90-percent exceedance level, these variations do not represent appreciable departures from modeled flows for the NAA. HEC-ResSim model outputs indicate that daily flows would be expected to equal or exceed the FERC daily average target flow of 1,350 cfs on 94.9 percent of the days over the modeled period of record (the same as for the NAA) (Figure 6.1-45).

Overall, Alt7B would result in a slighly beneficial effect on flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations from the NAA, principally at the 90-percent exceedance level, would principally be attributable to updates to systemwide water management practices in Water Management Alternative 7. A minor contribution to differences between Alt7B and the NAA also would be water supply withdrawal assumptions for Lake Lanier: Alt7B assuming gross withdrawals limited to relocation contracts only (20 mgd), and the NAA assuming gross withdrawals at current levels (128 mgd). For Alt7B, slightly higher median flows in April and May between West Point Dam and the headwaters of Walter F. George Lake, compared to the NAA, would reflect the influence of additional upstream releases to support downstream navigation flows during those months. At the 90-percent exceedance level (indicative of severe drought conditions), slightly lower flows in the late winter/early spring months for Alt7B would be the result of other updates to water management

practices in Water Management Alternative 7, including revised action zones, seasonal minimum flows at Peachtree Creek, and revised drought operations to conserve storage. Alt7B is identical to Alt7A except for the assumptions related to water supply withdrawals from Lake Lanier as stated above. For the river reach from West Point Dam to Walter F. George Lake, the lower withdrawal levels from Lake Lanier for Alt7B would result in marginally higher flows throughout most of the year than for Alt7A.

6.1.1.2.3.5 Alternative 7H

Downstream of West Point Dam, median daily flows for Alt7H would be nearly the same as those described for Alt7A in comparison to the NAA (Figure 6.1-37). Daily flows at the 90-percent exceedance level for Alt7H also would be nearly equivalent to those described for Alt7A in comparison to the NAA (Figure 6.1-39). For Alt7H, daily minimum flows below West Point Dam equaling but not exceeding 675 cfs would likely occur on 10 percent of the days over the period of record (the same as for the NAA).

Median daily flows at Columbus for Alt7H would be nearly the same throughout the year as those described for Alt7A in comparison to the NAA (Figure 6.1-41). Daily flows for Alt7H at the 90-percent exceedance level would closely match those described for Alt7A in comparison to the NAA (Figure 6.1-43). HEC-ResSim model outputs indicate that daily flows at Columbus would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 94.8 percent of the days over the modeled period of record, compared to 94.9 percent for the NAA (Figure 6.1-45).

Overall, Alt7H would result in no appreciable change over the range of possible flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations, appearing principally at the 90-percent exceedance level, would be attributable to updates to systemwide water management practices in Water Management Alternative 7. For Alt7H, slightly higher median flows in January and May between West Point Dam and the headwaters of Walter F. George Lake, compared to the NAA, would reflect the influence of additional upstream releases to support downstream navigation flows during those months. At the 90-percent exceedance level (indicative of severe drought conditions), slightly lower flows in the late winter/early spring months for Alt7H would be the result of other updates to water management practices in Water Management Alternative 7, including revised action zones, seasonal minimum flows at Peachtree Creek, and revised drought operations to conserve storage. The water supply withdrawal assumptions at Lake Lanier and downstream of Buford Dam in Alt7H are substantially higher than those in Alt7A. However, the larger withdrawal values would have no appreciable incremental effect on modeled flow conditions between West Point Dam and Walter F. George Lake compared to Alt7A.

6.1.1.2.3.6 Alternative 7I

Downstream of West Point Dam, median daily flows for Alt7I would be nearly the same as those described for Alt7A in comparison to the NAA (Figure 6.1-38). From January through May, the flow values for Alt7I would follow a pattern similar to that for the NAA values but would tend to range slightly higher in January and May (ranging from 100 to about 800 cfs). Daily flows at the 90-percent exceedance level for Alt7I also would be nearly the same as those described for Alt7A in comparison to the NAA (Figure 6.1-40). These daily flows would nearly equal the NAA flows from May through November, and they would tend to be slightly lower than NAA flows intermittently from December through mid-March and from mid-June through mid-July. From mid-April through mid-June, flows for Alt7I would be intermittently higher than for the NAA. However, at the 90-percent exceedance level, the deviations do not represent appreciable departures from modeled flows for the NAA. For Alt7I, daily minimum flows below West Point Dam equaling but not exceeding 675 cfs would likely occur on about 10 percent of the days over the period of record (the same as for the NAA).

Median daily flows at Columbus for Alt7I would be nearly the same throughout the year as those described for Alt7A in comparison to the NAA (Figure 6.1-42). Alt7I flows would be slightly higher than NAA flows in the months of January and April–May. Daily flows for Alt7I at the 90-percent exceedance level also would closely match those described for Alt7A in comparison to the NAA (Figure 6.1-44). Alt7I flows would be nearly equivalent to those under the NAA from June through November, with some intermittent instances with slightly lower flows. From December through March, Alt7I flows would be lower than NAA flows, ranging intermittently from minimal amounts up to as much as 1,000 cfs. In April and May, Alt7I flows would be slightly higher than NAA flows. At the 90-percent exceedance level, the deviations do not represent appreciable departures from modeled flows for the NAA. HEC-ResSim model outputs indicate that daily flows at Columbus would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 94.8 percent of the days over the modeled period of record, compared to 94.9 percent for the NAA (Figure 6.1-46).

Overall, Alt7I would result in no appreciable change over the range of possible flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations, appearing principally at the 90-percent exceedance level, would be attributable to updates to systemwide water management practices in Water Management Alternative 7. For Alt7I, slightly higher median flows in January and May between West Point Dam and the headwaters of Walter F. George Lake, compared to the NAA, would reflect the influence of additional upstream releases to support downstream navigation flows during those months. At the 90-percent exceedance level (indicative of severe drought conditions), slightly lower flows in the late winter/early spring months for Alt7I would be the result of other updates to water management practices in Water Management Alternative 7. The water supply withdrawal assumptions for Lake Lanier and downstream of Buford Dam in Alt7I are substantially higher than those in Alt7A, which has the same water supply assumptions as the NAA but includes the same reservoir water management measures as Alt7I. Comparing Alt7I and Alt7A helps identify the incremental effect of a potential scenario for future water supply withdrawals compared to current withdrawals using a consistent set of reservoir management measures. The larger withdrawal values for Alt7I would have no appreciable incremental effect on modeled flow conditions between West Point Dam and Walter F. George Lake compared to Alt7A.

6.1.1.2.3.7 Alternative 7J

Downstream of West Point Dam, median daily flows for Alt7J would closely follow the pattern throughout the year described for Alt7A in comparison to the NAA, except that the daily flows would be slightly higher from November through June (typically ranging from 100 to about 500 cfs higher) for Alt7J (Figure 6.1-38). Daily flows at the 90-percent exceedance level for Alt7J also would be similar to those described for Alt7A in comparison to the NAA, except that those flows would be slightly higher at times during January–March (Figure 6.1-40). For Alt7J, daily minimum flows below West Point Dam equaling but not exceeding 675 cfs would likely occur on 10 percent of the days over the period of record (the same as for the NAA).

Median daily flows at Columbus for Alt7J would closely follow those described for Alt7A in comparison to the NAA, except that they would be slightly higher throughout the year (Figure 6.1-42). Daily flows for Alt7J at the 90-percent exceedance level also would closely follow those described for Alt7A in comparison to the NAA, except that they would be marginally higher from December through May (Figure 6.1-44). HEC-ResSim model outputs indicate that daily flows at Columbus would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 95.1 percent of the days over the modeled period of record, compared to 94.9 percent for the NAA (Figure 6.1-46).

Overall, Alt7J would have a slightly beneficial effect on flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. Relatively minor deviations, appearing principally at the

90-percent exceedance level, would be attributable to updates to systemwide water management practices in Water Management Alternative 7. Additionally, the water supply withdrawal assumptions for Lake Lanier and for the Chattahoochee River downstream of Buford Dam for Alt7J, compared to the NAA, could contribute to the slightly improved flow conditions between West Point Dam and Walter F. George Lake. Lake Lanier withdrawals would be significantly smaller under Alt7J than under the NAA, 20 mgd for relocation contracts only (with 50 percent returns) versus 128 mgd representing current use (with 29 percent returns). Withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek for Alt7J are assumed to be 379 mgd (the projected 2050 need at a return ratio of 95 percent) compared to 277 mgd for the NAA (the current use at a return ratio of 82 percent). Accordingly, the net withdrawals from the Chattahoochee River at the Whitesburg gage would be 18 mgd for Alt7J and 50 mgd for the NAA. Thus, slightly more water would reach and be discharged through West Point Dam under Alt7J than under the NAA.

6.1.1.2.3.8 Alternative 7K (PAA)

Downstream of West Point Dam, median daily flows for the PAA would be nearly the same as those described for Alt7A above in comparison to the NAA (Figure 6.1-38). From January through May, the flow values for the PAA would follow a pattern similar to that for the NAA but would tend to range slightly higher than NAA values in January and May (ranging from 100 to about 800 cfs). Daily flows at the 90-percent exceedance level for the PAA also would be nearly the same as those described for Alt7A in comparison to the NAA (Figure 6.1-40). These daily flows would nearly equal NAA flows from May through November, and they would tend to be slightly lower than NAA flows intermittently from December through mid-March and from mid-June through mid-July. From mid-April through mid-June, flows for the PAA would be intermittently higher than for the NAA. However, at the 90-percent exceedance level, the deviations do not represent appreciable departures from modeled flows for the NAA. For the PAA, daily minimum flows below West Point Dam equaling but not exceeding 675 cfs would likely occur on about 10 percent of the days over the period of record (the same as for the NAA).

Median daily flows at Columbus for the PAA would be nearly the same throughout the year as those described for Alt7A in comparison to the NAA (Figure 6.1-42). PAA flows would be slightly higher than NAA flows in the months of January and April through May. Daily flows for the PAA at the 90-percent exceedance level also would closely match those described for Alt7A in comparison to the NAA (Figure 6.1-44). PAA flows would be nearly equivalent to NAA flows from June through November, with some intermittent instances with slightly lower flows. From December through March, PAA flows would be lower than NAA flows, ranging intermittently from minimal amounts up to as much as 1,000 cfs. In April and May, PAA flows would be slightly higher than NAA flows. At the 90-percent exceedance level, the deviations in flows at Columbus do not represent appreciable departures from modeled flows for the NAA. HEC-ResSim model outputs indicate that daily flows at Columbus would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 94.8 percent of the days over the modeled period of record, compared to 94.9 percent for the NAA (Figure 6.1-46).

Overall, the PAA would result in no appreciable change over the range of possible flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations, appearing principally at the 90-percent exceedance level, would be attributable to updates to systemwide water management practices in Water Management Alternative 7. For the PAA, slightly higher median flows in January and May between West Point Dam and the headwaters of Walter F. George Lake, compared to the NAA, would reflect the influence of additional upstream releases to support downstream navigation flows during those months. At the 90-percent exceedance level (indicative of severe drought conditions), slightly lower flows in the late winter/early spring months for the PAA would be the result of other updates to water management measures included in Water Management Alternative 7. The water supply withdrawal assumptions for Lake Lanier and downstream of Buford Dam in the PAA are

substantially higher than those in Alt7A, which has the same water supply assumptions as the NAA but includes the same reservoir water management measures as the PAA. Comparing the PAA and Alt7A helps identify the incremental effect of a potential scenario for future water supply withdrawals compared to current withdrawals using a consistent set of updated reservoir management measures. The larger withdrawal values for the PAA would have no appreciable incremental effect on modeled flow conditions between West Point Dam and Walter F. George Lake when compared to Alt7A.

6.1.1.2.3.9 Alternative 7L

HEC-ResSim model results over the 73-year simulated period of record for Alt7L downstream of West Point Dam are depicted in Figure 6.1-38 (median daily flows) and Figure 6.1-40 (daily flows at the 90-percent exceedance level). Model results for Alt7L at Columbus are depicted in Figure 6.1-42 (median daily flows), Figure 6.1-44 (daily flows at the 90-percent exceedance level), and Figure 6.1-46 (flow-duration curve). Based on these results, flow conditions for Alt7L throughout the year in the Chattahoochee River from West Point Dam downstream to Walter F. George Lake would be nearly identical to those described for the PAA in comparison to the NAA.

Daily average flows at Columbus for Alt7L would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 94.8 percent of the days over the modeled period of record, compared to 94.9 percent for the NAA (Figure 6.1-46).

Overall, Alt7L would result in no appreciable change over the range of possible flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations would be attributable to updates to systemwide water management practices in Water Management Alternative 7, including releases to support navigation. The large increase in withdrawals in Alt7L for the Chattahoochee River downstream of Buford Dam (379 mgd) would have little incremental effect on the flow conditions in the the river between West Point Dam and Walter F. George Lake compared to Alt7A. Comparing Alt7L and Alt7A helps identify the incremental effect of a potential scenario that would retain current withdrawals from Lake Lanier in both alternatives but increase future withdrawals downstream of Buford Dam from current for Alt7A (277 mgd) to the projected 2050 value for Alt7L (379 mgd) using a consistent set of updated reservoir management measures. Also, Alt7L results in virtually no measurable difference in flow conditions between West Point Dam and Walter F. George Lake compared to the PAA, despite assumed gross withdrawal levels from Lake Lanier that would be 114 mgd lower than the PAA (128 mgd versus 242 mgd).

6.1.1.2.3.10 Alternative 7M

HEC-ResSim model results over the 73-year simulated period of record for Alt7M downstream of West Point Dam are depicted in Figure 6.1-38 (median daily flows) and Figure 6.1-40 (daily flows at the 90-percent exceedance level). Model results for Alt7M at Columbus are depicted in Figure 6.1-42 (median daily flows), Figure 6.1-44 (daily flows at the 90-percent exceedance level), and Figure 6.1-46 (flow-duration curve). Based on the results, flow conditions throughout the year in the Chattahoochee River from West Point Dam downstream to Walter F. George Lake for Alt7M would be nearly identical to those described for the PAA in comparison to the NAA.

Daily average flows at Columbus for Alt7M would likely equal or exceed the FERC daily average target flow of 1,350 cfs on 94.9 percent of the days over the modeled period of record (the same as for the NAA) (Figure 6.1-46).

Overall, Alt7M would result in no appreciable change over the range of possible flow conditions from West Point Dam to Walter F. George Lake compared to the NAA. The relatively minor deviations would be attributable to updates to systemwide water management practices in Water Management Alternative 7.

Alt7M would result in virtually no measurable difference in flow conditions from West Point Dam to Walter F. George Lake compared to the PAA, despite assumed gross withdrawal levels from Lake Lanier that would be 57 mgd lower than under Alt7M (185 mgd versus 242 mgd).

6.1.1.2.4 Walter F. George Lock and Dam to Jim Woodruff Lock and Dam

Figure 6.1-47 through Figure 6.1-52 present model outputs for flow conditions below George W. Andrews Lock and Dam over the modeled period of record. The site is on the Chattahoochee River between Walter F. George Lock and Dam and Jim Woodruff Lock and Dam. Flow conditions at that location were examined to assess changes that would be expected under the water management alternatives/water supply options considered in detail for the ACF Basin under Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M compared to the NAA. Flow values at that location are considered representative of conditions in this reach of the river. The figures present model results for median daily flows, daily flows at the 90-percent exceedance level, and flow duration. In consideration of the number of alternatives and the ease of viewing the information about each alternative, the results for each parameter (e.g., magnitude of flow conditions) are presented in two figures with half of the alternatives presented on each figure. Using the results from these figures, and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

As described in section 6.1.1.2.1, the Southern Nuclear Operating Company and the Alabama OWR have indicated that a minimum average daily flow of 2,000 cfs at the Farley Nuclear Plant (a short distance downstream of George W. Andrews Lock and Dam) is necessary for the continued uninterrupted operation of the plant (see section 6.1.1.2.1). This section addresses the extent to which the Farley flow need would likely be met under each of the alternatives considered herein.



Figure 6.1-47. Chattahoochee River Median Daily Flows below George W. Andrews Lock and Dam, GA, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.



Figure 6.1-48. Chattahoochee River Median Daily Flows below George W. Andrews Lock and Dam, GA, for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

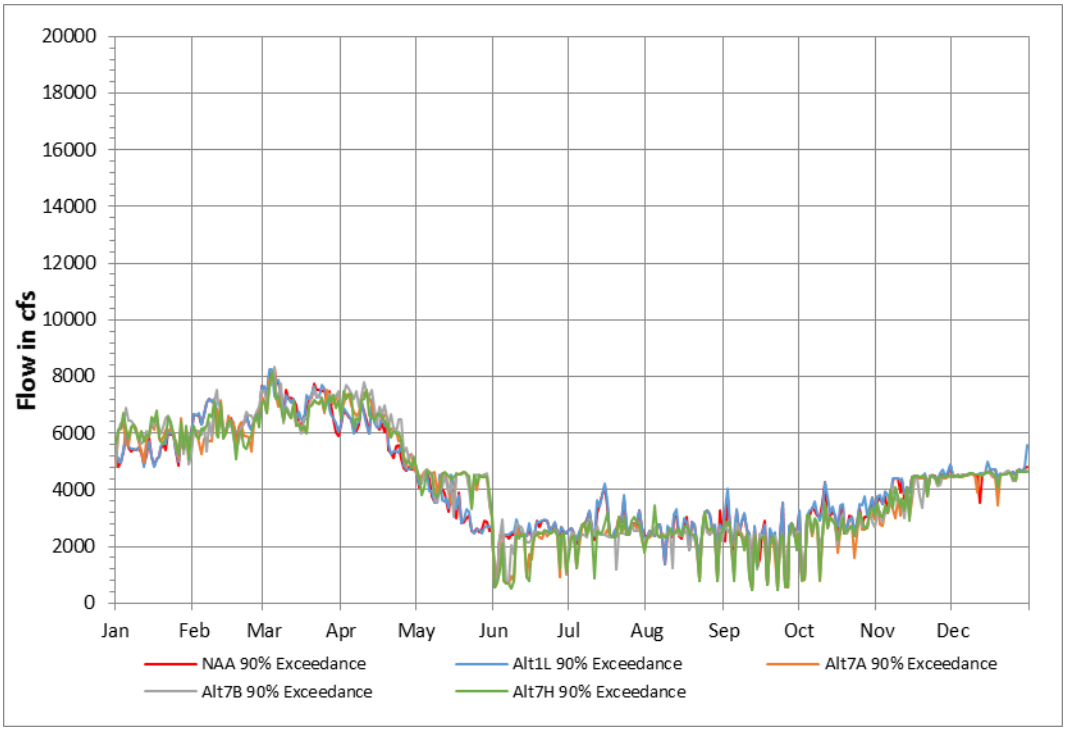


Figure 6.1-49. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level below George W. Andrews Lock and Dam, GA, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

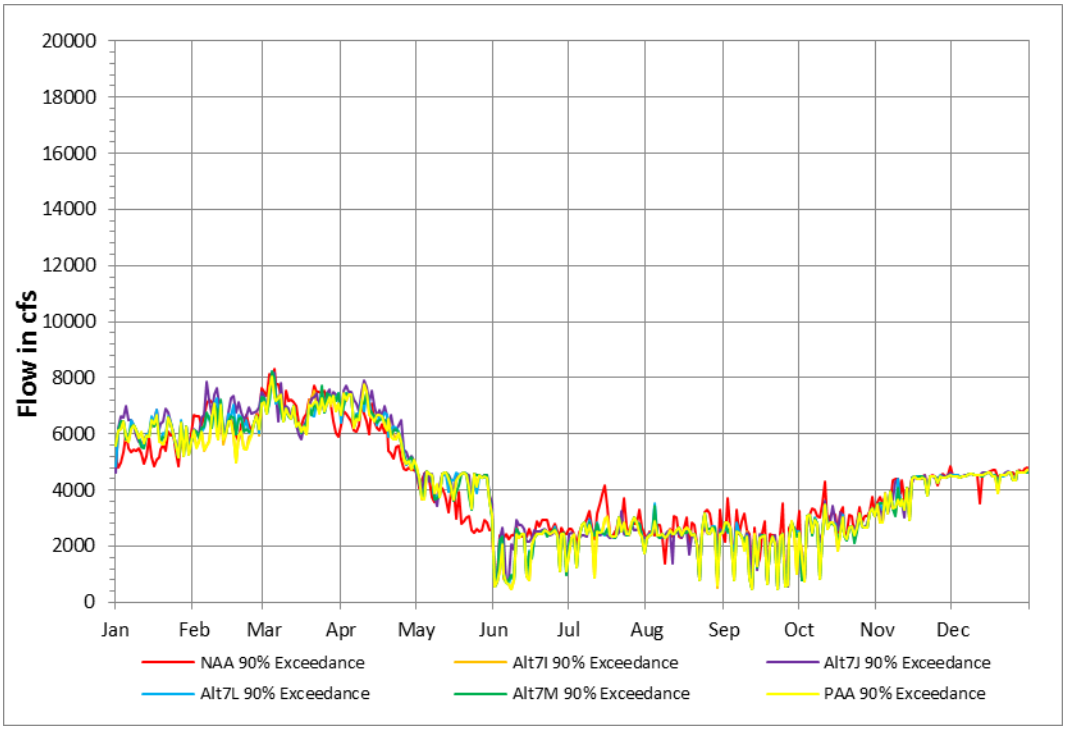


Figure 6.1-50. Chattahoochee River Daily Flows at the 90-Percent Exceedance Level below George W. Andrews Lock and Dam, GA, for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

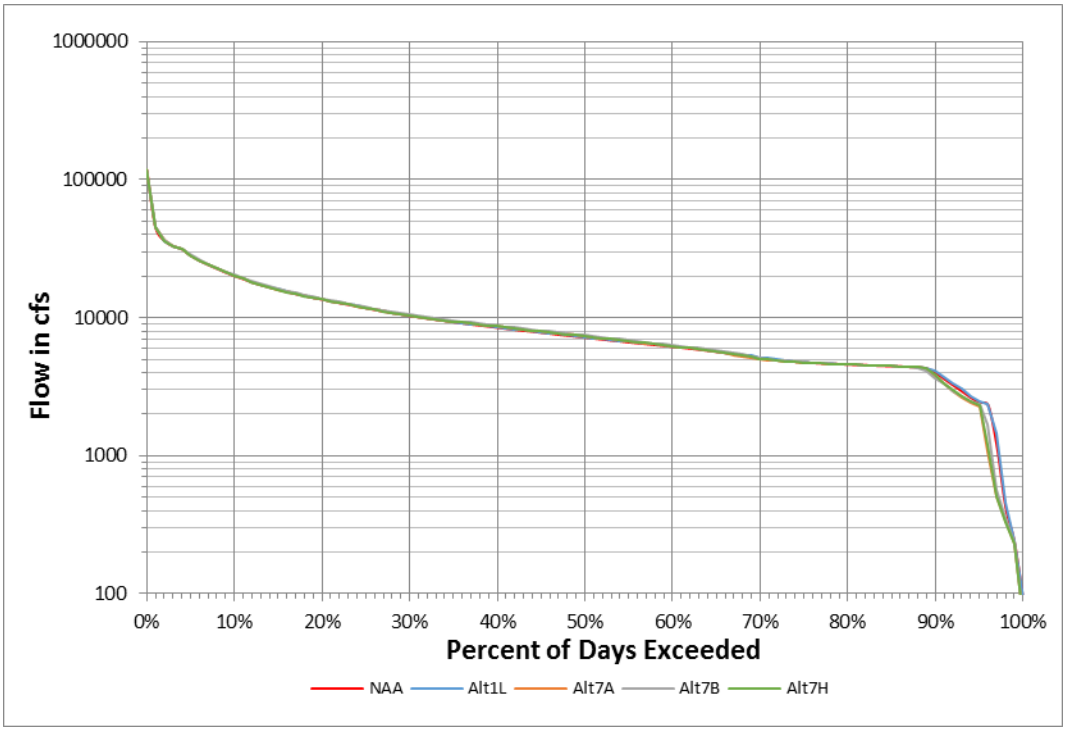


Figure 6.1-51. Chattahoochee River Flows below George W. Andrews Lock and Dam, GA, Percent of Days Exceeded for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

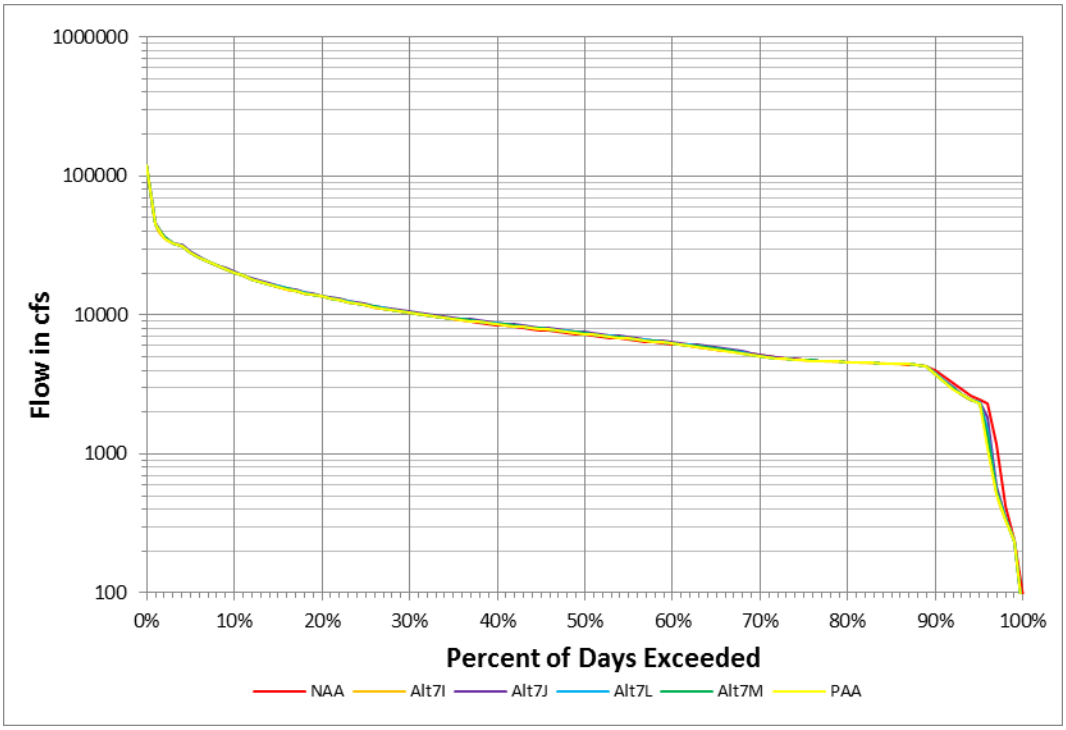


Figure 6.1-52. Chattahoochee River Flows below George W. Andrews Lock and Dam, GA, Percent of Days Exceeded for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

6.1.1.2.4.1 No Action Alternative

Under the NAA, median daily flows in the Chattahoochee River downstream of George W. Andrews Lock and Dam from June through October would likely range between about 4,600 cfs and 6,000 cfs (Figure 6.1-47). From November through May, median daily flows would typically range between about 6,000 cfs and about 16,700 cfs. Peak median daily flow levels would occur in March.

Daily flows at the 90-percent exceedance level at George W. Andrews Lock and Dam (indicative of drought conditions) would generally be in the range of 2,000–3,000 cfs during the months of the year that are typically drier (June–November). During that period, daily flows could briefly range from as low as 500 cfs to as high as 4,200 cfs. In the balance of the year (December–May), daily flows at the 90-percent exceedance level would likely range from about 3,000 cfs up to about 8,300 cfs, with peak flows occurring in March (Figure 6.1-49).

Based on HEC-ResSim model outputs over the simulated period of record, daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 96.3 percent of the days over the modeled period of record (Figure 6.1-51).

6.1.1.2.4.2 Alternative 1L

For Alt1L, model results for median daily flows in the Chattahoochee River downstream of George W. Andrews Lock and Dam would closely match NAA flows throughout the year. Minor deviations in the general range of 100–400 cfs occur sporadically, mostly between the months of March and June (Figure 6.1-47). At the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for Alt1L would be nearly the same as for the NAA. Deviations from the NAA would be minor and sporadic (Figure 6.1-49).

Based on HEC-ResSim model outputs over the simulated period of record, daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 96.4 percent of the time for Alt1L compared to 96.3 percent of the time for the NAA (Figure 6.1-51).

Alt1L would result in no appreciable change in flow conditions downstream of George W. Andrews Lock and Dam compared to the NAA. Any minor deviations in daily flow values over the period of record for Alt1L would be attributable to the slight effect of increased water supply withdrawals downstream of Buford Dam included in Alt1L (379 mgd) compared to the NAA (277 mgd) since all other features of Alt1L and the NAA are the same.

6.1.1.2.4.3 Alternative 7A

For Alt7A, model results for median daily flows downstream of George W. Andrews Lock and Dam would closely match the NAA throughout the year with some exceptions. Minor deviations for Alt7A flows would occur in January and from mid-April through May and would be higher than NAA flows (ranging sporadically from about 100 cfs higher to as much as about 1,500 cfs higher). Alt7A flows for June and July would be slightly lower than NAA flows (ranging from about 100 cfs to as much as about 1,000 cfs lower) (Figure 6.1-47). At the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for Alt7A would be similar to the daily flows for the NAA with the following deviations: Alt7A flows would be higher in January and from April through May (ranging from 100 to about 1,500 cfs higher), and they would be slightly lower from February through March and from June through December (ranging from about 100 cfs to 1,000 cfs lower) (Figure 6.1-49).

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.2 percent of the time for Alt7A compared to 96.3 percent of the time for the NAA (Figure 6.1-51).

Overall, Alt7A would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam compared to the NAA. The changes would be attributable to updated water management practices in Water Management Alternative 7, including provision of increased reservoir releases as needed from January through May to support downstream navigation, revised action zones in USACE reservoirs, and drought operations provisions. The water supply withdrawal and return flow assumptions associated with Lake Lanier and the Chattahoochee River downstream of Buford Dam would not contribute to any differences in flow conditions below George W. Andrews Lock and Dam between Alt7A and the NAA since those assumptions are the same for both alternatives.

6.1.1.2.4.4 Alternative 7B

For Alt7B, model results for median daily flows downstream of George W. Andrews Lock and Dam throughout the year would closely match those described for Alt7A as compared to the NAA (Figure 6.1-47). At the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for Alt7B also would closely match the daily flows for the NAA (Figure 6.1-49). Any deviations in modeled daily flows (median and 90-percent exceeded) between Alt7B and Alt7A are minor and discountable.

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.5 percent of the time for Alt7B compared to 96.3 percent of the time for the NAA (Figure 6.1-51).

Overall, Alt7B would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam throughout the year compared to the NAA. Those changes in flow conditions for Alt7B below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. The water supply assumption for Lake Lanier associated with Alt7B (limited to relocation contracts only—20 mgd) versus

Alt7B (current withdrawals—128 mgd) could account for marginally higher flow conditions for Alt7B than for Alt7A when compared to the NAA. However, the upstream water supply assumptions do not have an appreciable influence on flow conditions downstream of George W. Andrews Lock and Dam.

6.1.1.2.4.5 Alternative 7H

For Alt7H, median daily flows downstream of George W. Andrews Lock and Dam throughout the year follow the same seasonal pattern and would closely match those described for Alt7A in comparison to the NAA (Figure 6.1-48). Likewise, at the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for Alt7H would track closely with those described for Alt7A in comparison to the NAA (Figure 6.1-50).

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.3 percent of the time for the Alt7H compared to 96.3 percent of the time for the NAA (Figure 6.1-52).

Overall, Alt7H would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam throughout the year compared to the NAA. The changes in flow conditions for Alt7H below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. The large increase in withdrawals assumed for Lake Lanier and downstream of Buford Dam in Alt7H would have little incremental effect on flow conditions in the Chattahoochee River downstream of George W. Andrews Lock and Dam.

6.1.1.2.4.6 Alternative 7I

For Alt7I, model results for median daily flows downstream of George W. Andrews Lock and Dam would closely match those described for Alt7A in comparison to the NAA. Minor deviations for Alt7I flows compared to the NAA would occur in January and from mid-April through May and would be higher (ranging sporadically from about 100 cfs higher to as much as about 1,500 cfs higher). Alt7I flows for June and July would be slightly lower than NAA flows (ranging from about 100 cfs to as much as about 1,000 cfs lower) (Figure 6.1-48).

At the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for Alt7I also would closely match the daily flows described for Alt7A as compared to the NAA. Alt7I flows would be higher in January and from April through May (ranging from 100 to about 1,500 cfs higher), and they would be slightly lower from February through March and from June through December (ranging from about 100 cfs to 1,000 cfs lower) (Figure 6.1-50).

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.3 percent of the time for the Alt7I compared to 96.3 percent of the time for the NAA (Figure 6.1-52).

Overall, Alt7I would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam throughout the year compared to the NAA. Those changes in flow conditions for Alt7I below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7, including provision of increased reservoir releases as needed from January through May to support downstream navigation, revised action zones in USACE reservoirs, and drought operations provisions. The large increase in withdrawals assumed for Lake Lanier and downstream of Buford Dam in Alt7I compared to Alt7A (which assumes current withdrawals) would have little incremental effect on the flow conditions in the Chattahoochee River downstream of George W. Andrews Lock and Dam.

6.1.1.2.4.7 Alternative 7J

For Alt7J, model results for median daily flows downstream of George W. Andrews Lock and Dam would closely match those described for Alt7A in comparison to the NAA (Figure 6.1-48). At the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for Alt7I also would closely match the daily flows described for Alt7A as compared to the NAA (Figure 6.1-50). Over the year, Alt7J values tend to be slightly higher than Alt7A values, but the increase is marginal and discountable.

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.7 percent of the time for Alt7J compared to 96.3 percent of the time for the NAA (Figure 6.1-52).

Overall, Alt7J would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam throughout the year compared to the NAA. The changes in flow conditions for Alt7J below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. Different assumptions for water supply withdrawals from Lake Lanier and from the Chattahoochee River downstream of Buford Dam for Alt7J (20 mgd and 379 mgd, respectively) and for the NAA (128 and 277, respectively) do not appreciably affect modeled flow conditions downstream of George W. Andrews Lock and Dam.

6.1.1.2.4.8 Alternative 7K (PAA)

For the PAA, model results for median daily flows downstream of George W. Andrews Lock and Dam would closely match those described for Alt7A in comparison to the NAA. Minor deviations in PAA flows compared to NAA flows would occur in January and from mid-April through May and would be higher (ranging sporadically from about 100 cfs higher to as much as about 1,500 cfs higher). PAA flows for June and July would be slightly lower than NAA flows (ranging from about 100 cfs to as much as about 1,000 cfs lower) (Figure 6.1-48).

At the 90-percent exceedance level, the daily flows downstream of George W. Andrews Lock and Dam for the PAA also would closely match the daily flows described for Alt7A as compared to the NAA. PAA flows would be higher in January and from April through May (ranging from 100 to about 1,500 cfs higher), and they would be slightly lower from February through March and from June through December (ranging from about 100 cfs to 1,000 cfs lower) (Figure 6.1-50).

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.3 percent of the time for the PAA compared to 96.3 percent of the time for the NAA (Figure 6.1-52).

Overall, the PAA would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam throughout the year compared to the NAA. Those changes in flow conditions for the PAA below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7, including provision of increased reservoir releases as needed from January through May to support downstream navigation, revised action zones in USACE reservoirs, and drought operations provisions. The large increase in withdrawals assumed for Lake Lanier and downstream of Buford Dam in the PAA compared to Alt7A (which assumes current withdrawals) would have little incremental effect on the flow conditions in the Chattahoochee River downstream of George W. Andrews Lock and Dam. The PAA would result in virtually no measurable difference in flow conditions downstream of George W. Andrews Lock and Dam compared to Alt7I, despite assumed withdrawal levels from Lake Lanier that would be 17 mgd higher than under Alt7I (242 mgd versus 225 mgd).

6.1.1.2.4.9 Alternative 7L

HEC-ResSim model results over the 73-year simulated period of record for Alt7L are depicted in Figure 6.1-48 (median daily flows), Figure 6.1-50 (daily flows at the 90-percent exceedance level), and Figure 6.1-52 (flow-duration curve). Based on these results, flow conditions for Alt7L throughout the year in the Chattahoochee River downstream of George W. Andrews Lock and Dam would be nearly identical to those described for the PAA in comparison to the NAA.

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.4 percent of the time for the Alt7L compared to 96.3 percent of the time for the NAA (Figure 6.1-52).

Overall, Alt7L would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam compared to the NAA. Those changes in flow conditions for Alt7L below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. The large increase in withdrawals assumed for downstream of Buford Dam in Alt7L compared to Alt7A (which assumes current withdrawals) would have little incremental effect on the flow conditions in the Chattahoochee River downstream of George W. Andrews Lock and Dam. Also, Alt7L would likely result in virtually no measurable difference in flow conditions downstream of George W. Andrews Lock and Dam compared to the PAA, despite assumed gross withdrawal levels from Lake Lanier that would be 114 mgd (128 mgd versus 242 mgd).

6.1.1.2.4.10 Alternative 7M

HEC-ResSim model results over the 73-year simulated period of record for Alt7M are depicted in Figure 6.1-48 (median daily flows), Figure 6.1-50 (daily flows at the 90-percent exceedance level), and Figure 6.1-52 (flow-duration curve). Based on these results, flow conditions for Alt7M throughout the year in the Chattahoochee River downstream of George W. Andrews Lock and Dam would be nearly identical to those described for the PAA in comparison to the NAA.

Daily average flows equal to or exceeding the Farley flow need of 2,000 cfs would occur about 95.3 percent of the time for the Alt7M compared to 96.3 percent of the time for the NAA (Figure 6.1-52).

Overall, Alt7M would likely have a slightly adverse effect on flow conditions downstream of George W. Andrews Lock and Dam compared to the NAA. Those changes in flow conditions for Alt7M below George W. Andrews Lock and Dam compared to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. Alt7M would result in virtually no measurable difference in flow conditions downstream of George W. Andrews Lock and Dam compared to the PAA, despite assumed gross withdrawal levels that would be 57 mgd lower than Alt7M (185 mgd versus 242 mgd).

6.1.1.2.5 Apalachicola River

Figure 6.1-53 through Figure 6.1-58 present model outputs for flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam. Flow conditions at Chattahoochee, Florida, a short distance downstream of Jim Woodruff Lock and Dam, were examined to assess changes that would be expected under the water management alternatives/water supply options considered in detail for the ACF Basin under Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M compared to the NAA.

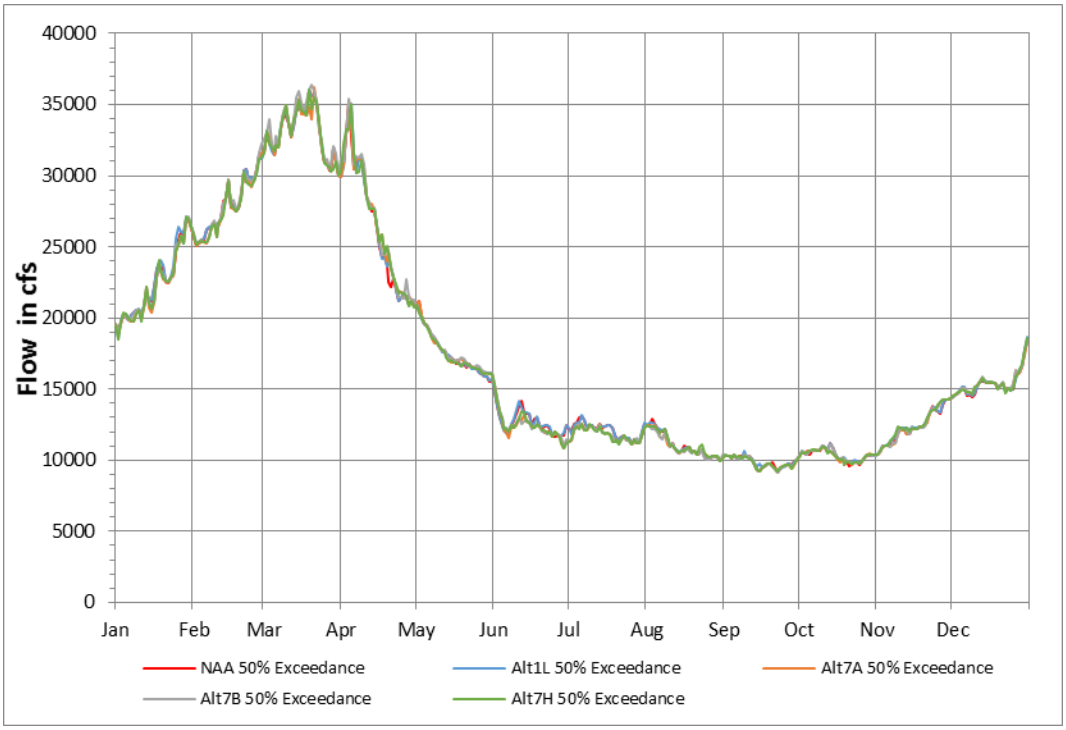


Figure 6.1-53. Apalachicola River Median Daily Flows at Chattahoochee, FL, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

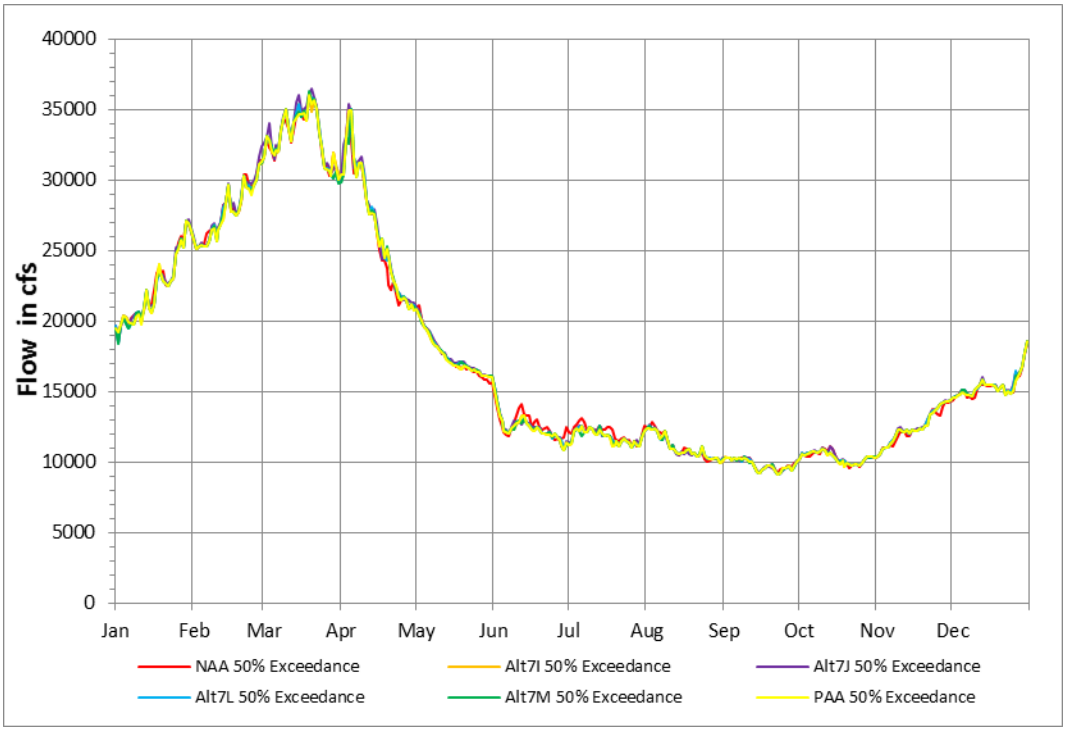


Figure 6.1-54. Apalachicola River Median Daily Flows at Chattahoochee, FL, for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

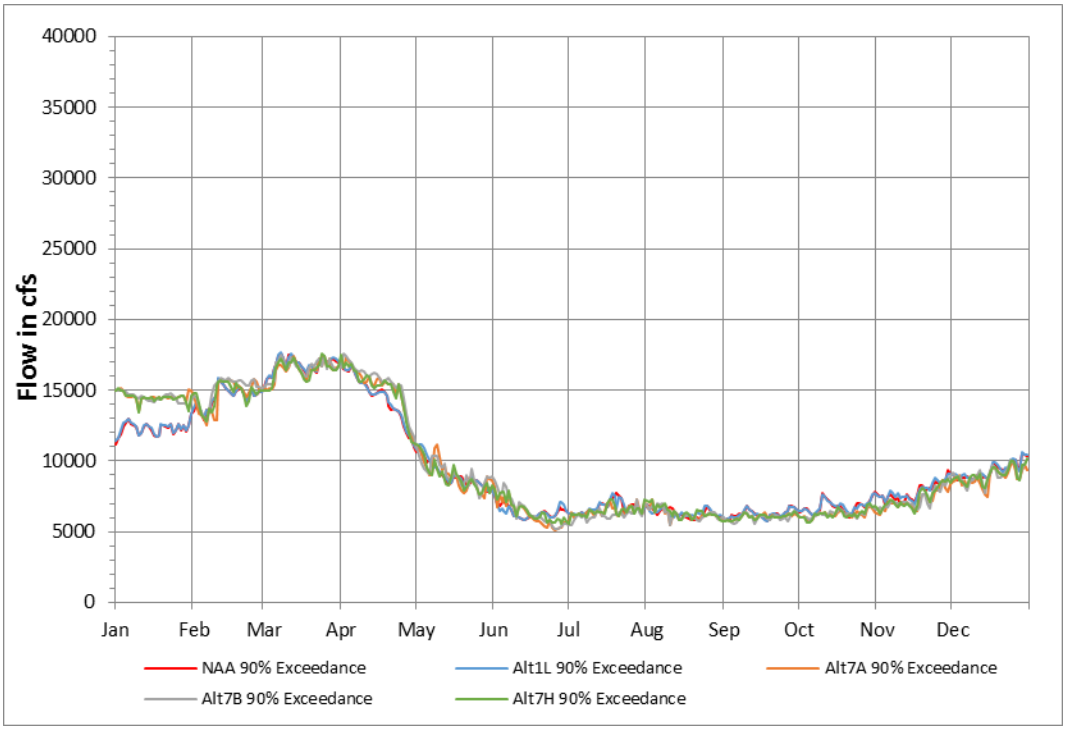


Figure 6.1-55. Apalachicola River Daily Flows at the 90-Percent Exceedance Level at Chattahoochee, FL, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

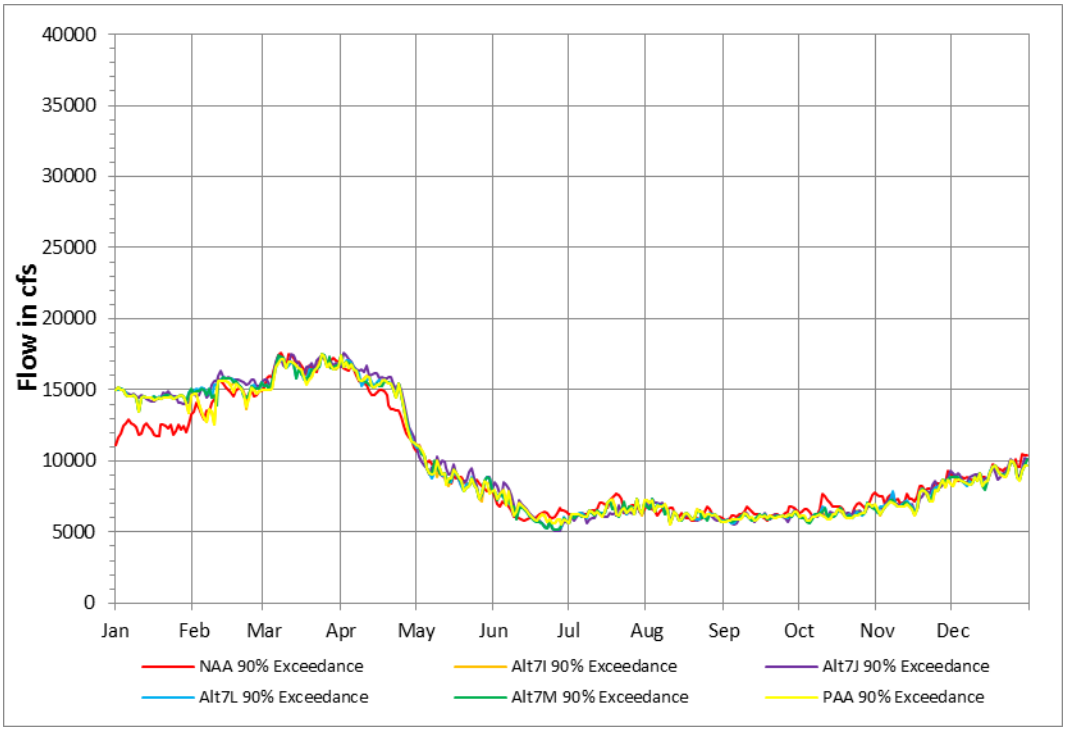


Figure 6.1-56. Apalachicola River Daily Flows at the 90-Percent Exceedance Level at Chattahoochee, FL for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

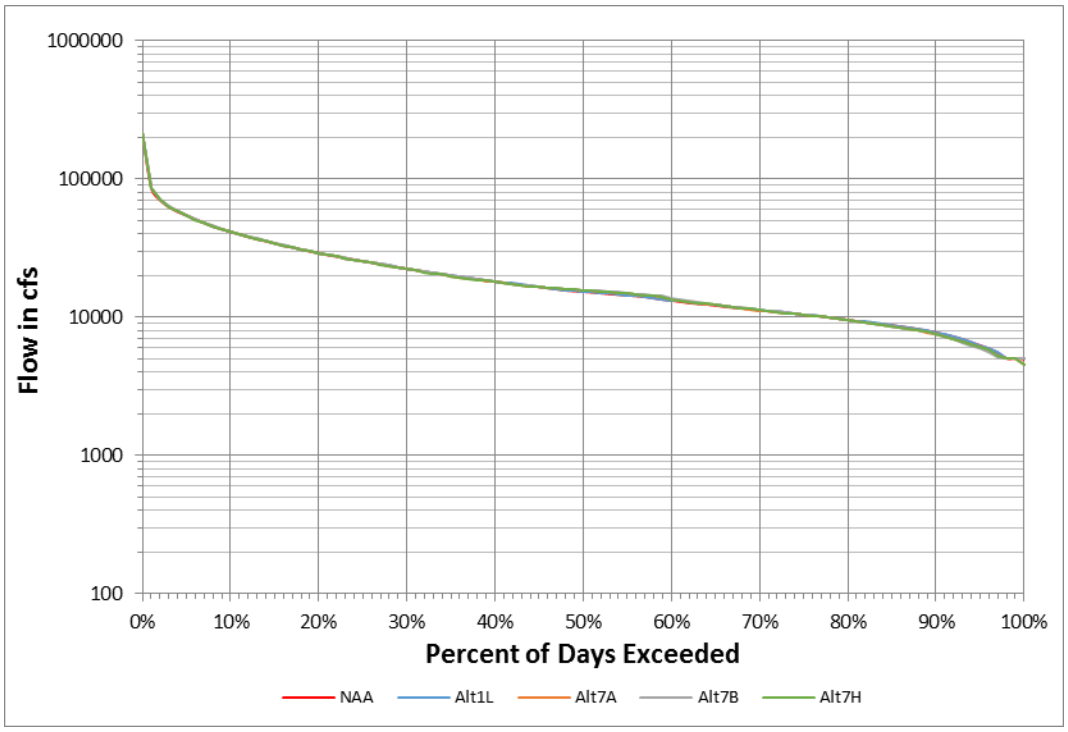


Figure 6.1-57. Apalachicola River Flows below Jim Woodruff Lock and Dam at Chattahoochee, FL, Percent of Days Exceeded for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

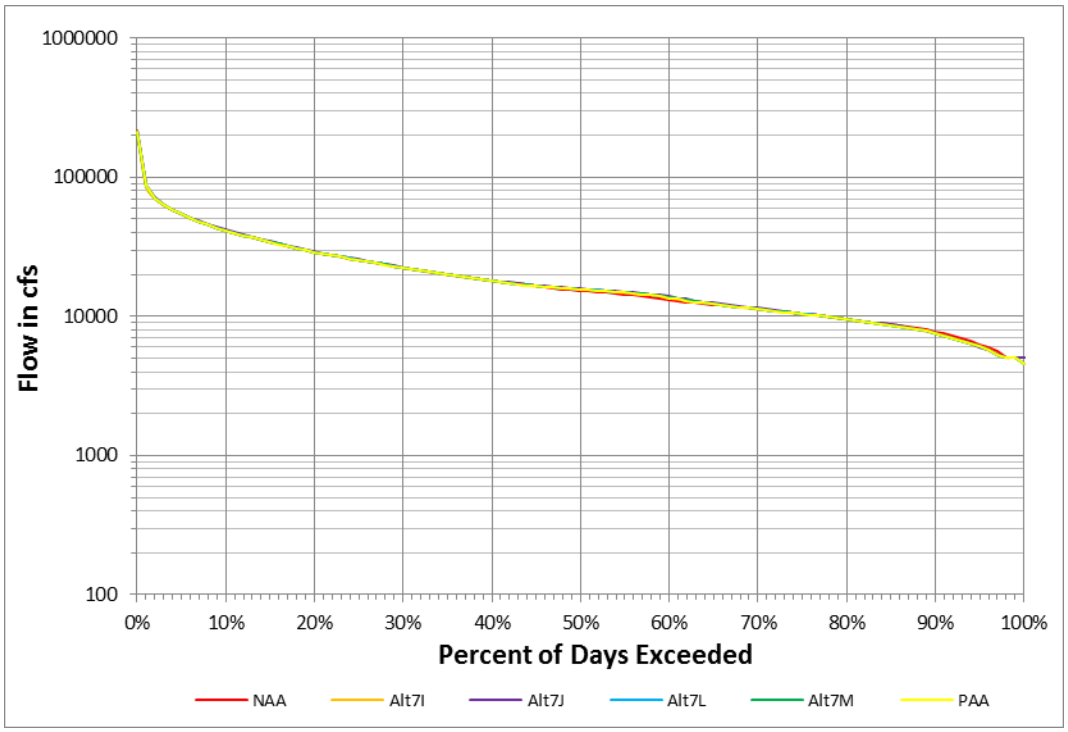


Figure 6.1-58. Apalachicola River Flows below Jim Woodruff Lock and Dam at Chattahoochee, FL, Percent of Days Exceeded for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

The figures present model results for median daily flows, daily flows at the 90-percent exceedance level, and flow duration. In consideration of the number of alternatives and the ease of viewing the information about each alternative, the results for each parameter (e.g., magnitude of flow conditions) are presented in two figures, with half of the alternatives presented on each figure. In addition, Table 6.1-12 provides a direct comparison of the percent of days over the modeled period of record for all of the alternatives for which the Apalachicola River flows would likely exceed five selected flow values. Using the results from these figures, the table, and other information as appropriate, the relative effects associated with each alternative are discussed in subsequent subsections.

Table 6.1-12.
Apalachicola River at Chattahoochee, FL, Gage, Percent of Days over the Modeled Period of Record that Flows Would Equal or Exceed Selected Flow Values

Flows - Chattahoochee gage	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
≥ 20,000 cfs	35.1%	35.3%	34.8%	35.0%	34.8%	34.8%	35.1%	34.8%	34.9%	34.8%
≥ 16,000 cfs	47.0%	47.1%	47.8%	48.4%	47.7%	47.7%	48.6%	47.7%	48.0%	47.9%
≥ 12,000 cfs	65.8%	66.0%	66.1%	66.6%	66.2%	66.1%	67.1%	66.1%	66.3%	66.3%
≥ 8,000 cfs	89.0%	89.1%	88.1%	88.0%	88.2%	88.1%	88.4%	88.1%	88.2%	88.1%
≥ 6,000 cfs	95.8%	95.9%	95.2%	95.0%	95.3%	95.3%	95.1%	95.3%	95.4%	95.2%
≥ 5,000 cfs	100%	100%	99.9%	100%	99.8%	99.7%	100%	99.7%	99.9%	99.8%

The following subsections address the specific effects on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam associated with the NAA and each of the alternatives. Each section generally concludes that the differences in flow condition in the Apalachicola River between the NAA and each alternative would be negligible. Accordingly, any differences in the inflows to Apalachicola Bay from these alternatives would be similarly negligible. The following paragraphs provide a general explanation of why the alternatives are likely to have no appreciable incremental effect on flow conditions in the Apalachicola River compared to the NAA.

Jim Woodruff Lock and Dam
Jim Woodruff Lock and Dam has no dedicated conservation storage and essentially operates as a run-of-river reservoir project with pondage that provides limited capacity to control downstream discharges for short periods of time (see section 2.1.1.1.6.7). Under the NAA, the operational provisions of the 2012 RIOP would govern all releases into the Apalachicola River from Jim Woodruff Lock and Dam. Some of the alternatives proposed only minor adjustments to the 2012 RIOP to suspend ramping rates under prolonged drought conditions. Thus, discharges from Jim Woodruff Lock and Dam under the various alternatives would not differ appreciably from each other or from the NAA unless BI conditions to Lake Seminole from the Flint or Chattahoochee rivers under these alternatives would be notably different.

Flint River Basin
The Flint River Basin comprises about 50 percent of the ACF Basin drainage area upstream of Jim Woodruff Lock and Dam. Inflows to Lake Seminole from the Flint River Basin pass through two nonfederal run-of-river dams and are effectively uncontrolled. Consequently, Flint River BIs to Lake Seminole would be unaffected by the NAA or the other alternatives, and the inflows to Lake Seminole from the Flint River Basin over the period of record would be the same for all alternatives.

Chattahoochee River Basin
In the Chattahoochee River Basin, proposed revisions to the action zones at Walter F. George Lake and further upstream at West Point Lake included in the alternatives would have no appreciable effect on inflows into Lake Seminole compared to the NAA. This conclusion is supported by HEC-ResSim outputs for flow conditions below George W. Andrews Lock and Dam over the modeled period of record that show little change in flow conditions in the lower Chattahoochee River among the various alternatives in comparison to the NAA.

In addition, proposed revisions to water management operations at Buford Dam—including various water supply options for Lake Lanier and downstream of Buford Dam (all of which would occur in the uppermost 10 percent of the Chattahoochee River Basin)—would generally have an inconsequential effect on flow conditions into Lake Seminole and downstream of Jim Woodruff Lock and Dam. The absence of appreciable differences in simulated flow conditions downstream of George W. Andrews Lock and Dam among the alternatives with different water supply options supports this conclusion. Based on HEC-ResSim outputs over the modeled period of record, flow in the Apalachicola River and into the bay would be more influenced by hydrologic conditions in the 90 percent of the ACF Basin downstream of Metro Atlanta, except during severe drought conditions when flows would be supported by conservation storage in Lake Lanier and the other USACE reservoirs.

6.1.1.2.5.1 No Action Alternative

Under the NAA, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam at Chattahoochee would range from about 10,000 cfs to 15,000 cfs in the lower flow season from June through November (Figure 6.1-53). From December through May, median daily flows would range from about 15,000 cfs to 36,000 cfs, with the peak flows typically occurring in March. Daily flows at the 90-percent exceedance level (indicative of drought conditions) would range between 6,000 cfs and 8,000 cfs from June through November and between 8,000 cfs and about 17,500 cfs from December through May, with peak flows generally occurring in March (Figure 6.1-55). Model results indicate that daily flows over the simulated period of record would equal 5,000 cfs about 3 percent of the time and would exceed that minimum level about 97 percent of the time (Figure 6.1-57). During the months of November–May, the percent of time flows would exceed 5,000 cfs would be slightly higher (98–100 percent), and from June through October, the percent of time that flows would exceed 5,000 cfs would be slightly lower (94–96 percent).

Downstream of the Chattahoochee gage, BI to the Apalachicola River is essentially uncontrolled. Flows at the Chattahoochee gage plus the uncontrolled inflows from downstream tributaries to the Apalachicola River, minus any depletions occurring in the Florida portion of the ACF Basin, comprise virtually all of the freshwater inflow to the Apalachicola Bay. The remaining balance of freshwater inflow to the bay comes from smaller watersheds that drain directly into the bay.

6.1.1.2.5.2 Alternative 1L

For Alt1L, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam would be nearly identical to those for the NAA (Figure 6.1-53). Daily flows for Alt1L at the 90-percent exceedance level would closely match those for the NAA (Figure 6.1-55). Any minor deviations between Alt1L and the NAA throughout the year at the 90-percent exceedance level (representing extreme drought conditions) are discountable.

HEC-ResSim model outputs indicate that daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time (the same as for the NAA). The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. Flows would be equal to 5,000 cfs about 3 percent of the time and would not be expected to decline below 5,000 cfs at any time

over the modeled period of record (Figure 6.1-57). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions for Alt1L would not be appreciably different from the NAA.

Alt1L would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. The increase in water supply withdrawals downstream of Buford Dam included in Alt1L (379 mgd) compared to the NAA (277 mgd) would have little incremental effect on flow conditions downstream of Jim Woodruff Lock and Dam.

6.1.1.2.5.3 Alternative 7A

For Alt7A, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam would closely match those for the NAA (Figure 6.1-53). Minor deviations would include a brief slight increase in April and a slight decrease in mid-June–mid-July. Daily flows for Alt7A at the 90-percent exceedance level would be similar to the NAA flows (Figure 6.1-55), except as follows: Alt7A flow values would be higher than NAA flows in January and April (by up to about 2,000 cfs) and slightly lower than NAA flows in June–December (typically about 100 cfs lower, but occasionally ranging up to about 800 cfs lower for brief periods). These minor deviations could be associated with the inclusion of water management updates in Alt7A.

HEC-ResSim model outputs indicate that daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. There would be one occurrence over the modeled period of record for Alt7A when daily flows would likely decline to between 5,000 and 4,500 cfs for about 60 days (0.2 percent of the time). Otherwise, flows would be equal to 5,000 cfs about 2.8 percent of the time (Figure 6.1-57). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions for Alt7A would not be appreciably different than those for the NAA.

Overall, Alt7A would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. Minor deviations in flow conditions in the Apalachicola River for Alt7A in comparison to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7, including provisions for releases to support navigation channel depths when sufficient water is available in the system and updated drought operations measures.

6.1.1.2.5.4 Alternative 7B

For Alt7B, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA would closely match those described for Alt7A (Figure 6.1-53). Daily flows for Alt7B at the 90-percent exceedance level would closely match those described for Alt7A in comparison to the NAA (Figure 6.1-55). In comparison to the NAA, minor deviations in the modeled daily flows at the 90-percent exceedance level between Alt7B and Alt7A are discountable.

HEC-ResSim model outputs indicate that daily flows downstream of Jim Woodruff Lock and Dam over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. For Alt7B, there would be no occurrence over the modeled period of record when daily flows would likely decline below 5,000 cfs. Flows would be equal to 5,000 cfs about 3 percent of the time (Figure 6.1-57). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from

5,000 up to 20,000 cfs) indicates that flow conditions for Alt7B would not be appreciably different from those for the NAA.

Overall, Alt7B would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. Minor deviations in flow conditions in the Apalachicola River for Alt7B in comparison to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7, including provisions for navigation target flows when sufficient water is available in the system and updated drought operations measures.

6.1.1.2.5.5 Alternative 7H

For Alt7H, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam would closely match those described for Alt7A in comparison with the NAA (Figure 6.1-53). Daily flows for Alt7H at the 90-percent exceedance level would be similar to those described for Alt7A in comparision to the NAA (Figure 6.1-55). Alt7H flow values would be higher than NAA flows in January and April (by up to about 2,000 cfs) and slightly lower than NAA flows in June–December (typically about 100 cfs lower, but occasionally ranging up to about 800 cfs lower for brief periods).

HEC-ResSim model outputs indicate that daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. There would be one occurrence for Alt7H over the modeled period of record when daily flows would likely decline to between 5,000 and 4,500 cfs for about 60 days (0.2 percent of the time). Flows would equal 5,000 cfs about 2.8 percent of the time (Figure 6.1-57). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions between Alt7H and the NAA would not be appreciably different.

Overall, Alt7H would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. Minor deviations in flow conditions in the Apalachicola River for Alt7H in comparison to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. USACE assumptions regarding water supply withdrawals and return flows for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek for Alt7H would have little incremental effect on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA or the other alternatives.

6.1.1.2.5.6 Alternative 7I

For Alt7I, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam would closely match those described for Alt7A in comparison with the NAA (Figure 6.1-54). Daily flows for Alt7I at the 90-percent exceedance level would be similar to those described for Alt7A in comparison to the NAA (Figure 6.1-56). Alt7I flow values would be higher than NAA flows in January and April (by up to about 2,000 cfs) and slightly lower than NAA flows in June–December (typically about 100 cfs lower, but occasionally ranging up to about 800 cfs lower for brief periods).

HEC-ResSim model outputs indicate that daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. There would be one occurrence for Alt7I over the modeled period of record when daily flows would likely decline to a level between 5,000 and 4,500 cfs for about 90 days (0.3 percent of the time). Flows would equal 5,000 cfs about 2.7 percent of the time (Figure 6.1-58). As depicted in, the percent of days exceeded over the modeled period of record for a range of flows (from

5,000 up to 20,000 cfs) indicates that flow conditions between Alt7I and the NAA would not be appreciably different.

Overall, Alt7I would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. Minor deviations in flow conditions in the Apalachicola River for Alt7I in comparison to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. USACE assumptions regarding water supply withdrawals and return flows for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek for Alt7I would have little incremental effect on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA or the other alternatives.

6.1.1.2.5.7 Alternative 7J

For Alt7J, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam would closely match those described for Alt7A in comparison with the NAA (Figure 6.1-54). Daily flows for Alt7J at the 90-percent exceedance level would be similar to those described for Alt7A in comparison to the NAA (Figure 6.1-56). Daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. Flows would be equal to 5,000 cfs about 3 percent of the time and would not be likely to decline below 5,000 cfs at any time over the modeled period of record (Figure 6.1-58). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions between Alt7J and the NAA would not be appreciably different.

Overall, Alt7J would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. Minor deviations in flow conditions in the Apalachicola River for Alt7J in comparison to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. USACE assumptions regarding water supply withdrawals and return flows for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek for Alt7J would have little effect on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA or the other alternatives.

6.1.1.2.5.8 Alternative 7K (PAA)

For the PAA, median daily flows in the Apalachicola River downstream of Jim Woodruff Lock and Dam would closely match those described for Alt7A in comparison with the NAA (Figure 6.1-54). Daily flows for the PAA at the 90-percent exceedance level would be similar to those described for Alt7A in comparison to the NAA (Figure 6.1-56). PAA flow values would be higher than NAA flows in January and April (by up to about 2,000 cfs) and slightly lower than NAA flows in June–December (typically about 100 cfs lower, but occasionally ranging up to about 800 cfs lower for brief periods).

HEC-ResSim model outputs indicate that daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. The percent of days exceeding 5,000 cfs by month would be similar to the pattern described for the NAA. There would be one occurrence for the PAA over the modeled period of record when daily flows would likely decline to a level between 5,000 and 4,500 cfs for about 90 days (0.3 percent of the time). Flows would equal 5,000 cfs about 2.7 percent of the time (Figure 6.1-58). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions between the PAA and the NAA would not be appreciably different.

Overall, the PAA would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. Minor deviations in flow conditions in the Apalachicola River for the PAA in comparison to the NAA would principally be attributable to updates to water management practices in Water Management Alternative 7. USACE assumptions regarding water supply withdrawals and return flows for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek for the PAA would have little effect on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA or the other alternatives. Those alternatives have substantially different water supply withdrawal and return assumptions than the PAA in most cases.

6.1.1.2.5.9 Alternative 7L

The effects of Alt7L on flow conditions in the Apalachicola River at the Chattahoochee gage downstream of Jim Woodruff Lock and Dam would be nearly the same as those described for the PAA in comparison to the NAA (see Figure 6.1-54 and Figure 6.1-56). Daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. There would be one occurrence for Alt7L over the modeled period of record when daily flows would likely decline to a level between 5,000 and 4,500 cfs for about 30 days (0.1 percent of the time). Flows would equal 5,000 cfs about 2.9 percent of the time (Figure 6.1-58). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions between Alt7L and the NAA would not be appreciably different.

Overall, Alt7L would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. USACE assumptions regarding water supply withdrawals and return flows for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek for Alt7L would have little effect on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA or the other alternatives.

6.1.1.2.5.10 Alternative 7M

The effects of Alt7M on flow conditions in the Apalachicola River at the Chattahoochee gage downstream of Jim Woodruff Lock and Dam would be nearly the same as those described for the PAA in comparison to the NAA (see Figure 6.1-54 and Figure 6.1-56). Daily flows over the simulated period of record would exceed 5,000 cfs about 97 percent of the time. There would be one occurrence for Alt7M over the modeled period of record when daily flows would likely decline to a level between 5,000 and 4,500 cfs for about 60 days (0.2 percent of the time). Flows would equal 5,000 cfs about 2.8 percent of the time (Figure 6.1-58). As depicted in Table 6.1-12, the percent of days exceeded over the modeled period of record for a range of flows (from 5,000 up to 20,000 cfs) indicates that flow conditions between Alt7M and the NAA would not be appreciably different.

Overall, Alt7M would result in little change in flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam compared to the NAA and would have no incremental effect on freshwater inflows to Apalachicola Bay. USACE assumptions regarding water supply withdrawals and return flows for Lake Lanier and for the Chattahoochee River between Buford Dam and Peachtree Creek for Alt7M would have little effect on flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam in comparison to the NAA or the other alternatives.

6.1.1.3 Drought Operations

This section discusses the effects of incorporating a basinwide drought plan into USACE operations in the ACF Basin. Features of current and proposed drought operations are described in section 2.1.1.2.4.4 and section 4.1.2.3, respectively. Composite conservation storage in USACE projects in the basin is a critical consideration in systemwide water management, particularly for project operations as drought conditions develop in the basin and for as long as those drought conditions exist. Composite conservation storage values are used to manage the system and to meet flow requirements below Jim Woodruff Lock and Dam for conservation of federally listed threatened and endangered species. This section focuses on the frequency and extent to which drought operations are encountered for the alternatives compared to conditions under the NAA, including the associated effects on the reservoirs (conservation storage) in the ACF Basin, while continuing to meet project purposes and downstream needs. The number of times that drought operations are triggered and the length of time that drought operations are in effect could have implications for other natural resource and socioeconomic resource areas (e.g., hydropower and navigation). Those effects are addressed in the pertinent resource area discussions in section 6.

Table 6.1-13 provides a qualitative assessment of the effects of the alternatives relative to drought operations in the ACF Basin. To more specifically characterize and compare the effects of drought operations among the alternatives, several parameters are considered. They include the percent of the simulated period of record in drought operations; percent of time in composite conservation storage zones 3 and 4; number of times Drought Zone operations (formerly referred to as extreme drought operations or EDO) would be triggered; and percent of time in Drought Zone operations (see Table 6.1-14). The following sections provide a more specific discussion for each alternative. Generally, a more proactive approach to conserve reservoir storage as drier conditions develop in the basin, while continuing to meet downstream commitments and needs, would be a beneficial effect of drought operations. The revised drought plan could trigger slightly constrained operations more frequently and over slightly longer periods, and the extent of those constrained operations would gradually increase only as worsening drought conditions may dictate over time. The revised drought operations plan would enable USACE to operate the USACE reservoir projects more effectively in response to drought conditions similar to those experienced several times over the modeled period of record and better position USACE to address a more severe drought of record in the future.

Table 6.1-13.
Summary of the Effects on Drought Operations for the Alternatives Compared to the NAA during the Modeled Period of Record (1939–2011)

	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
ACF Basin Drought Operations	Baseline	Slightly adverse	Beneficial	Beneficial	Slightly Beneficial	Slightly Beneficial	Beneficial	Slightly Beneficial	Beneficial	Beneficial

Notes:
Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.
Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.
Beneficial—Any beneficial impact is clearly detectable and would have an appreciable effect.

6.1.1.3.1 No Action Alternative

Under the NAA, drought operations would be triggered three times during the 73-year simulated period of record and would be in effect about 6.7 percent of the time (Table 6.1-14), equivalent to 59 months (or about 5 years). Drought operations would be initiated when the composite conservation storage enters Zone 4 and would continue until it recovers to Zone 1. The composite conservation storage level would be within zones 3 and 4 for a combined 12.4 percent of the modeled period and in Zone 4 for about 0.9 percent of the modeled period. The composite conservation storage values would not be expected to decline into the Drought Zone, triggering Drought Zone operations, over the modeled period of record.

Triggering drought operations would suspend some provisions of the RIOP. Under the NAA, the minimum release rate from Jim Woodruff Lock and Dam would near 5,000 cfs during the three periods when drought operations would be triggered (Table 6.1-14). Minimum flows would not be less than 5,000 cfs from Jim Woodruff Lock and Dam since the composite conservation storage would not decline into the Drought Zone. The 5,000 cfs minimum flow would remain in place until composite conservation storage recovers into Zone 1. At that time, the temporary drought operations provisions would be suspended and all the other operational provisions reinstated.

Table 6.1-14.
Number of Years Drought Operations and Drought Zone Operations Are Triggered and Percent of Time in Composite Zones 3 and 4, Drought Operations, and Drought Zone Operations in the ACF Basin over the Modeled Period of Record (1939–2011)

Alternative	No. of Times Drought Operations Triggered	Percent of Simulated Period in Drought Operations [a]	Percent of Time in Composite Zone 3[a]	Percent of Time in Composite Zone 4[a]	No. of Times Drought Zone Operations Triggered	Percent of Simulated Period in Drought Zone operations[a]
NAA (Alt1A)	3	6.7%[b]	11.5%	0.9%	0	0.0%
Alt1L	4	8.2%[b]	11.6%	1.2%	0	0.0%
Alt7A	21	16.3%	5.9%	3.2%	1	0.2% (2 months)
Alt7B	23	15.2%	5.5%	2.2%	0	0.0%
Alt7H	21	17.6%	6.8%	3.6%	1	0.2% (2 months)
Alt7I	21	17.6%	6.8%	3.4%	1	0.3% (3 months)
Alt7J	21	14.3%	5.8%	2.0%	0	0.0%
PAA (Alt7K)	21	17.6%	6.8%	3.5%	1	0.3% (3 months)
Alt7L	19	16.3%	5.7%	2.8%	1	0.1% (1 month)
Alt7M	19	17.0%	6.1%	3.1%	1	0.2% (2 months)

Notes:
[a] 1% of modeled period of record (73 years) = 267 days; 0.1% = 27 days.
[b] The NAA and Alt1L trigger drought operations when composite conservation storage declines into Zone 4. Drought operations for all other alternatives would be initiated when composite conservation storage declines into Zone 3.

6.1.1.3.2 Alternative 1L

Alt1L includes the same drought operations provisions as the NAA. Water supply withdrawal assumptions for Alt1L include current withdrawals from Lake Lanier (128 mgd) and projected future withdrawals from the Chattahoochee River between Buford Dam and Peachtree Creek (379 mgd), as described in section 5.2.2.1.

Alt1L would have drought operations effects similar to those under the NAA, but slightly more adverse in comparison. Alt1L would involve a slightly higher percentage of time in drought operations (8.2 percent compared to 6.7 percent for the NAA) and a higher percent of time in composite conservation storage Zone 4 (1.2 percent compared to 0.9 percent for the NAA). As with the NAA, Drought Zone operations would not occur over the modeled period of record. The slightly increased effects of drought operations under Alt1L compared to the NAA would be the result of increased releases from Buford Dam to support future water supply withdrawals from the Chattahoochee River for Metro Atlanta.

6.1.1.3.3 Alternative 7A

Alt7A incorporates the features of Water Management Alternative 7 (see section 4.2.7), which includes revised reservoir action zones and would trigger drought operations when the composite conservation storage declines into Zone 3, rather than into Zone 4, as defined for the NAA. Triggers to suspend drought operations and to initiate Drought Zone operations would remain unchanged from the NAA. Drought operations provisions would be suspended when composite conservation storage recovers into Zone 1, and Drought Zone operations would be triggered when the composite conservation storage level declines into the Drought Zone. Alt7A assumes current water supply withdrawals in Lake Lanier and downstream of Buford Dam, as described in section 5.2.3.1.

By revising the reservoir action zones and changing the drought operations trigger to composite conservation storage Zone 3 under Water Management Alternative 7, Alt7A would trigger drought operations on 21 occasions over the modeled period of record, 7 times more frequently than the NAA (see Table 6.1-14). Drought operations would be in effect 16.3 percent of the modeled period, equivalent to 143 months, or about 12 years of the 73-year period of record. While drought operations would be triggered more frequently and for more total time under Alt7A than under the NAA, less time would be spent in composite conservation storage zones 3 and 4 (Table 6.1-14). Thus, composite conservation storage values for the reservoirs would tend to remain higher for a greater portion of the time. Composite conservation storage would be in zones 3 and 4 for a combined 9.1 percent of the modeled period for Alt7A compared to 12.4 percent for the NAA. Drought Zone operations would be expected to occur one time under Alt7A and last for about 0.2 percent of the modeled period (equivalent to about 2 months), compared to no Drought Zone operations occurrences under the NAA (Table 6.1-14). During Drought Zone operations, minimum flows from Jim Woodruff Lock and Dam would temporarily be less than 5,000 cfs, but not less than 4,500 cfs.

6.1.1.3.4 Alternative 7B

Alt7B has the same drought operations provisions as Alt7A. Water supply withdrawal assumptions for Alt7B include withdrawals from Lake Lanier limited to existing relocation contracts only (20 mgd) and current water supply withdrawals downstream of Buford Dam, as described in section 5.2.4.1.

Alt7B would trigger drought operations 23 times over the modeled period of record, 20 more occurrences than under the NAA (see Table 6.1-14). Drought operations would be in effect 15.2 percent of the modeled period, equivalent to 133 months, or about 11 years of the 73-year period of record. While drought operations would be triggered more frequently and for more total time under Alt7B than under the NAA, less time would be spent in composite conservation storage zones 3 and 4 (Table 6.1-14). Thus, composite conservation storage values for the reservoirs would tend to remain higher for a greater portion of the time. Composite conservation storage would be in zones 3 and 4 for a combined 7.7 percent of the modeled period for Alt7B compared to 12.4 percent for the NAA. As with the NAA, Drought Zone operations would not be expected to occur under Alt7B over the modeled period of record (Table 6.1-14).

6.1.1.3.5 Alternative 7H

Alt7H has the same drought operations provisions as Alt7A. Water supply withdrawal assumptions for Alt7H include 185 mgd directly from Lake Lanier, 40 mgd indirectly from Lake Lanier via Glades Reservoir (no longer under consideration), and 408 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, as described in section 5.2.5.1. Alt7H was the PAA presented in the draft EIS and has been retained in the final EIS for continuity and comparison to revised alternatives that were developed following publication of the draft EIS in response to Georgia's revised 2015 water supply request.

Alt7H would be expected to trigger drought operations on 21 occasions over the modeled period of record, 18 more occurrences than for the NAA (see Table 6.1-14). Drought operations would be in effect 17.6 percent of the modeled period, equivalent to 154 months, or a total of about 12.8 years of the 73-year period of record (versus 6.7 percent of the modeled period for the NAA). The percent of cumulative time in composite conservation storage zones 3 and 4 would be less for Alt7H than for the NAA (10.4 percent versus 12.4 percent) (Table 6.1-14). Composite conservation storage values for the reservoirs would tend to remain higher for a greater portion of the modeled period under Alt7H than under the NAA. Drought Zone operations would be expected to occur one time under Alt7H and last for about 0.2 percent of the modeled period (equivalent to about 2 months) compared to no Drought Zone operations occurrences under the NAA (Table 6.1-14). During Drought Zone operations, minimum flows from Jim Woodruff Lock and Dam would temporarily be less than 5,000 cfs, but not less than 4,500 cfs.

6.1.1.3.6 Alternative 7I

Alt7I has the same drought operations provisions as Alt7A. Water supply withdrawal assumptions for Alt7I include 225 mgd from Lake Lanier and 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, as described in section 5.2.6.1.

Alt7I would trigger drought operations 21 times over the modeled period of record, 18 more occurrences than for the NAA (see Table 6.1-14). The drought operations effects would be nearly identical to those described for Alt7H, except that Alt7I would result in a slightly lower percent of time in composite conservation storage Zone 4 than Alt7H (3.4 percent versus 3.6 percent) and a slightly higher percent of time in Drought Zone operations (0.3 percent versus 0.2 percent, or about 3 months versus 2 months). These slight changes are principally the result of minor deviations in the water supply withdrawal and return assumptions for Lake Lanier and the Chattahoochee River.

6.1.1.3.7 Alternative 7J

Alt7J has the same drought operations provisions as Alt7A. Water supply withdrawal assumptions for Alt7J include withdrawals from Lake Lanier limited to existing relocation contracts only (20 mgd) and withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, as described in section 5.2.7.1.

Alt7J would trigger drought operations 21 times over the modeled period of record, 18 more occurrences than under the NAA (see Table 6.1-14). Drought operations would be in effect 14.3 percent of the modeled period, equivalent to 125 months, or about 10.4 years of the 73-year period of record. While drought operations would be triggered more frequently and for more total time under Alt7J than under the NAA, less time would be spent in composite conservation storage zones 3 and 4 (Table 6.1-14). Thus, composite conservation storage values for the reservoirs would tend to remain higher for a greater portion of the time. Composite conservation storage would be in zones 3 and 4 for a combined 7.8 percent of the modeled period for Alt7J compared to 12.4 percent for the NAA. As with the NAA, Drought Zone operations would not be expected to occur under Alt7J over the modeled period of record (Table 6.1-14).

6.1.1.3.8 Alternative 7K (PAA)

The PAA has the same drought operations provisions as Alt7A. Water supply withdrawal assumptions for the PAA include 242 mgd from Lake Lanier and 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, as described in section 5.2.8.1. These withdrawal values are consistent with the State of Georgia's revised water supply request of December 2015.

The PAA would trigger drought operations 21 times over the modeled period of record, 18 more occurrences than under the NAA (see Table 6.1-14). Drought operations would be in effect 17.6 percent of the modeled period, equivalent to 154 months, or a total of about 12.8 years of the 73-year period of record (versus 6.7 percent of the modeled period for the NAA). The percent of cumulative time in composite conservation storage zones 3 and 4 would be less for the PAA than for the NAA (10.3 percent versus 12.4 percent) (Table 6.1-14). Composite conservation storage values for the reservoirs would tend to remain higher for a greater portion of the modeled period under the PAA than under the NAA. Drought Zone operations would be expected to occur one time under the PAA and last for about 0.3 percent of the modeled period (equivalent to about 3 months) compared to no Drought Zone operations occurrences under the NAA (Table 6.1-14). During Drought Zone operations, minimum flows from Jim Woodruff Lock and Dam would temporarily be less than 5,000 cfs, but not less than 4,500 cfs.

The drought operations effects associated with the PAA would be nearly identical to those described for Alt7I, except that the PAA would result in a slightly higher percent of time in composite conservation storage Zone 4 than Alt7I (3.5 percent versus 3.4 percent). This slight difference is principally the result of an 8 percent increase in the assumed water supply withdrawals from Lake Lanier reflected in the PAA compared to Alt7I.

6.1.1.3.9 Alternative 7L

Alt7L has the same drought operationst provisions as Alt7A. Water supply withdrawal assumptions for Alt7L include current withdrawals (128 mgd) from Lake Lanier and 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, as described in section 5.2.9.1. The withdrawal value below Buford Dam reflects future water supply withdrawal demands consistent with the State of Georgia's revised water supply request of December 2015.

Alt7L would trigger drought operations 19 times over the modeled period of record, 16 more occurrences than under the NAA (see Table 6.1-14). Compared to the NAA, the drought operations effects for Alt7L would be similar to those described for Alt7A with the following exceptions: Alt7L would result in a slightly lower percent of cumulative time in composite conservation storage zones 3 and 4 than Alt7A (8.5 percent versus 9.1 percent) and a slightly lower percent of time in Drought Zone operations (0.1 percent versus 0.2 percent, or about 1 month versus 2 months). These slight changes result from different assumptions between the alternatives for water supply withdrawals and return flows in the Chattahoochee River downstream of Buford Dam.

6.1.1.3.10 Alternative 7M

Alt7M has the same drought operations provisions as Alt7A. Water supply withdrawal assumptions for Alt7M include 185 mgd from Lake Lanier and 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, as described in section 5.2.10.1. The withdrawal value for Lake Lanier would partially meet future water supply withdrawal needs consistent with the State of Georgia's revised water supply request of December 2015, and the withdrawal value below Buford Dam would be fully consistent with that request.

Alt7M would trigger drought operations 19 times over the modeled period of record, 16 more occurrences than under the NAA (see Table 6.1-14). Compared to the NAA, the drought operations effects for Alt7M would be similar to those described for Alt7A with the following exceptions: Alt7M would result in a slightly higher percent of cumulative time in composite conservation storage zones 3 and 4 than Alt7A (9.2 percent versus 9.1 percent) and a slightly higher percent of time in Drought Zone operations (0.2 percent versus 0.1 percent, or about 2 months versus 1 month). These slight deviations result from different assumptions between the alternatives for water supply withdrawals and return flows in Lake Lanier and downstream of Buford Dam.

6.1.1.4 Navigation Flow Targets

Section 4.1.2.6 describes the development of several options to provide sufficient flows to support a navigable channel in the Apalachicola River (for both 7-ft and 9-ft channel depths) in conjunction with other pertinent operating parameters and constraints for the ACF Basin. To provide these navigation channel depths, releases from Jim Woodruff Lock and Dam must be sufficient to ensure flows at Blountstown, Florida, of 16,200 cfs to support a 7-ft channel depth and 20,600 cfs to support a 9-ft channel depth. USACE analyzed the navigation options to determine which one would perform the most effectively overall. A 5-month navigation season (January–May) was selected as the best overall measure to support navigation channel availability (section 4.1.2.6.4). Implementation of the navigation season in any given year would be dependent upon sufficient BI to support navigation releases on balance with other authorized project purposes, as described in section 5.4.5 and Figure 5.4-6. Inflow conditions in the ACF Basin, particularly during drier seasons, as well as the actual or planned use of the channel for commercial navigation, could influence the actual length of the navigation season each year. Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M incorporate the 5-month navigation season as a feature. The NAA and Alt1L represent alternatives that reflect current water management operations in the ACF Basin and do not include specific provisions to provide for specific releases to support navigation. However, the analysis that follows presents information on the extent to which the NAA and Alt1L would incidentally provide sufficient navigation flows between January and May for comparison to the other alternatives.

The proposed navigation season is based on the critical assumption that the channel in the Apalachicola River downstream of Jim Woodruff Lock and Dam is relatively stable and would continue to support a minimum navigable depth of 7 ft and/or 9 ft when the necessary flows described above are provided. USACE would monitor channel conditions in the Apalachicola River to ensure that the flow levels actually provide the requisite navigable depths and to identify where in the river any potential navigation constraints might exist.

Water management operations in support of navigation under the proposed alternatives would generally be compatible with fish and wildlife conservation objectives in the Apalachicola River and with the recommendations of the USFWS, in coordination with the National Marine Fisheries Service and the Florida Fish and Wildlife Conservation Commission. Releases to sustain navigable channel depths during January–May each year, when practicable, can intermittently provide increased flows in the Apalachicola River above that necessary to sustain fish and wildlife. These releases also provide an incidental benefit to fisheries downstream of Jim Woodruff Lock and Dam. See section 6.4 for a more detailed discussion of the effects of the alternatives on fish and wildlife resources.

The following analysis focuses on the extent to which specific navigation flow targets at Blountstown, Florida, can be met on balance with other factors that may limit the ability to meet those flow targets from January through May, including BI and the available conservation storage in upstream reservoirs. Representative summaries of HEC-ResSim model outputs provide the principal basis for the analysis and represent simulation of project operations under the alternatives over the modeled period of record.

Table 6.1-15 provides a qualitative assessment of the effects of the alternatives on flow conditions necessary to support navigation channel availability compared to the NAA. The general assessment is based on the interpretation of the model results in the figures and tabulated information presented below. The model results for the alternatives are discussed in more detail in the following sections.

Table 6.1-15.
Summary of the Effects on Channel Availability of the Alternatives from the NAA during the Modeled Period of Record (1939–2011)

Channel Availability	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
7.0-ft	Baseline	Negligible/ No change	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial
9.0-ft	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
Substantially beneficial—Any beneficial impact would result in a highly noticeable effect.

Figure 6.1-59 through Figure 6.1-64 present model outputs for navigation operations over the modeled period of hydrologic record for the NAA along with the results for the alternatives for the Master Manual update as defined by Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M. The figures present results for percent availability of a 7-ft channel, the number of seasons the 7-ft channel would be fully available (100 percent), and the number of navigation seasons the 7-ft channel would be available at least 90 percent of the time. In consideration of the number of alternatives and the ease of viewing the information about each alternative, the results for each parameter (e.g., percent availability of 7-ft channel) are presented in two figures with half of the alternatives presented on each figure. Using the results from these figures and other information as appropriate, the relative effects associated with each alternative are presented below.

This section does not include figures depicting model results that address 9-ft navigation channel availability. Model outputs for the NAA and all other alternatives indicate that values for the percent of time over the modeled period of record that a 9-ft channel would be available are all extremely low and vary little among alternatives (ranging from 2.7 percent to 5.5 percent). Likewise, values for the number of navigation seasons that a 9-ft channel would be fully available over the period of record are insignificantly low and vary little among the alternatives (ranging from 2 years to 4 years). Consequently, the values, and differences among those values, for the availability of 9-ft channel depths for a January–May navigation season would be of little benefit to navigation users and are not discussed further in the EIS.

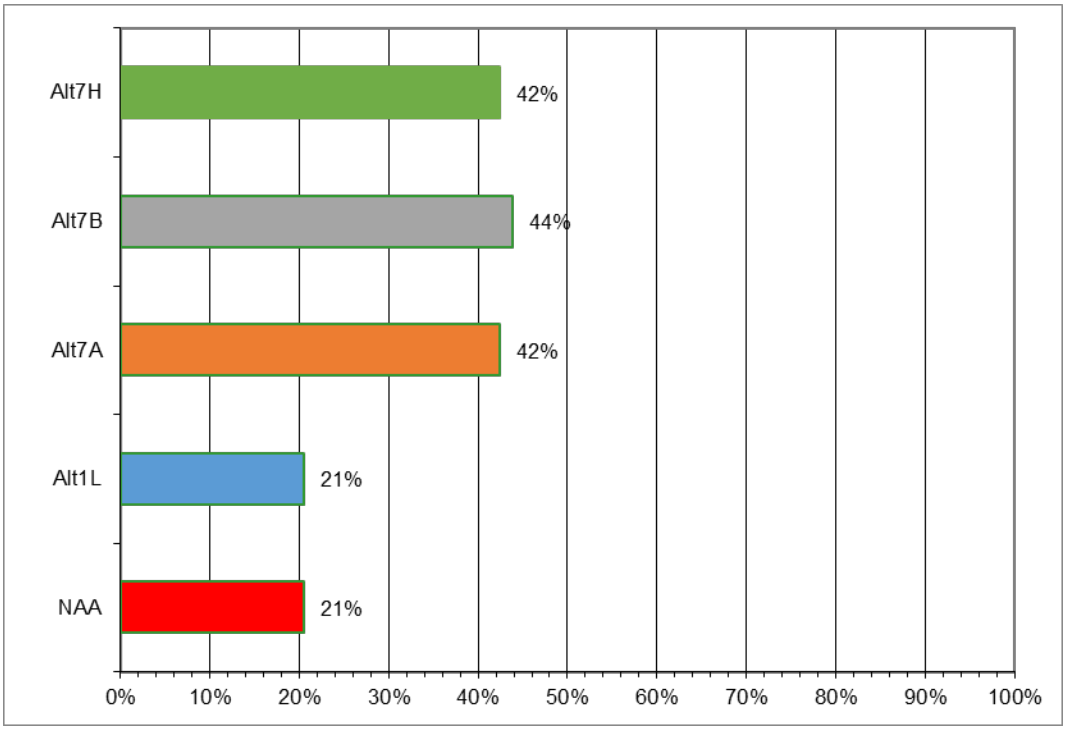


Figure 6.1-59. Percent of Years a 7-ft-deep Channel would be Available during the Entire Navigation Season (Jan–May) in the ACF Basin over the Simulated Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

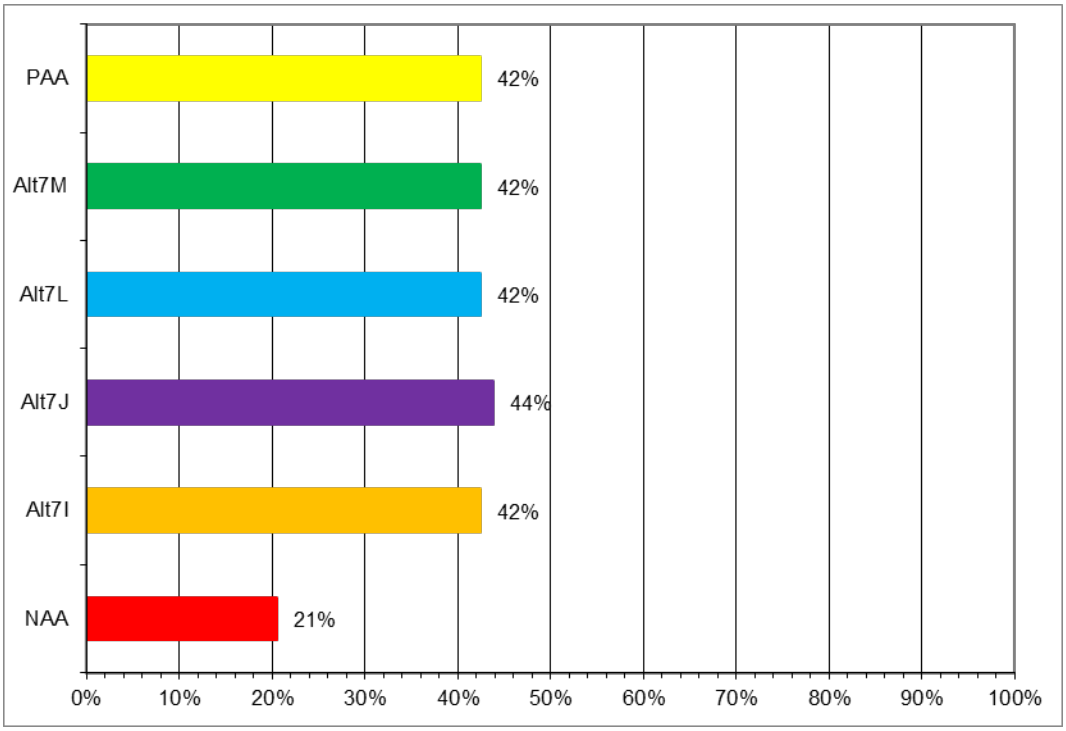


Figure 6.1-60. Percent of Years a 7-ft-deep Channel Would Be Available during the Entire Navigation Season (Jan–May) in the ACF Basin over the Simulated Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

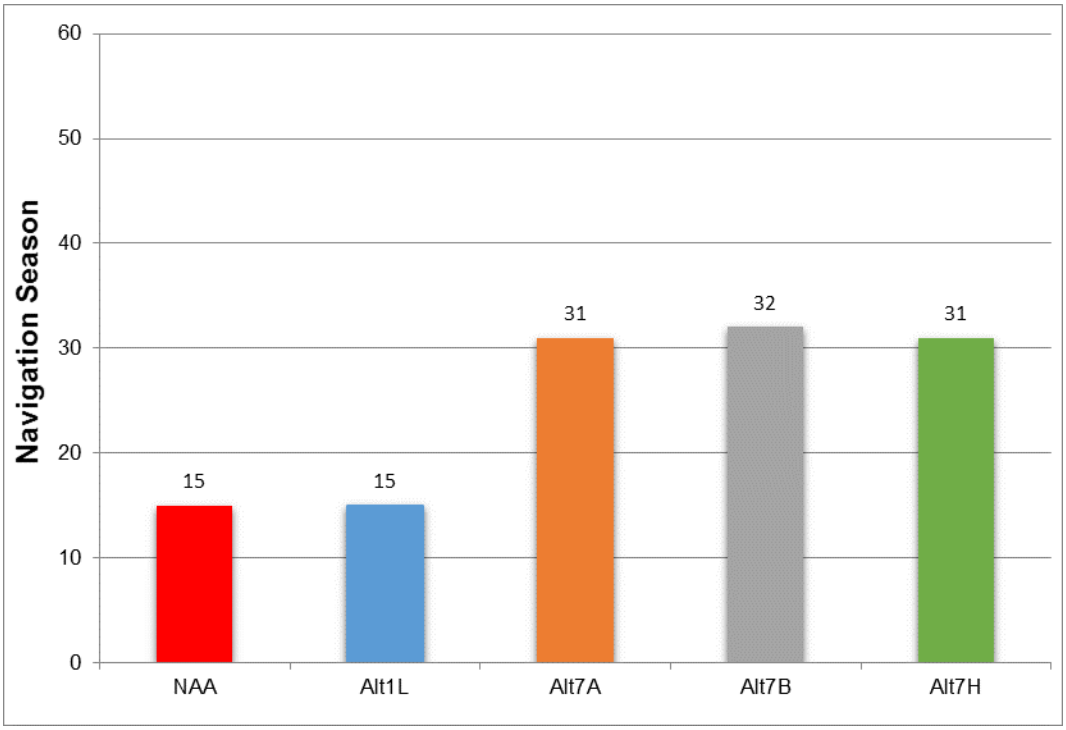


Figure 6.1-61. Number of Navigation Seasons Providing 7-ft-deep Channel (100-Percent Availability) in ACF Basin Projects over the Simulated Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

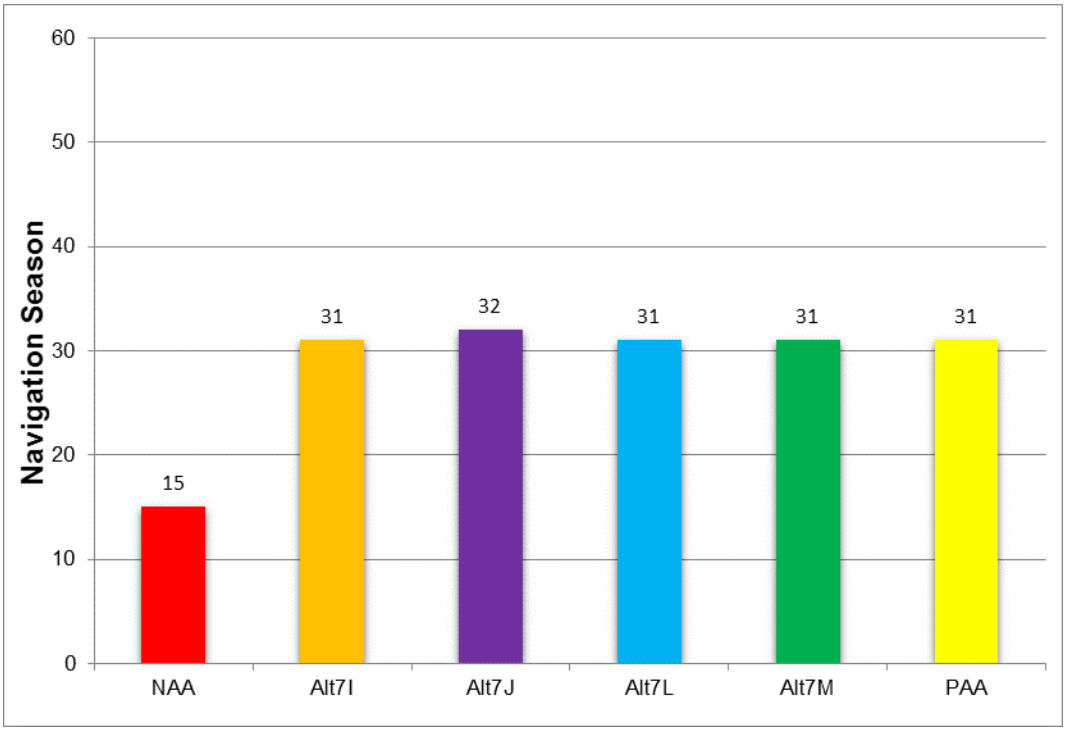


Figure 6.1-62. Number of Navigation Seasons Providing 7-ft-deep Channel (100-Percent Availability) in ACF Basin Projects over the Simulated Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

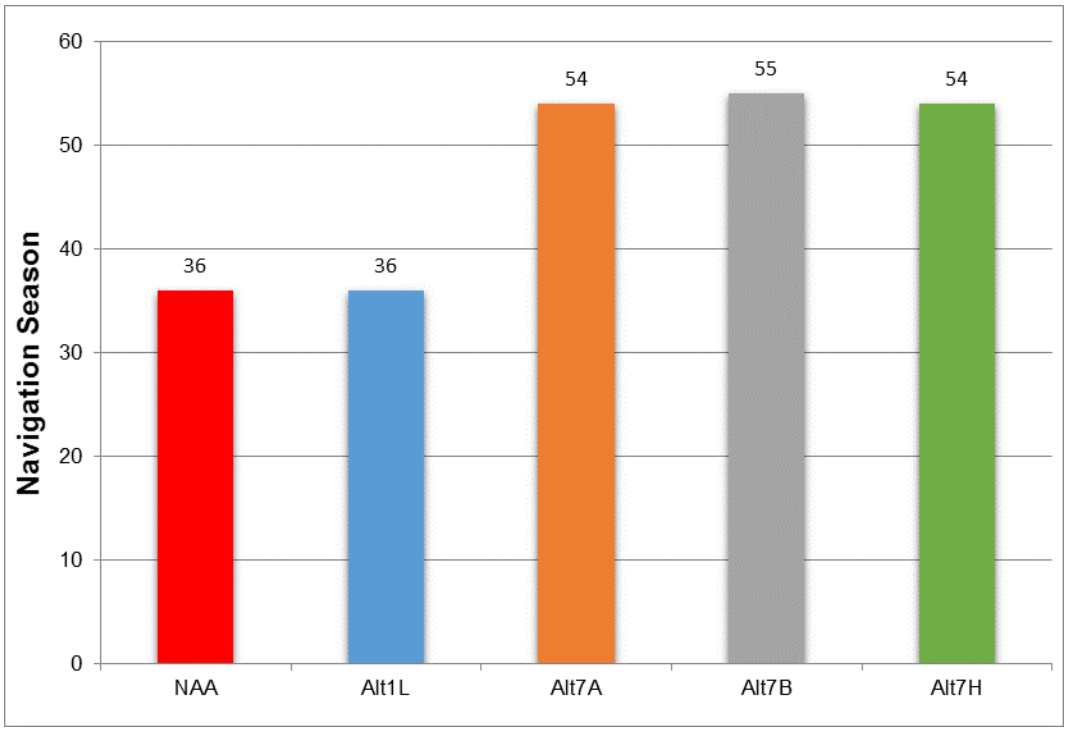


Figure 6.1-63. Number of Navigation Seasons Providing 7-ft-deep Channel (90-Percent Availability) in ACF Basin Projects over the Simulated Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

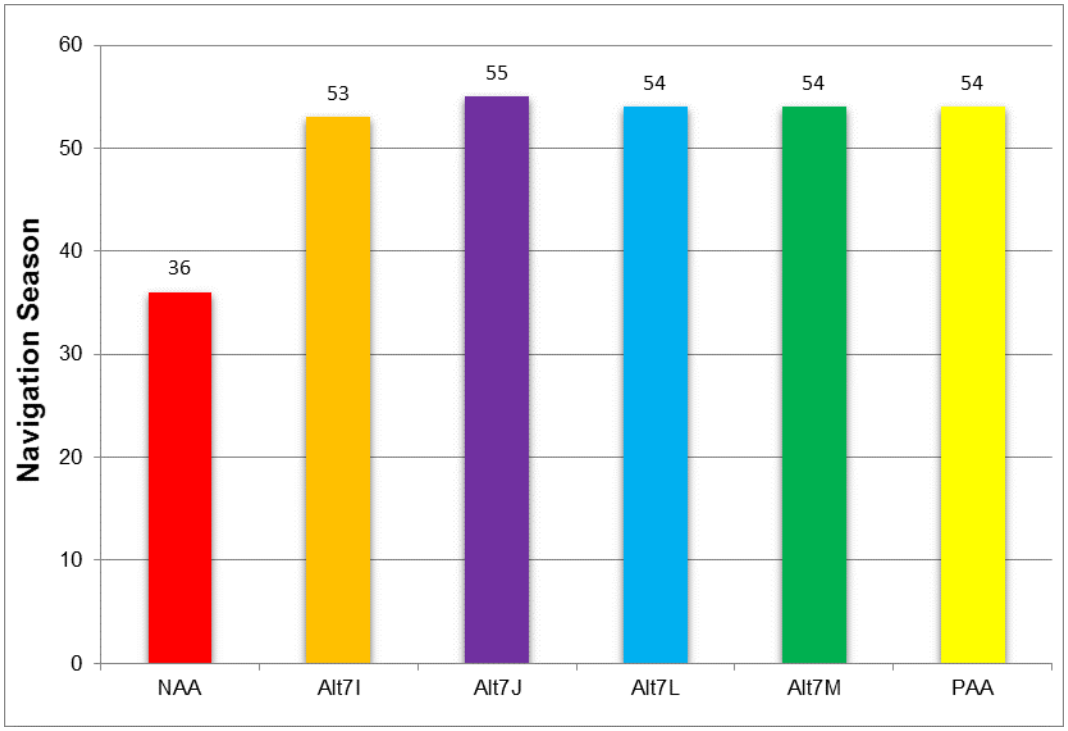


Figure 6.1-64. Number of Navigation Seasons Providing 7-ft-deep Channel (90-Percent Availability) in ACF Basin Projects over the Simulated Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

6.1.1.4.1 No Action Alternative

USACE has not specifically implemented routine water management measures to sustain reliable navigation conditions in the Apalachicola River since 2001. Before 2001, maintenance of year-round navigation channel reliability in the Apalachicola River was provided by a combination of training works, snagging and maintenance dredging in the Apalachicola River, and releases from Jim Woodruff Lock and Dam, particularly in the low-water season in late summer and fall. Under the NAA, no change in current USACE practices would occur specifically for navigation purposes. Based on experience and consultation with navigation interests, a 7-ft channel would meet the minimum requirements of most navigation users. Even under historical operations, flow conditions in the ACF Basin did not enable the USACE to provide the authorized 9-ft by 100-ft navigation channel on a year-round basis during all years. Without maintenance dredging in the Apalachicola River, it is unreasonable to expect that navigation releases alone could sustain the authorized 9-ft-deep channel, although at times during the spring high-water season, flows could support 9-ft navigation depths for intermittent periods.

Water management operations in the ACF Basin under the NAA would consist of short-term releases to provide minimum required channel depths to address specific short-term navigation needs as they may arise. Special navigation releases would be considered on a case-by-case basis, as requested by navigation interests and as determined by USACE to be consistent with other ACF Basin requirements.

USACE evaluated the NAA over the modeled period of record to determine, for comparison purposes, the degree to which the navigation channel would incidentally be available to users between January and May each year. For the NAA, flows sufficient to support a minimum 7-ft channel for 5 months would be expected to be available at least 21 percent of the years in January–May (Figure 6.1-59). The differences in channel availability are likely to be primarily the result of operations under the NAA with no operational features specifically aimed at meeting a navigation flow target.

Figure 6.1-61 indicates the number of navigation seasons (January–May) that a 7-ft channel would be available in the Apalachicola River. For the NAA, 7-ft channel depths would likely be fully available (i.e., 100 percent) in 15 of 73 years. In addition, model results for the NAA were reviewed to determine the extent to which navigable depths would be available using a 90-percent reliability standard (i.e., channel depths available 90 percent of the time during the navigation season). This is an important benchmark used by the navigation industry to judge channel reliability. Using this 90-percent reliability standard, navigable depths of 7 ft under the NAA would be available from January through May in 36 of 73 years (about 50 percent) (Figure 6.1-63).

6.1.1.4.2 Alternative 1L

As with the NAA, Alt1L does not include specific operational measures to provide releases from Jim Woodruff Lock and Dam sufficient to support a January–May navigation season. Therefore, Alt1L would provide the same results as the NAA with respect to navigation channel availability (see Figure 6.1-59, Figure 6.1-61, and Figure 6.1-63).

6.1.1.4.3 Alternative 7A

Alt7A includes water management features to support a 5-month navigation season (January–May). For Alt7A, flows sufficient to support a minimum 7-ft channel for 5 months would be available in at least 42 percent of the years (Figure 6.1-59). That value represents a 100-percent improvement in the availability of a viable 7-ft navigation channel compared to the NAA.

Figure 6.1-61 indicates that the number of navigation seasons that a 7-ft channel would be fully available would increase from 15 years under the NAA to 31 years for Alt7A (out of 73 years). This would represent a 107-percent improvement compared to the NAA. Using a 90-percent reliability benchmark for navigation channel depths for each 5-month navigation season (January–May) over the 73-year modeled period of record, the ACF Basin project operations for Alt7A would meet the 90-percent standard in 54 of 73 years compared to 36 of 73 years for the NAA, an improvement of 50 percent (Figure 6.1-63).

6.1.1.4.4 Alternative 7B

Alt7B includes water management features to support a 5-month navigation season (January–May). Compared to the NAA, Alt7B would provide improvement in the availability of a 7-ft navigation channel depth similar to that described for Alt7A, except that results for Alt7B would be slightly higher. For Alt7B, 7-ft channel availability would occur in 44 percent of the years in the period of record (or 32 years) versus 42 percent (or 31 years) for Alt7A (see Figure 6.1-59 and Figure 6.1-61). For Alt7B, 90-percent availability of a 7-ft channel would occur in 55 of 73 years versus in 54 of 73 years for Alt7A (Figure 6.1-63). Limitations on water supply withdrawals in Lake Lanier to relocation contracts only (20 mgd) under Alt7B is the principal reason for the slightly improved result for channel availability compared to Alt7A.

6.1.1.4.5 Alternative 7H

Alt7H includes water management features to support a 5-month navigation season (January–May). Compared to the NAA, Alt7H would provide improvement in the availability of a 7-ft navigation channel depth identical to that described for Alt7A (see Figure 6.1-59, Figure 6.1-60, Figure 6.1-61, and Figure 6.1-63). This value represents a 100-percent improvement in the availability of a viable 7-ft navigation channel compared to the NAA.

Figure 6.1-62 indicates that the number of navigation seasons that a 7-ft channel would be fully available would increase from 15 of 73 years under the NAA to 31 of 73 years for Alt7H. That would represent a 107-percent improvement over the NAA. Using a 90-percent reliability benchmark for navigation channel depths for each 5-month navigation season (January–May) over the 73-year modeled period of record, ACF Basin project operations for Alt7H would meet the 90-percent standard in 54 of 73 years compared to 36 of 73 years for the NAA, an improvement of 50 percent (Figure 6.1-64).

6.1.1.4.6 Alternative 7I

Alt7I includes water management features to support a 5-month navigation season (January–May). Compared to the NAA, Alt7I would provide improvement in the availability of a 7-ft navigation channel depth nearly identical to that described for Alt7A. See results for Alt7I on Figure 6.1-60, Figure 6.1-62, and Figure 6.1-64.

6.1.1.4.7 Alternative 7J

Alt7J includes water management features to support a 5-month navigation season (January–May). The results for Alt7J compared to the NAA would be identical to those described for Alt7B. See results for Alt7J on Figure 6.1-60, Figure 6.1-62, and Figure 6.1-64.

6.1.1.4.8 Alternative 7K (PAA)

The PAA includes water management features to support a 5-month navigation season (January–May). Compared to the NAA, the PAA would provide improvement in the availability of a 7-ft navigation channel depth identical to that described for Alt7A. Flows sufficient to support a minimum 7-ft channel

would be expected to be available at least 42 percent of the days in January–May (Figure 6.1-60). This value represents a 100-percent improvement in the availability of a viable 7-ft navigation channel over the NAA.

Figure 6.1-62 indicates that the number of navigation seasons that a 7-ft channel would be fully available would increase from 15 of 73 years under the NAA to 31 of 73 years for the PAA. That would represent a 107-percent improvement over the NAA. Using a 90-percent reliability benchmark for navigation channel depths for each 5-month navigation season (January–May) over the 73-year modeled period of record, the PAA would meet the 90-percent standard in 54 of 73 years compared to 36 of 73 years for the NAA, an improvement of 50 percent (Figure 6.1-64).

6.1.1.4.9 Alternative 7L

Alt7L includes water management features to support a 5-month navigation season (January–May). Compared to the NAA, Alt7L would provide improvement in the availability of a 7-ft navigation channel depth identical to that described for Alt7A. See results for Alt7L on Figure 6.1-60, Figure 6.1-62, and Figure 6.1-64.

6.1.1.4.10 Alternative 7M

Alt7M includes water management features to support a 5-month navigation season (January–May). Compared to the NAA, Alt7M would provide improvement in the availability of a 7-ft navigation channel depth identical to that described for Alt7A. See results for Alt7M on Figure 6.1-60, Figure 6.1-62, and Figure 6.1-64.

All of the alternatives that include the features of Water Management Alternative 7 would provide essentially the same level of improvement in the availability of a 7-ft navigation channel depth in the Apalachicola River between January and May over the modeled period of record. The improvement in the availability of a 7-ft navigation channel depth would be substantial compared to the NAA, as reflected in the above analysis. The range of potential water withdrawals from Lake Lanier and the Chattahoochee River below Buford Dam have little influence on the extent to which the various alternatives (Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M) improve the availability of 7-ft navigation channel depths in the Apalachicola River between January and May each year.

6.1.1.5 Water Supply Intake Structures

This section discusses the potential impacts of alternatives to revising the Master Manual on existing M&I water intake structures in the reservoirs and mainstem rivers and their ability to continue to make water supply withdrawals under a range of hydrologic conditions. The impact descriptions summarized in Table 6.1-16 provide a qualitative assessment of the potential impacts. The assessment is based upon HEC-ResSim outputs, other studies as cited herein, and the historical record. The following subsections provide additional details on the potential effects.

Numerous M&I water supply withdrawals occur from the USACE and other nonfederal reservoirs and from the mainstem rivers in the ACF Basin. Those withdrawals are summarized in section 2.1.1.2.5. This section addresses potential effects on water withdrawals and intake structures from Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M.

Table 6.1-16.
Summary of the Effects on Water Supply Intake Conditions of the Alternatives from the NAA over the Modeled Period of Record (1939–2011)

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Buford Dam to West Point Dam	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Elsewhere in the ACF Basin	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.1.1.5.1 Water Supply Intake Structures in Lake Lanier, Georgia

Major M&I water intake structures in Lake Lanier include facilities owned and operated by Buford, Cumming/Forsyth County, Gainesville, and Gwinnett County, Georgia. About 128 mgd (monthly average) were withdrawn in 2007 through these structures.

6.1.1.5.1.1 No Action Alternative

The minimum water surface elevation under the NAA, based on the HEC-ResSim simulation over the 73-year hydrologic period of record, would be 1,054.3 ft. The historic low-pool level for Lake Lanier was elevation 1,050.8 ft in December 2007. At that time, all of the intake structures in the lake were able to function successfully. Thus, no effect on water intake structures would be expected under the NAA.

6.1.1.5.1.2 Alternative 1L

The minimum water surface elevation under Alt1L would be 1,053.8 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.1.3 Alternative 7A

The minimum water surface elevation under Alt7A would be 1,053.7 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.1.4 Alternative 7B

The minimum water surface elevation under Alt7B would be 1,053.7 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.1.5 Alternative 7H

The minimum water surface elevation under Alt7H would be 1,050.2 ft, based on the HEC-ResSim simulation over the period of record, about 0.6 ft lower than Lake Lanier's historic minimum pool elevation of 1,050.8 in December 2007. Reaching that elevation would be an extremely rare and

short-term occurrence, as the pool elevation would be expected to be 1,054.1 ft or higher on about 99 percent of the days over the simulated period of record. Even though pool elevations under Alt7H could briefly decline slightly below the historic minimum elevation under the most severe drought conditions, no adverse effect on water intake structures or operations in Lake Lanier would be expected.

6.1.1.5.1.6 Alternative 7I

The minimum water surface elevation under Alt7I would be 1,051.1 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.1.7 Alternative 7J

The minimum water surface elevation under Alt7J would be 1,054.6 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.1.8 Alternative 7K (PAA)

The minimum water surface elevation under the PAA would be 1,050.7 ft, based on the HEC-ResSim simulation over the period of record. This would be about 0.1 ft lower than Lake Lanier's historic minimum pool elevation of 1,050.8 in December 2007. Reaching that elevation would be an extremely rare and short-term occurrence, as the pool elevation would be expected to be 1,054.4 ft or higher on about 99 percent of the days over the simulated period of record. Even though pool elevations under the PAA could briefly decline slightly below the historic minimum elevation under the most severe drought conditions, no adverse effect on water intake structures or operations in Lake Lanier would be expected.

6.1.1.5.1.9 Alternative 7L

The minimum water surface elevation under Alt7L would be 1,053.0 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.1.10 Alternative 7M

The minimum water surface elevation under Alt7M would be 1,051.7 ft, based on the HEC-ResSim simulation over the period of record. As with the NAA, no effect on water intake structures in Lake Lanier or on their ability to function successfully would be expected.

6.1.1.5.2 Water Supply Intake Structures between Buford Dam and West Point Dam, Georgia

Operations at Buford Dam under the water management alternatives/water supply options for the ACF Basin were reviewed for potential effects on major M&I water supply intakes on the Chattahoochee River from Buford Dam to the vicinity of Whitesburg, Georgia (at Chattahoochee RM 259.8 above the headwaters of West Point Lake). Alternatives that include seasonal minimum flows at Peachtree Creek of less than 750 cfs could result in decreases to the downstream water surface profile in this reach of the Chattahoochee River and potentially conflict with the operational requirements for the intake structures. River stages at those intakes under various hydrologic conditions could be insufficient to support proper operation of the intakes. The current and future rates of withdrawal from the structures are discussed separately in section 5.2.

Four major M&I and two thermoelectric power plant water intakes of particular interest are between Buford Dam and the vicinity of Whitesburg, Georgia. Those facilities are (from upstream to downstream):

- Atlanta—Fulton County Water Intake (RM 329.3)
- DeKalb County Water Intake near Norcross (RM 325.1)
- Cobb County—Marietta Water Intake below Morgan Falls Dam (RM 310.4)
- City of Atlanta Intake at Peachtree Creek (RM 300.4)
- GPC Plant McDonough Intake at Peachtree Creek (RM 299.2)
- GPC Plant Yates Intake near Whitesburg (RM 257.8)

In addition, the trout hatchery operated by the Georgia Department of Natural Resources has a water intake about 1.9 mi below Buford Dam.

Farther downstream of Whitesburg, the City of LaGrange, Georgia, withdraws its water supply from West Point Lake. Before West Point Dam was constructed, the city obtained its water supply from the Chattahoochee River. The city has a water withdrawal permit from GAEPD for up to 16.0 mgd (monthly average) and withdraws about 10 mgd to meet the water supply needs of the community.

6.1.1.5.2.1 No Action Alternative

In February 2008, in the midst of the severe 2007–2008 drought period, GAEPD requested that USACE consider temporarily reducing releases at Buford Dam sufficient to support a continuous minimum flow at Peachtree Creek of 550 cfs rather than the normal 750 cfs requirement (GAEPD 2008c). GAEPD proposed the change as a temporary means to conserve depleted conservation storage in Lake Lanier. As an integral part of that request, GAEPD performed modeling to document the potential effects of lowering the minimum flow at Peachtree Creek to 650, 600, and 550 cfs on the water surface profile in this reach of the Chattahoochee River and, consequently, on water supply intake structures and operations between Buford Dam and West Point Lake. The modeling performed by GAEPD confirmed that, even at the 550 cfs minimum flow level, all of the water intakes between Buford Dam and the headwaters of West Point Lake would remain viable and functional for their intended purposes. USACE subsequently curtailed releases to support a minimum flow of 650 cfs at Peachtree Creek in early 2008 on a temporary basis with no observed adverse effects on the water intake structures. Under the NAA, the minimum flow requirement at Peachtree Creek would remain at 750 cfs. Accordingly, no impacts on water intake structures in the Chattahoochee River between Buford Dam and West Point Lake would occur.

In West Point Lake, the lowest pool elevation that would be expected based upon the HEC-ResSim simulation over the 73-year hydrologic period of record would be 621 ft. The historic low-pool level for West Point Lake is elevation 619.7 ft, which occurred in November 1985. At that time and during other low water events, the LaGrange, Georgia, water intake structure has been able to function successfully. The intake structure houses a series of intakes at elevations of 628, 623, 618, and 600 ft. Thus, no effect on this water intake structure would be expected under the NAA.

6.1.1.5.2.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

For Alt1L, the minimum flow requirement at Peachtree Creek would remain at 750 cfs at all times, and no effects on intake structures between Buford Dam and West Point Lake would be expected. For Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M, the minimum flow requirement at Peachtree Creek would remain at 750 cfs from May through October and change to 650 cfs from November through April. Based upon the modeling by the GAEPD and the actual performance of the intake structures between Buford Dam and West Point Lake in 2008 as presented in section 6.1.1.5.2.1, no impacts on

water intake structures in the Chattahoochee River between Buford Dam and West Point Lake would be expected.

The minimum elevation for West Point Lake under all of the alternatives, based upon the HEC-ResSim simulation over the period of record, would be about elevation 621 ft compared to a historic low-pool elevation of 619.7 ft (November 1985). As with the NAA, no effect on the LaGrange water intake structure or its operation in West Point Lake would be expected.

6.1.1.5.3 Other Water Withdrawal Structures in the ACF Basin

There are a number of other M&I water supply withdrawal structures in the Chattahoochee River downstream of West Point Dam, in the Flint River (including the reservoirs on the Chattahoochee and Flint rivers), and in the Apalachicola River downstream of Jim Woodruff Lock and Dam. Water withdrawals throughout the basin are identified in section 2.1.1.2.5. None of the water intake structures in the Flint River would be affected by the ACF Basin water management alternatives/water supply options under consideration in this EIS.

The City of Columbus. Georgia, withdraws water directly from Lake Oliver, one of the run-of-river GPC hydroelectric projects on the Chattahoochee River near Columbus. The city's intake is below the Lake Oliver permanent pool elevation of 337 ft.

Stakeholders have expressed concern about potential impacts from ACF Basin water management activities on operations at two specific water supply intake structures in Walter F. George Lake and Lake Seminole. They are the intake structures for the WestRock (formerly MeadWestvaco) Mahrt Mill located along Walter F. George Lake between Phenix City and Eufaula, Alabama, and the Southern Nuclear Operating Company's Farley Nuclear Plant near Columbia, Alabama. Section 6.1.1.2 has additional information related to potential effects on those facilities related to minimum flow considerations.

6.1.1.5.3.1 No Action Alternative

The NAA would not affect the viability or operation of any water intake structures located in the GPC reservoirs on the Chattahoochee River between West Point Dam and Columbus, Georgia.

Based upon the HEC-ResSim simulation over the period of record, the lowest pool elevation for the NAA expected at Walter F. George Lake would be about elevation 184.6 ft compared to a historic low-pool elevation of 183.2 ft (April 1965). The HEC-ResSim simulation indicates that the pool elevation would exceed 186.2 ft about 99 percent of the time. The WestRock plant's water intake in the lake is at elevation 178.8 ft. Per previous input from WestRock, the pumping capacity at the structure reduces to 75 percent when the water surface elevation declines to 184.75 ft. WestRock has installed emergency pumps at the intake to operate temporarily at or below pool elevation 178.8 ft to maintain pumping capacity. The NAA would have a negligible effect on the viability and operation of the WestRock water intake structure.

For the NAA, Lake Seminole would be expected to generally operate within a range of elevation 76–77 ft, with a record low level of 74.2 ft (November 1978). Based upon their November 2008 scoping letter for the Master Manual update (and subsequently reaffirmed), the Southern Nuclear Operating Company has indicated that a pool elevation of 74.5 ft and a flow of 2,000 cfs are the minimum conditions necessary for long-term operation of Plant Farley. For short periods (defined by Southern Nuclear as a few days), the plant can operate slightly below these levels without significant restrictions. Minimum streamflow conditions are specifically addressed in section 6.1.1.2.4. The historic minimum pool level for Lake Seminole is elevation 74.2 (November 1978). The amount of time that pool levels would be expected to decline below elevation 74.5 ft over the modeled period of record would be negligible.

The only major surface water withdrawal structure in the Apalachicola River provided water for Gulf Power Company's Scholz Electric Generating Plant prior to plant closure. Gulf Power Company ceased water withdrawals and closed Plant Scholz in April 2015 (Jackson County Floridan 2015).

6.1.1.5.3.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Based upon the HEC-ResSim simulation over the period of record, the lowest pool elevation for these alternatives expected at Walter F. George Lake would be about elevation 184.5 ft compared to a historic low-pool elevation of 183.2 ft (April 1965). The HEC-ResSim simulation indicates that the pool elevation would exceed 185.6 ft about 99 percent of the time.

The effects of Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M on water intake structures and their operation in the Chattahoochee River downstream of West Point Lake and in the Apalachicola River would be the same as for the NAA. No adverse effects on those structures would be expected for any of the alternatives.

6.1.2 Water Quality Environmental Consequences

This section details the results of HEC-5Q modeling under the NAA and various water supply options and address the associated environmental consequences for each alternative. As of January 2010, USACE's TEN guidance listed HEC-5Q as "allowed for use." The water quality model was created to serve as a defensible screening tool to make relative comparisons of the impacts of the various alternatives. The central focus of this effort was to facilitate evaluation of the differences in water quality between alternatives over the algal growing season (April–October). The growing season is a period of plant productivity followed by warm temperatures and little rainfall. HEC-5Q also allows the evaluation of water quality effects in dam tailraces as a result of varying water management operations when other models might not allow simulation of systemwide effects.

The HEC-5Q results presented in this section are for the modeled period from 2001 through 2011. That period represents point and nonpoint contributions from 2001 through 2008, with monthly average values assumed for the remainder of the modeled period. Default values or relationships between parameters were used for periods with insufficient data (see appendix K). Loads from both point and nonpoint sources were varied in modeling the scenarios based on assumptions defined in section 5.2 for changes in withdrawals and wastewater return rates. Therefore, the results presented in this section illustrate how reallocating storage in Lake Lanier would affect water quality. Details of the modeling assumptions for withdrawal and return rates are provided in appendix K.

The purpose of simulating conditions during the period of 2001–2011 was not to capture historical changes in water quality, but to capture the range of potential hydrologic conditions that influence water quality. It also was important to consider the variation of critical conditions for water quality parameters under different flow and water temperature conditions. For example, water temperatures increase in warm-weather months and in low streamflow conditions. In wet-weather conditions, nutrient concentrations can increase. For that reason, water quality conditions are defined for representative wet, dry, and normal weather conditions. State and federal agencies also define warm-weather months, or the *growing season*, in different ways for regulatory purposes. The figures in this section illustrate annual conditions as well as seasons defined by May–October for water temperature and oxygen and April–October for nutrients. The modeled period includes wet, dry, and normal rainfall conditions, or weather years, to display the water quality response to varying hydrologic conditions. The wet, dry, and normal weather years are 2005, 2007, and 2004, respectively, based on a precipitation analysis.

The following sections present the difference—or *delta*—in various modeled parameters between the NAA and the nine alternatives. The longitudinal profiles presented illustrate the percentage of time a concentration of pollutants occurs as a *percent occurrence* at stations in the Apalachicola and Chattahoochee rivers. The locations of the stations are presented in appendix K in terms of RMsabove the mouth of the Apalachicola River. Occurrence profiles by RM illustrate how water quality varies along the reach and how dams, other structures, or discharges from point and nonpoint sources might affect water quality. This approach illustrates the amount of time a concentration is higher or lower than a particular value. In those plots, the 5th, 50th (or median), and 95th percent occurrences calculated from daily average modeled results are illustrated. Results were output every 6 hours from HEC-5Q, and the daily average results were computed from that output.

Percentiles in the figures to follow illustrate the range of concentrations that would be likely to occur. The median values reflect the points at which 50 percent of the calculated values are higher and 50 percent are lower. The 95th and 5th percent occurrences bracket the range of high and low calculated values that rarely occur. For example, if a dissolved oxygen (DO) plot shows a 5th percent occurrence level at 6 milligrams per liter (mg/L), 5 percent of the observations were lower than that concentration. A 95th percent occurrence level at 12 mg/L shows that 95 percent of modeled concentrations fell below 12 mg/L. Conversely, the same occurrence level indicates that 5 percent of the model values were higher than 12 mg/L. This approach to presenting modeled results should facilitate understanding of the system's response without allowing the data from extreme events to skew the results. Note that the percent *occurrence* is the opposite of the percent *exceedance*.

Each alternative was compared against the NAA to determine the effects that could be expected. The sections that follow define the changes from the NAA for various pollutants that could be affected by changes in the operation of USACE reservoirs and wastewater returns. As in past years, temporary water management actions could be considered and, when appropriate and as reservoir conditions would allow, conducted to alleviate critical problems, including water quality issues. Those temporary deviations in operations are not captured in the figures to follow. The operations of alternatives carried forward are defined in sections 4 and 5. Section 2.1.1.2.4.7 describes how special temporary operations could be implemented during extreme drought conditions based on coordination with project users and interested stakeholders.

Sections to follow describe if violations of water quality standards would be expected and if they would be attributed to water management activities (by comparing the NAA with Alt7A) or wastewater returns (by comparing Alt7I, Alt7J, the PAA, Alt7L, and Alt7M). Various regulatory agencies have authority over water quality in the ACF Basin. USACE has the authority to manage water quality conditions associated with reservoir operations. State agencies and the EPA have regulatory authority over National Pollutant Discharge Elimination System- (NPDES-) permitted facilities and nonpoint sources of pollution. For planning purposes, and to consider the cumulative effects of USACE operations on resources in the basin, a systemwide water quality model was developed to compare various alternatives with the NAA. USACE does not have the regulatory authority to manage NPDES permittees and, therefore, this evaluation did not look at the states' or EPA's site-specific individual or linked models. Where the USACE model indicated violations to water quality occur, USACE evaluated how those changes might affect water quality and existing total maximum daily loads (TMDLs).

Two TMDLs have been finalized on the mainstem of the Chattahoochee River and in USACE reservoirs: a temperature TMDL from Peachtree Creek to Utoy Creek and a low-oxygen TMDL below West Point Dam and Walter F. George Lock and Dam (GAEPD 2003b; USEPA 2000b). Details of the effects to finalized TMDLs also are included in sections 6.1.2.1 and 6.1.2.2.

6.1.2.1 Water Temperature

Reservoir operations generally have the greatest effect on water temperature and DO in dam tailraces, as well as some effect on algal growth in reservoir forebays. Those effects are clearly demonstrated downstream from Buford Dam, where cold water released from the deep water in Lake Lanier has created conditions to support a trout fishery in the Chattahoochee River.

Figure 6.1-65 through Figure 6.1-100 present the processed HEC-5Q modeled output for water temperature over the modeled period of record for the NAA and to illustrate variations between the results for proposed revisions to the Master Manual as defined in Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M and the NAA. The modeled results were compared longitudinally down the Chattahoochee River of the ACF Basin in select locations. Longitudinal plots, or *system profiles*, were examined to understand the most critical locations for water quality related to various parameters. Following an evaluation of the range of longitudinal modeled results, specific locations were selected where the range of modeled output was the greatest. In consideration of the number of alternatives and the ease of viewing the information about each alternative, the results are presented in three figures with a third of the alternatives presented on each figure. Using the results from the figures and modeled output as appropriate, the relative effects associated with each alternative are discussed in subsequent sections.

The median water temperature over the modeled period for each alternative was compared to that of the NAA and the potential impacts were rated as follows:

- Negligible impact if the change in water temperature was < 0.5 °C
- A slightly adverse impact if the water temperature increased by 0.5–1.0 °C
- An adverse impact if the water temperature increased by 1.0 to < 3.2 °C
- A substantial adverse impact if the water temperature increased by more than 3.2 °C, a level recommended by the State of Georgia
- A slightly beneficial impact if the water temperature decreased by 0.5–1.0 °C
- A beneficial impact if the water temperature decreased by 1.0 to < 3.2 °C
- A substantial beneficial impact if the water temperature decreased by more than 3.2 °C

Table 6.1-17 summarizes the effect of alternatives from the NAA based on the criteria stated above. The criteria used to define the effects of various alternatives compared with the NAA were established based on previous work in the southeast United States. Changes less than 0.5 °C were assumed within range of error in the modeling assumptions and, therefore, negligible, or no, change from the NAA was assumed. EPA water temperature criteria cite studies for coldwater fisheries that indicate reductions in fish growth at 1 and 2 °C breakpoints; this is reflected in Georgia's standards for trout streams as 2 °F. Therefore, changes more than or less than 1 °C were adverse or beneficial, respectively. The state critieria indicate that water temperatures should not be changed more than 5 °F—converted to 3.2 °C for comparisons here (ADEM 2015; GAEPD 2015). Therefore, changes more than 3.2 °C were considered substantial. The results obtained in the alternatives are discussed in detail in the following sections.

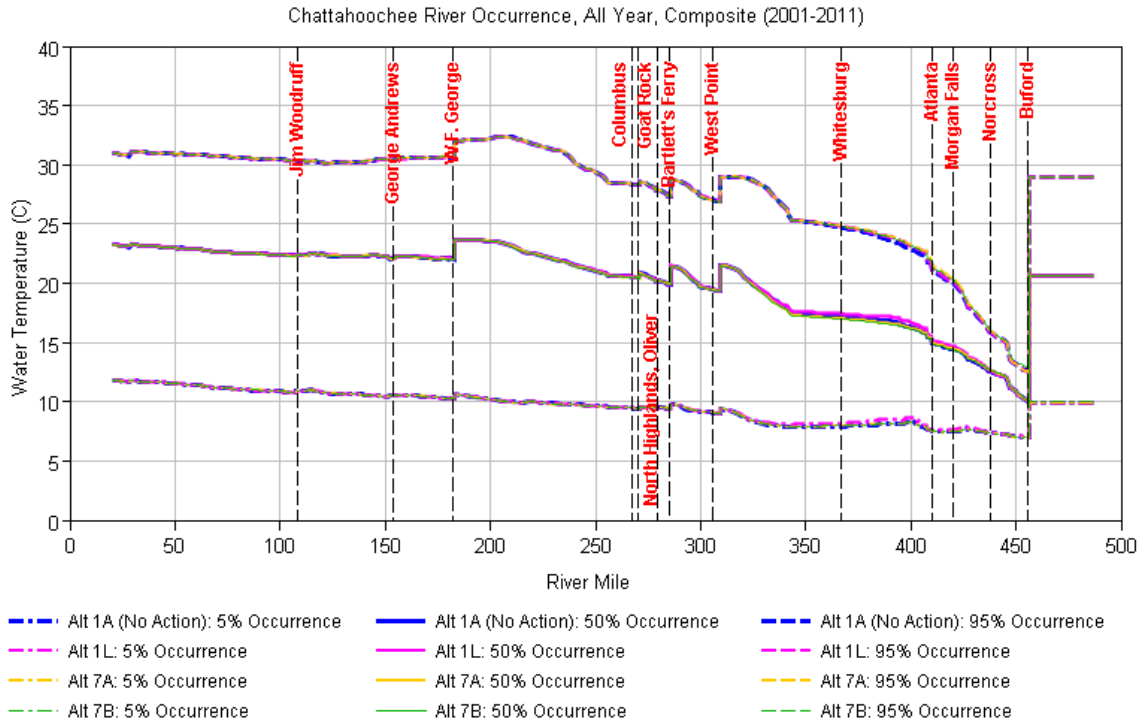


Figure 6.1-65. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

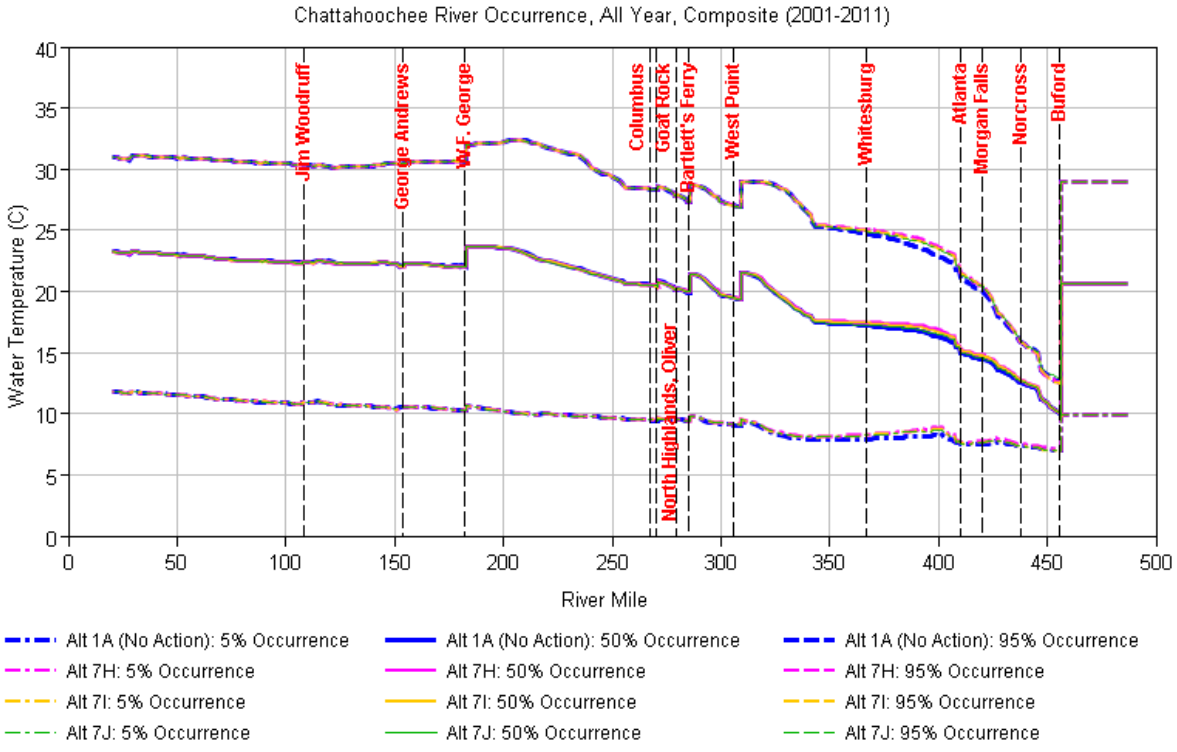


Figure 6.1-66. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

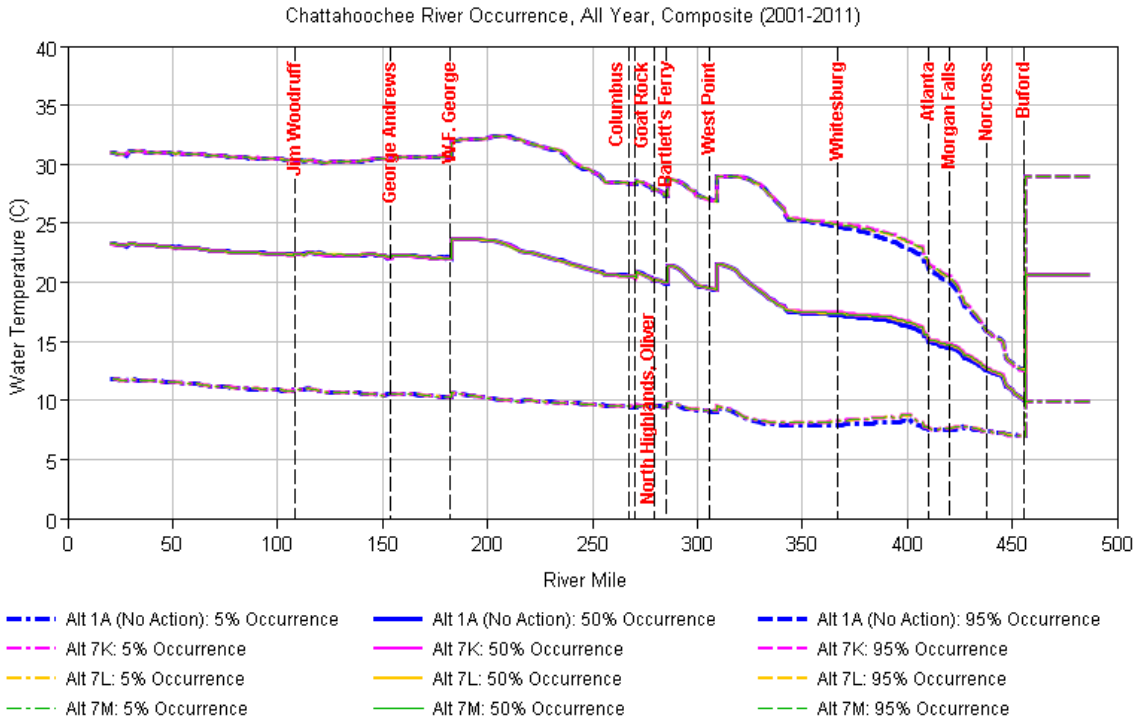


Figure 6.1-67. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

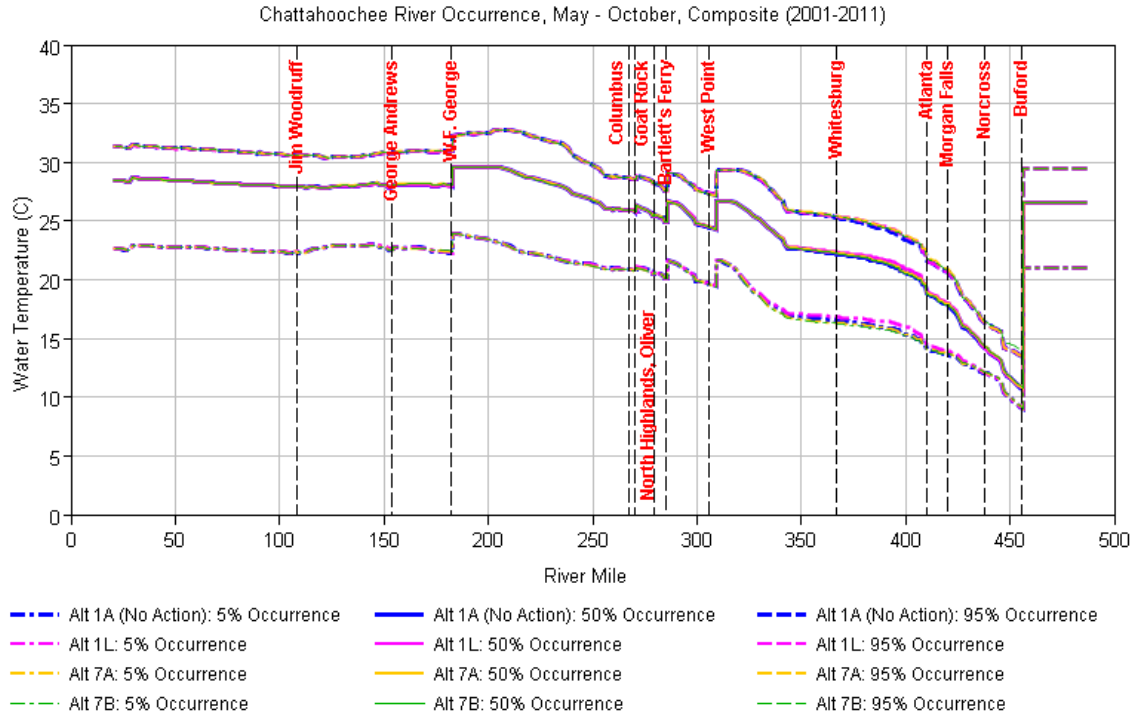


Figure 6.1-68. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

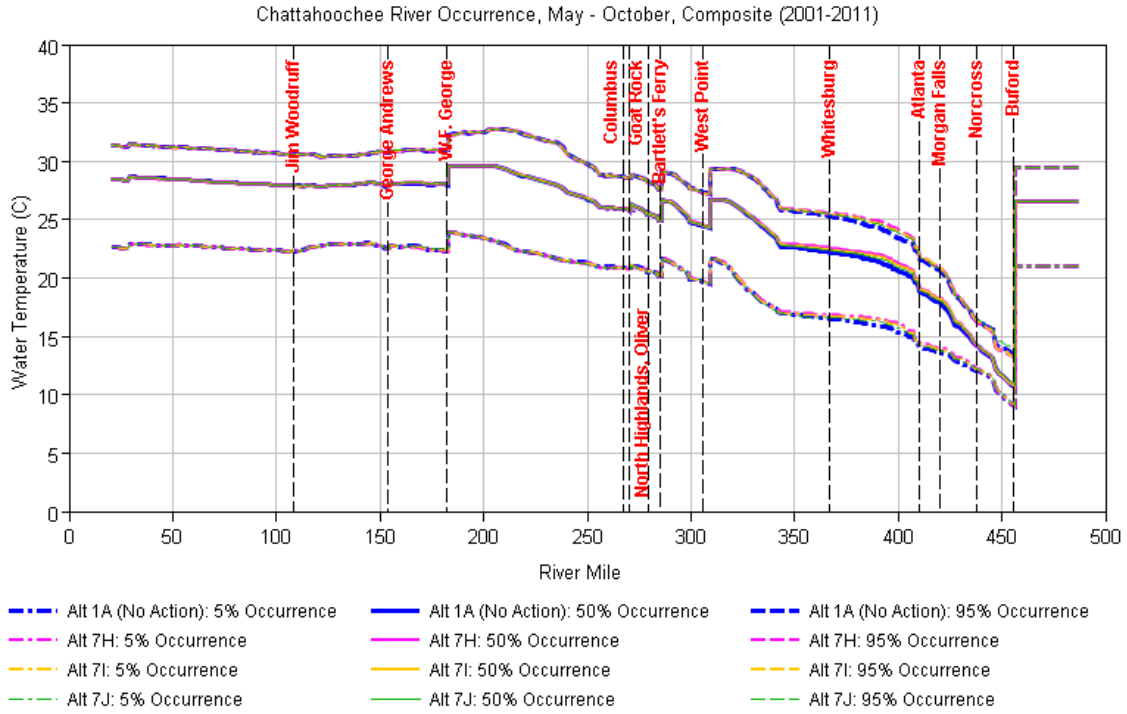


Figure 6.1-69. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

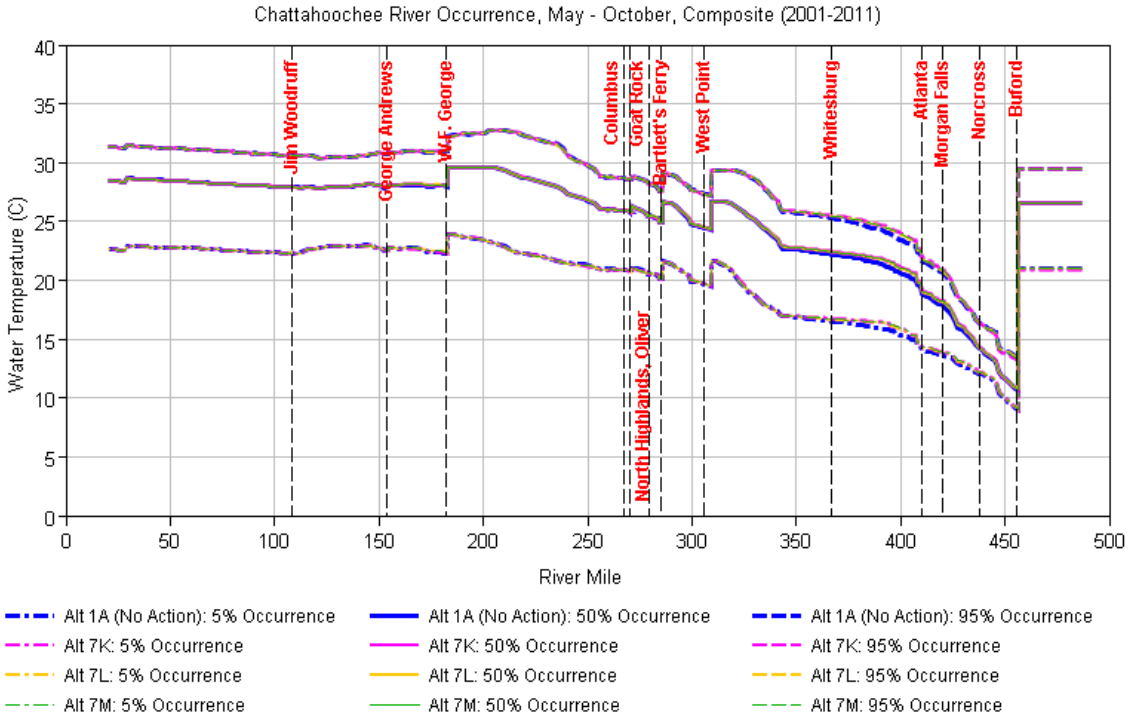


Figure 6.1-70. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

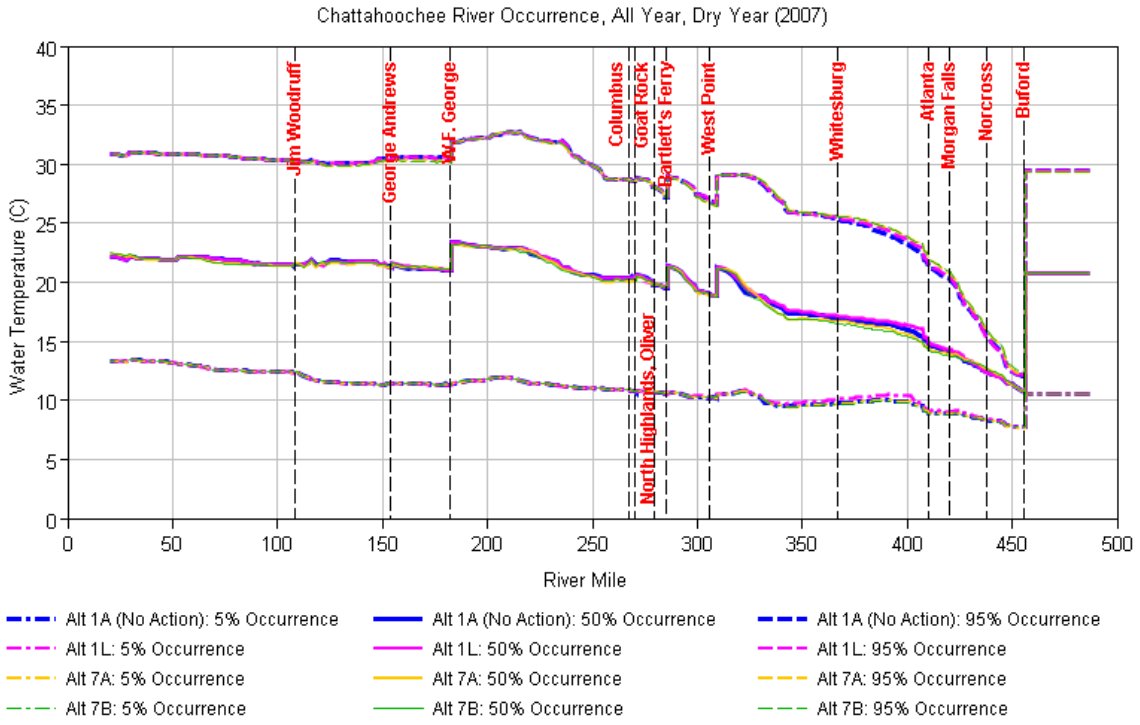


Figure 6.1-71. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

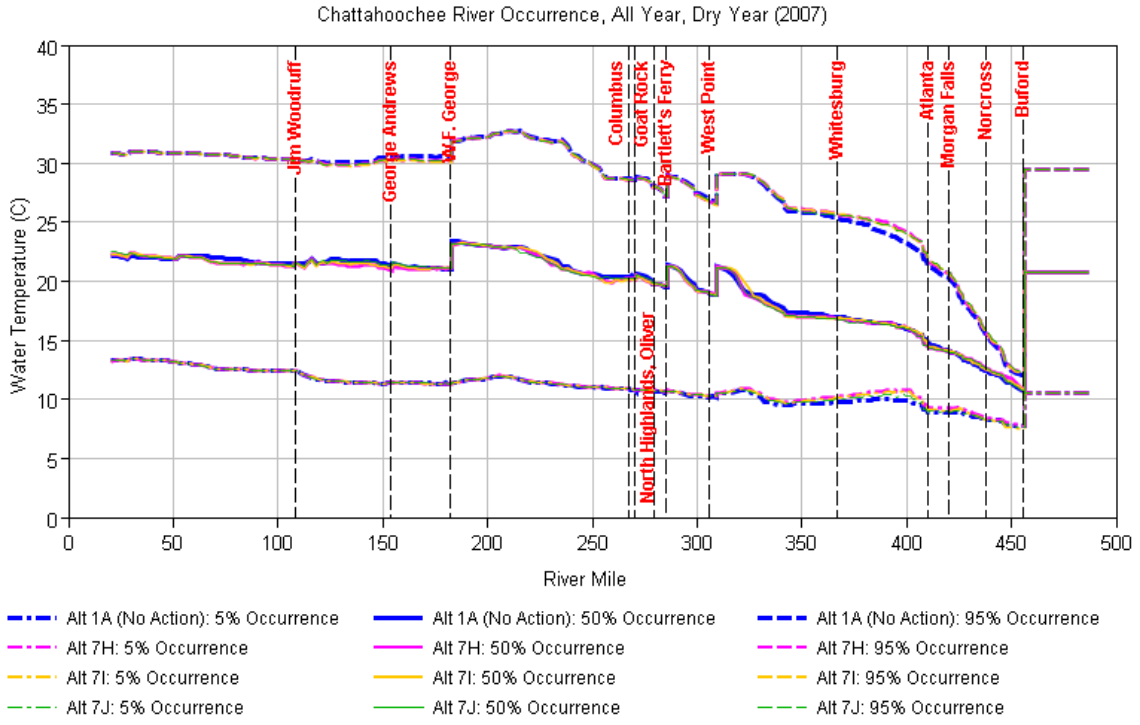


Figure 6.1-72. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

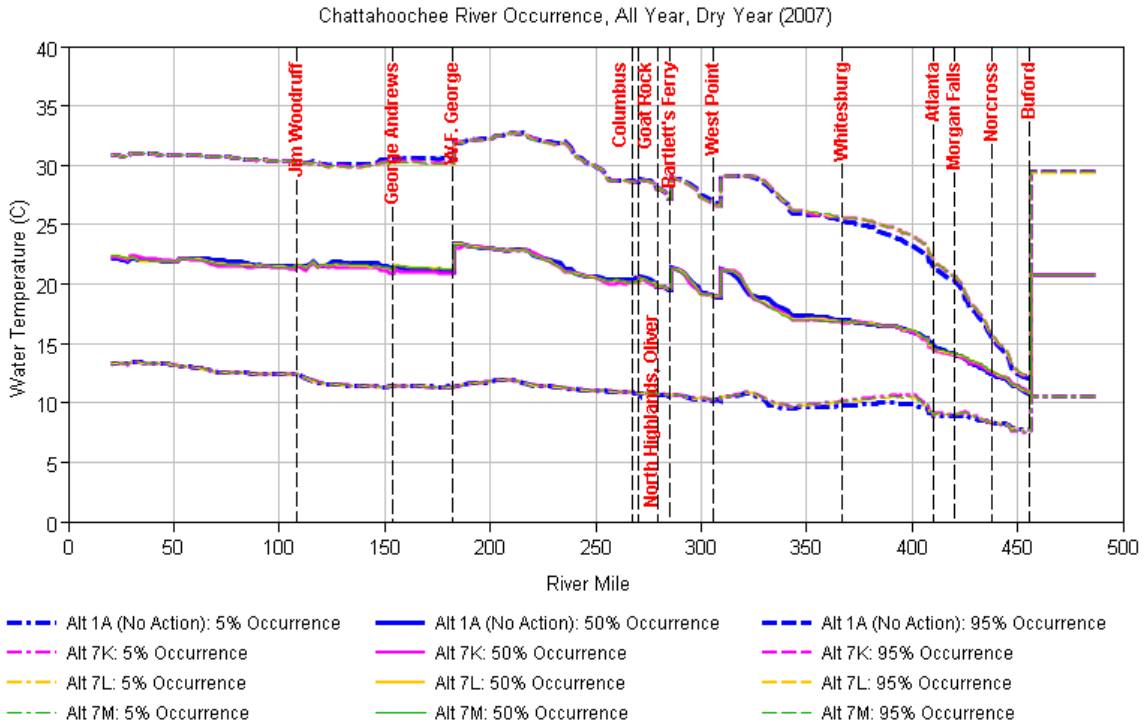


Figure 6.1-73. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

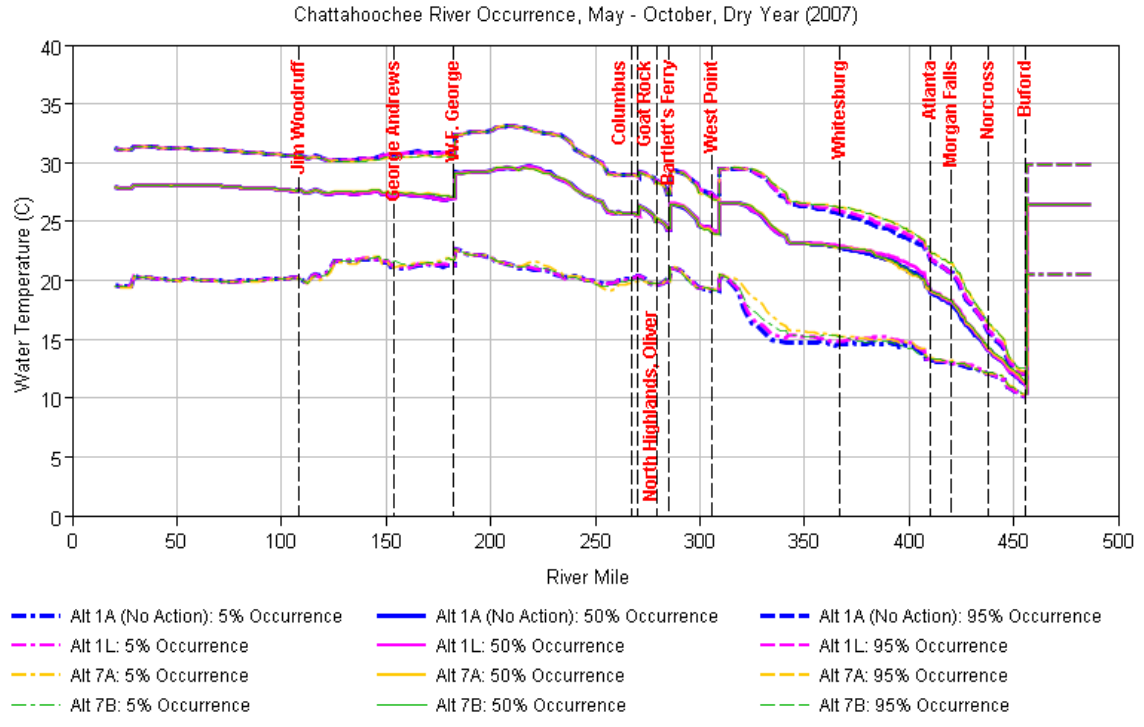


Figure 6.1-74. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

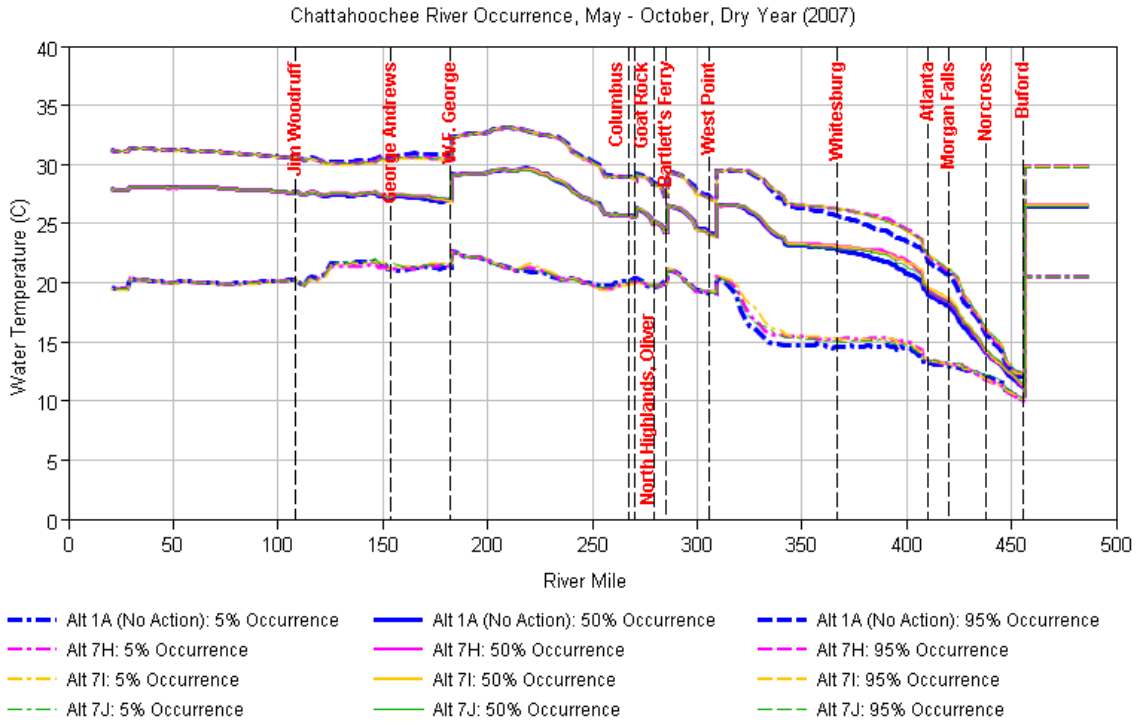


Figure 6.1-75. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

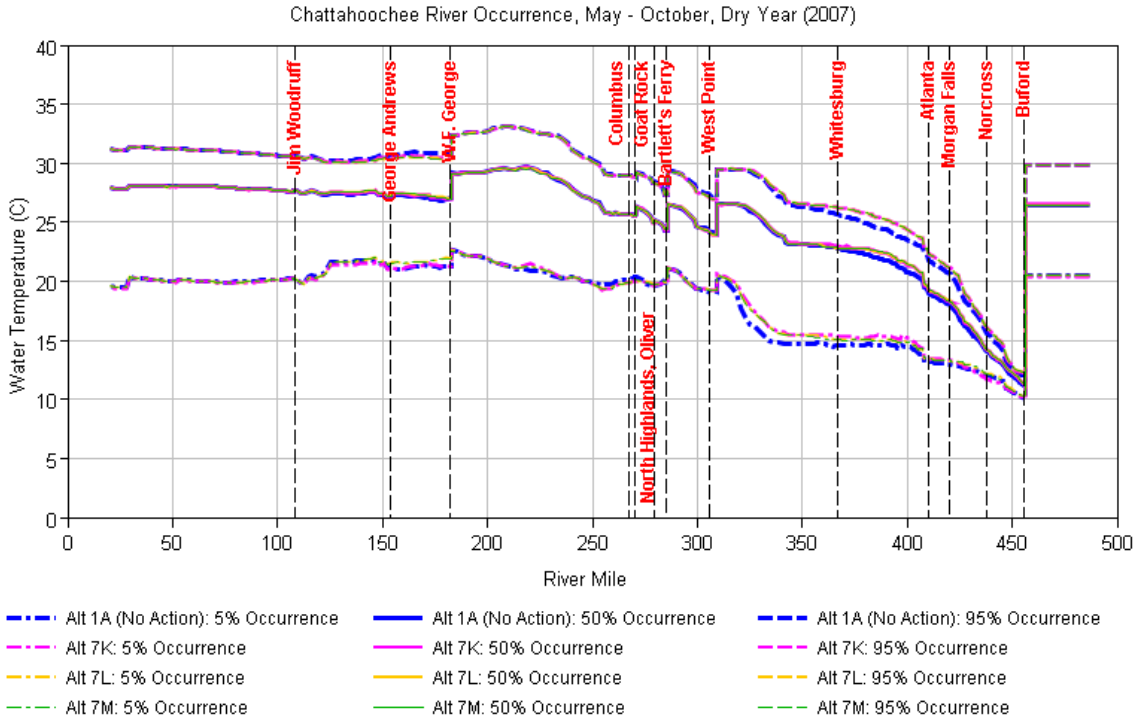


Figure 6.1-76. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

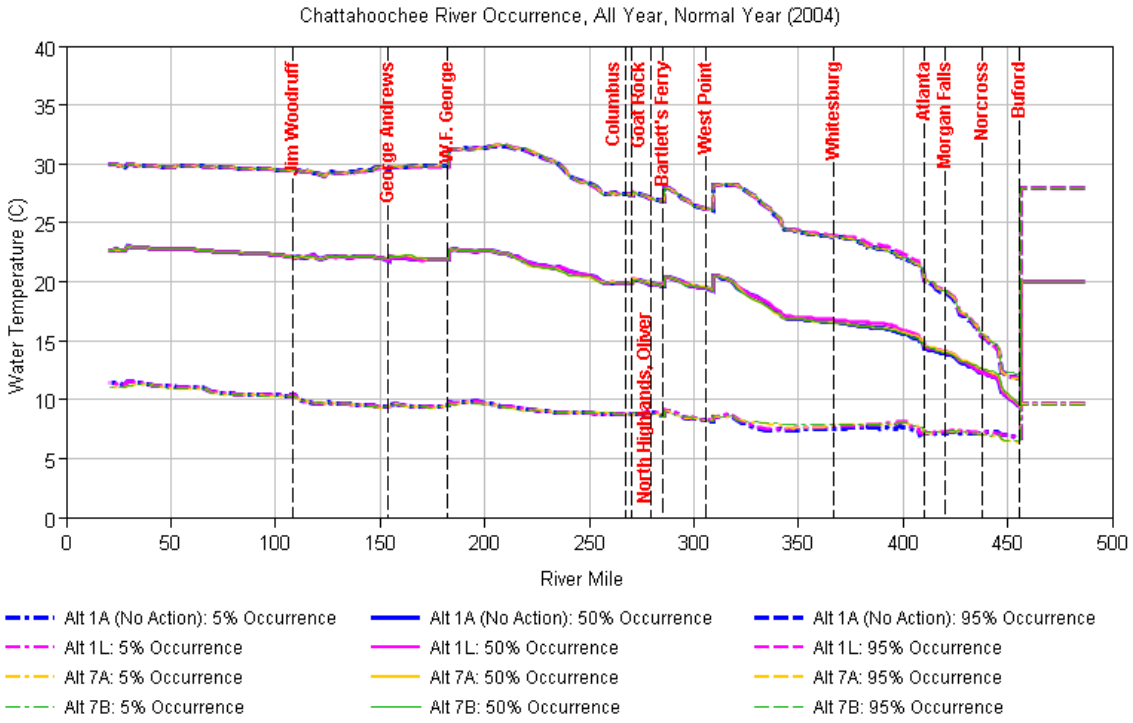


Figure 6.1-77. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for a Normal Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

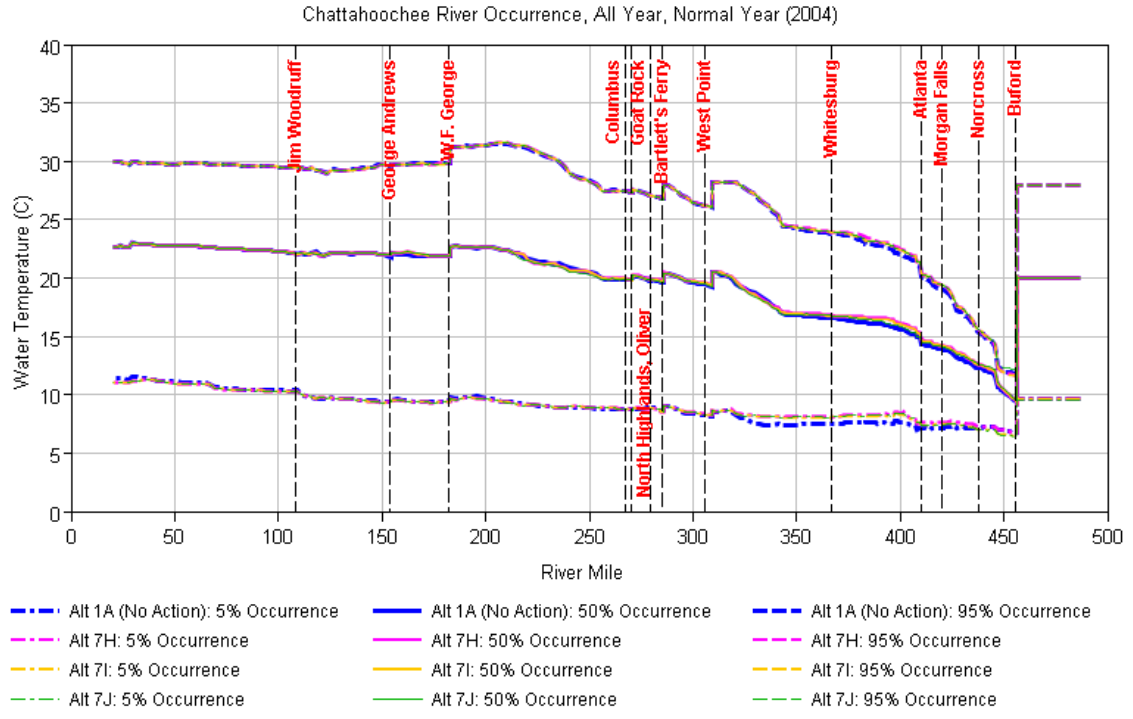


Figure 6.1-78. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for a Normal Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

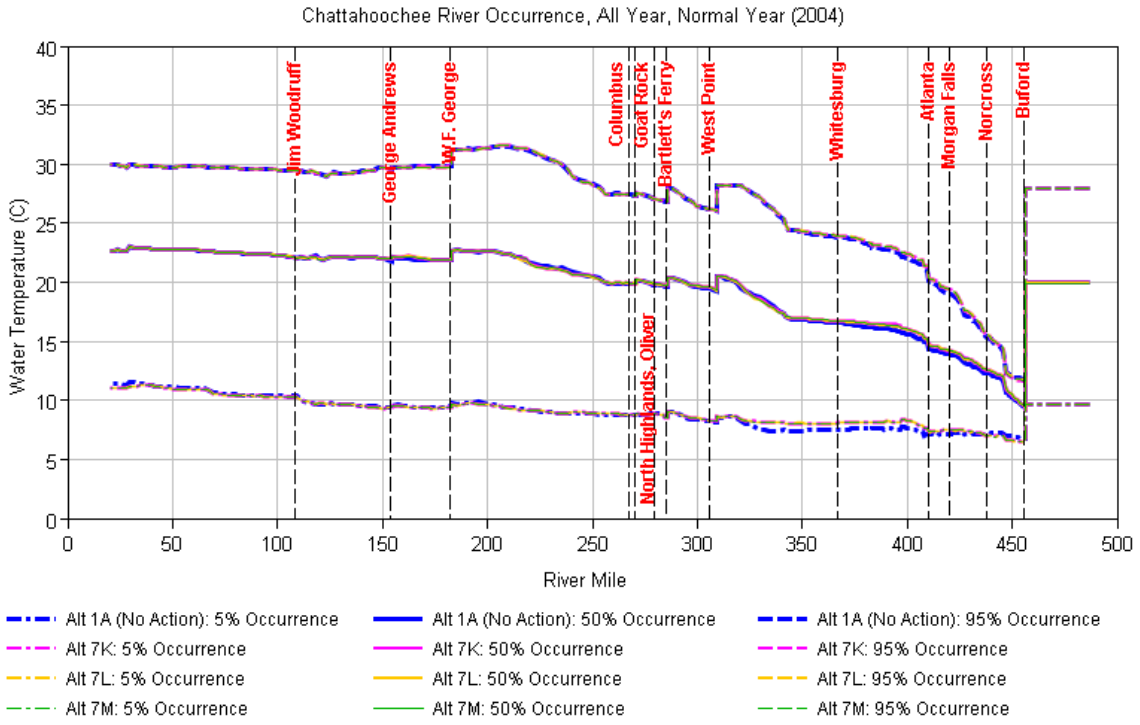


Figure 6.1-79. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin for a Normal Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

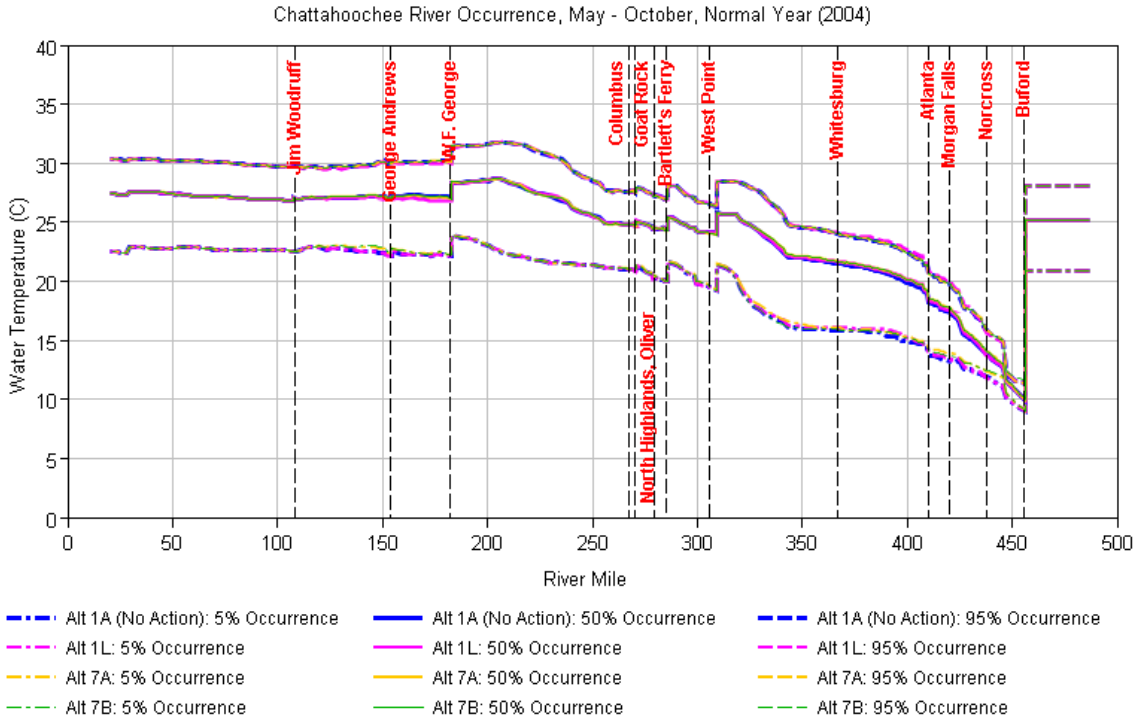


Figure 6.1-80. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for a Normal Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

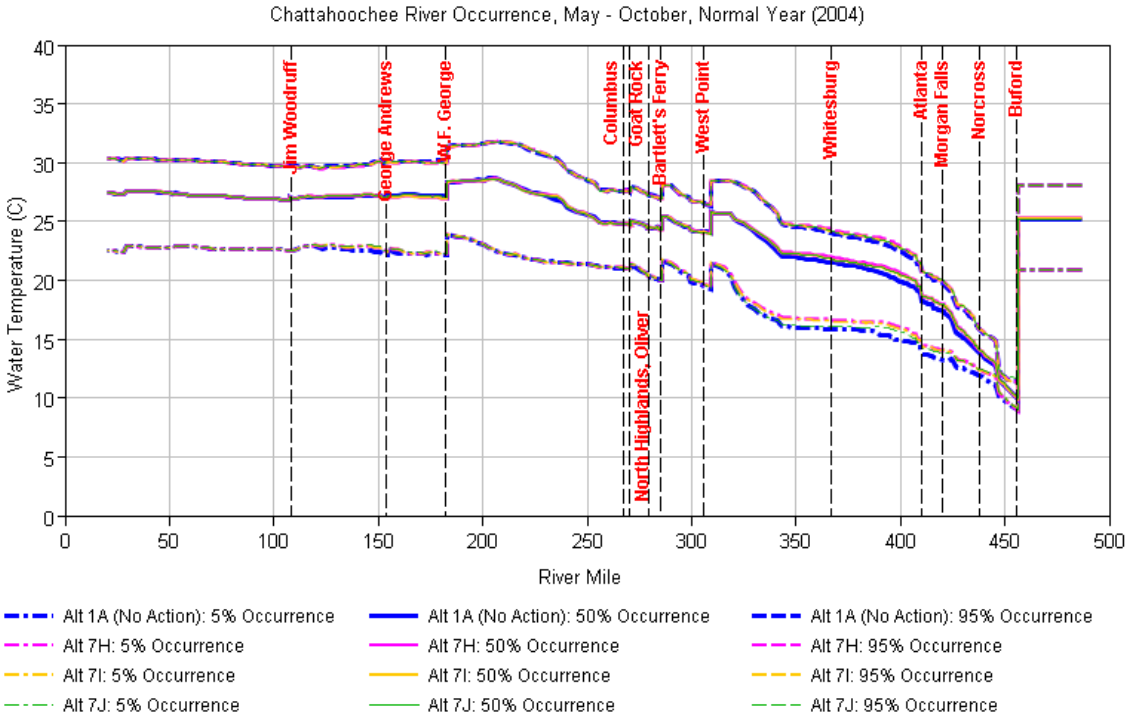


Figure 6.1-81. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for a Normal Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

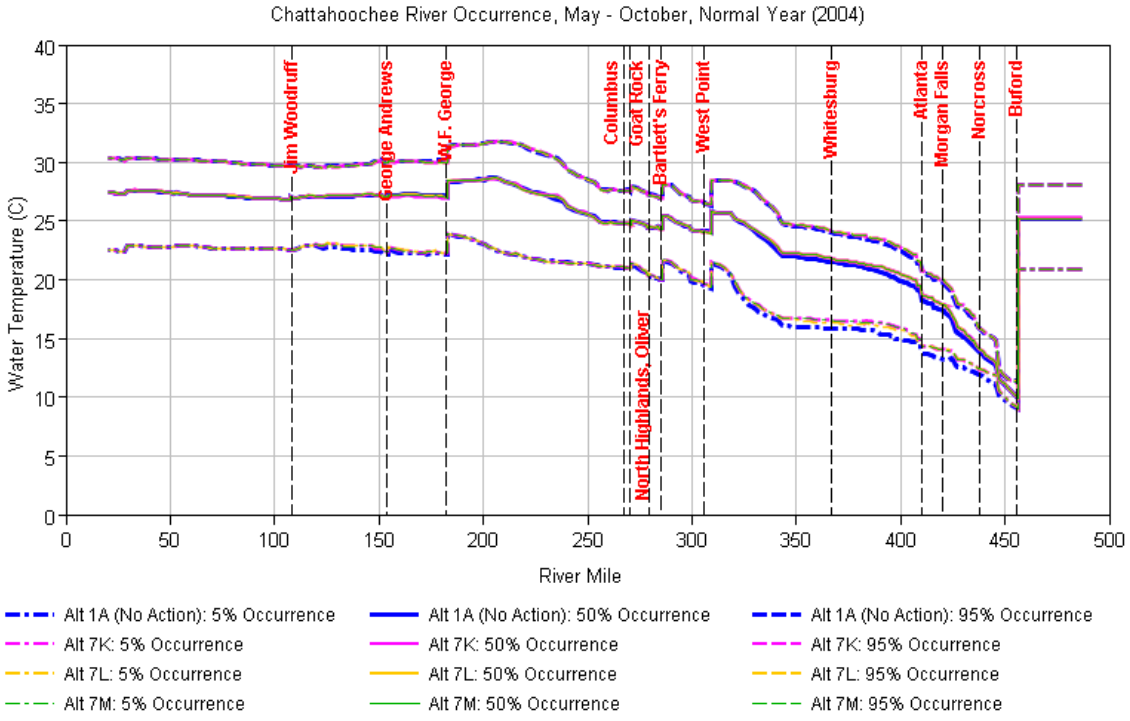


Figure 6.1-82. Longitudinal Profile Occurrence of Modeled Water Temperatures in the ACF Basin May–Oct for a Normal Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

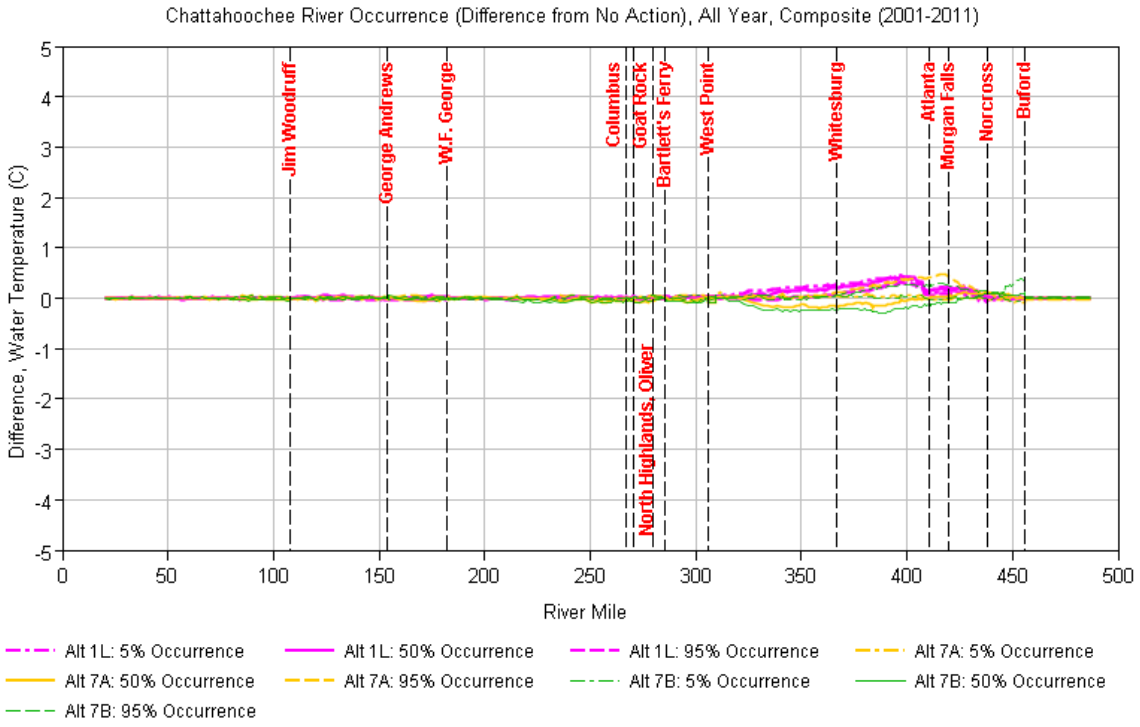


Figure 6.1-83. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

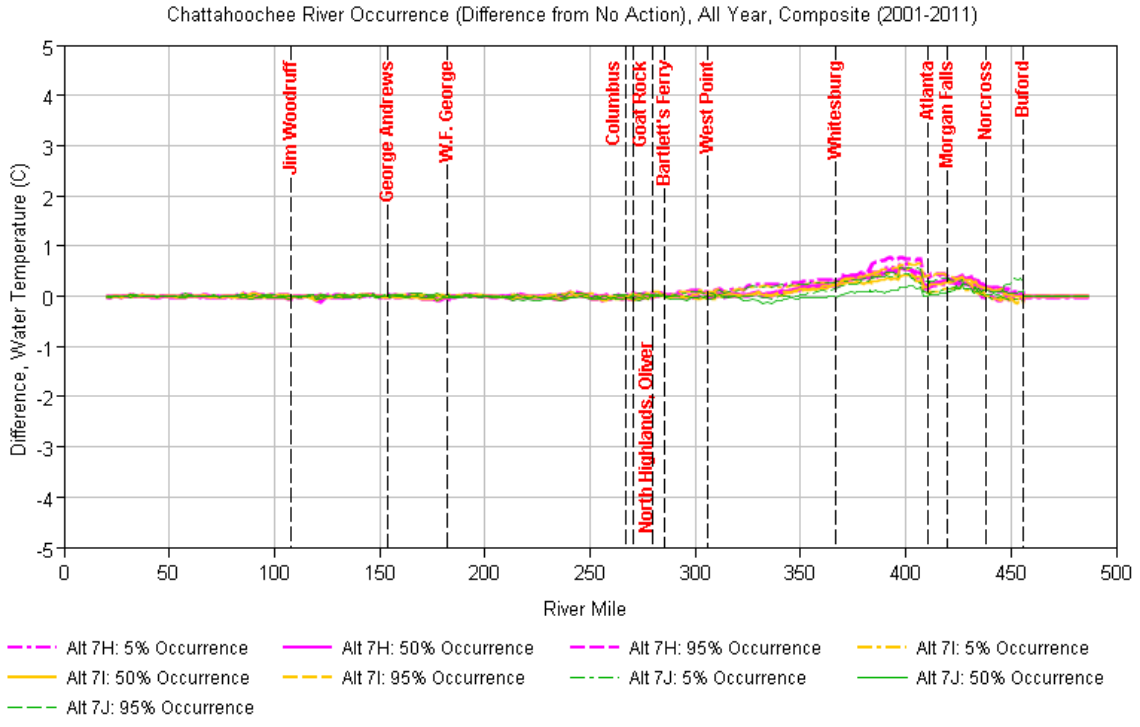


Figure 6.1-84. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

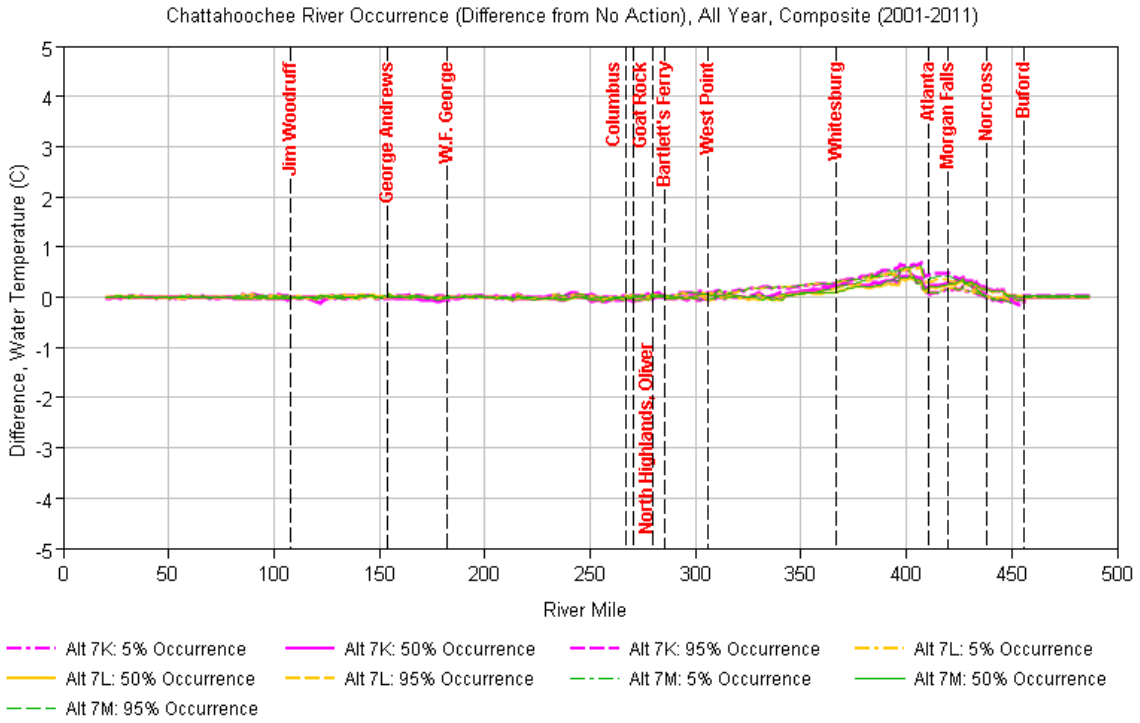


Figure 6.1-85. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

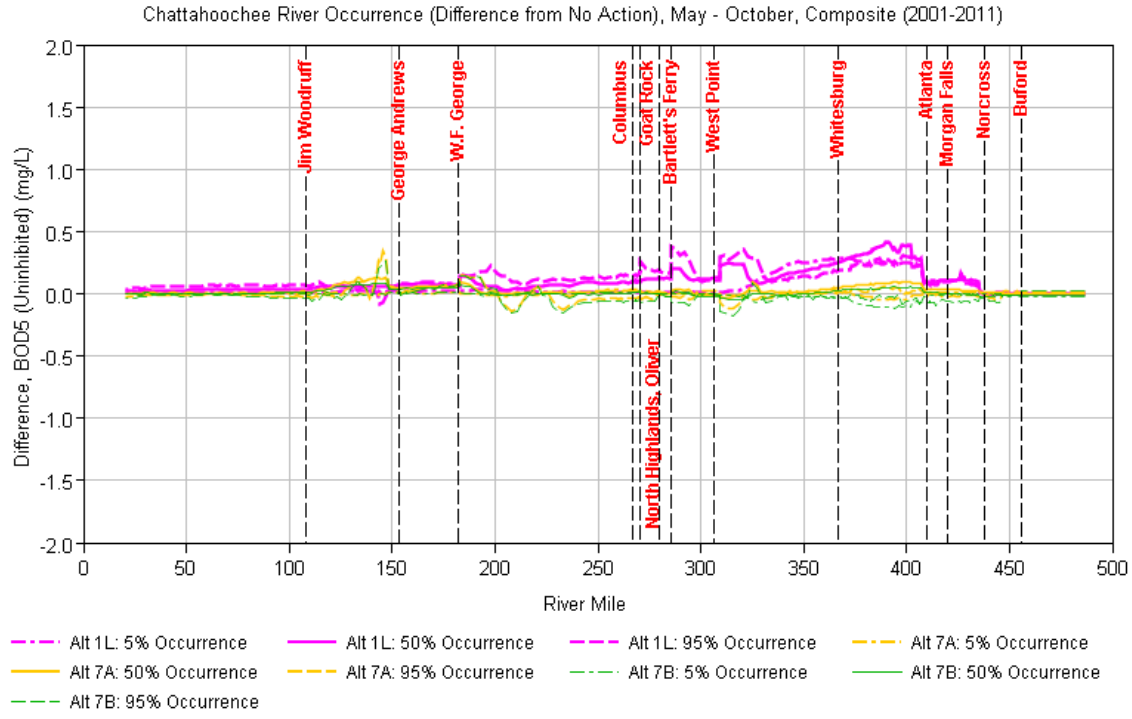


Figure 6.1-86. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

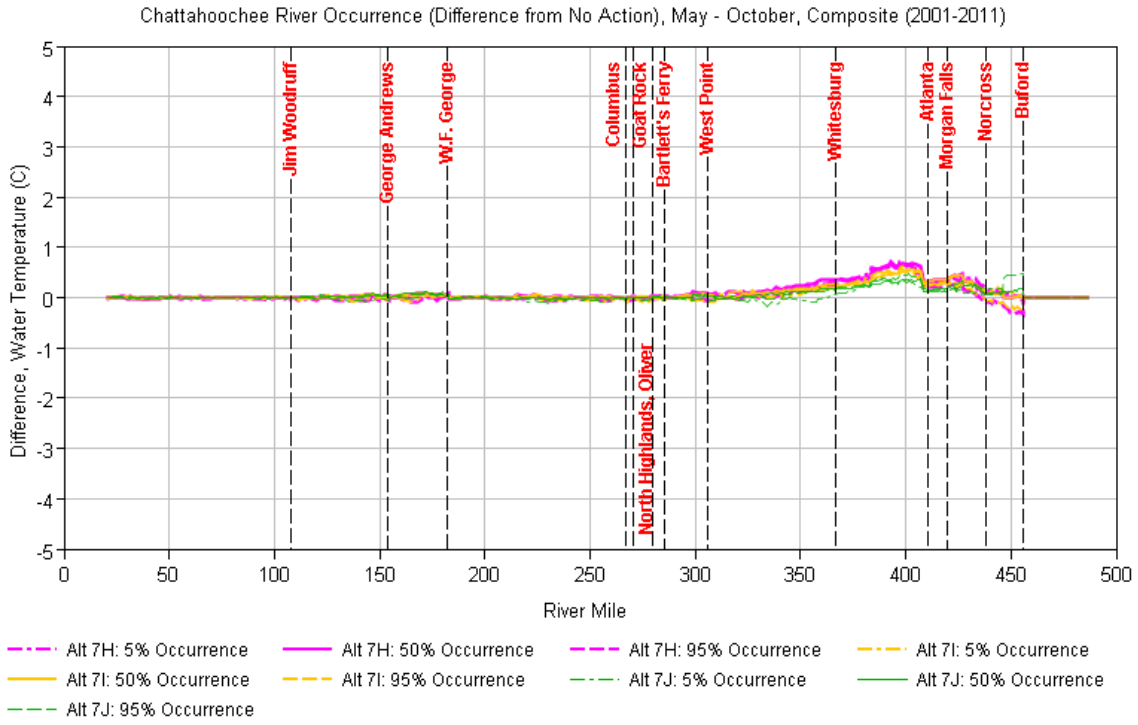


Figure 6.1-87. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

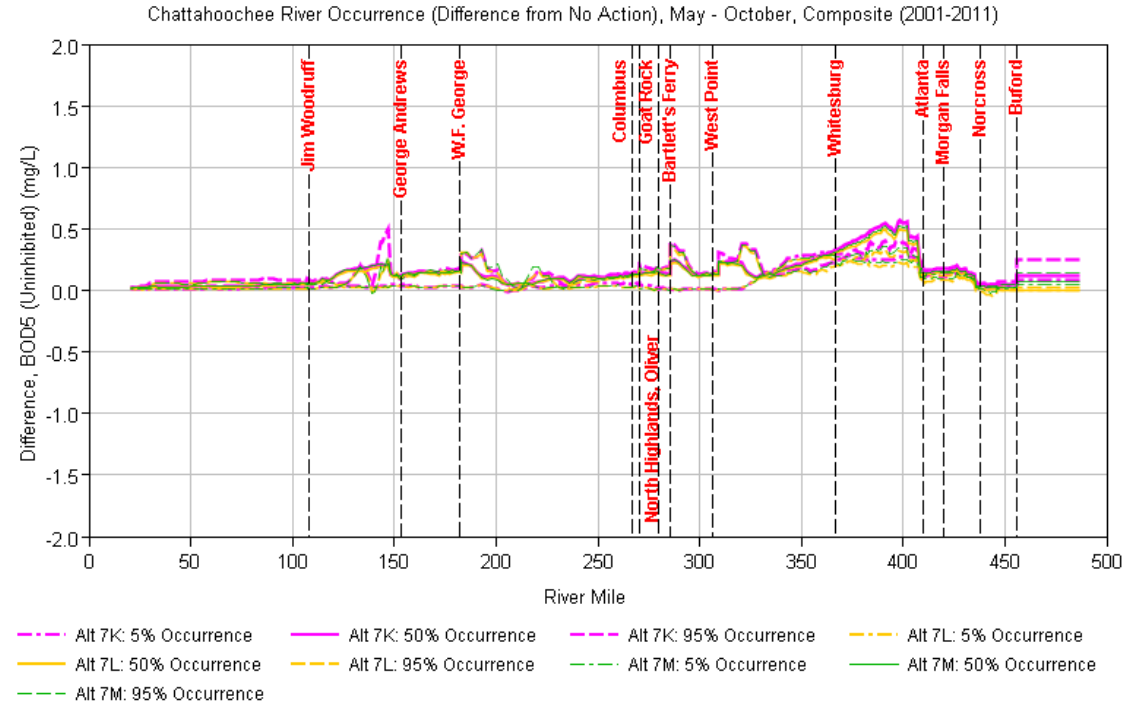


Figure 6.1-88. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

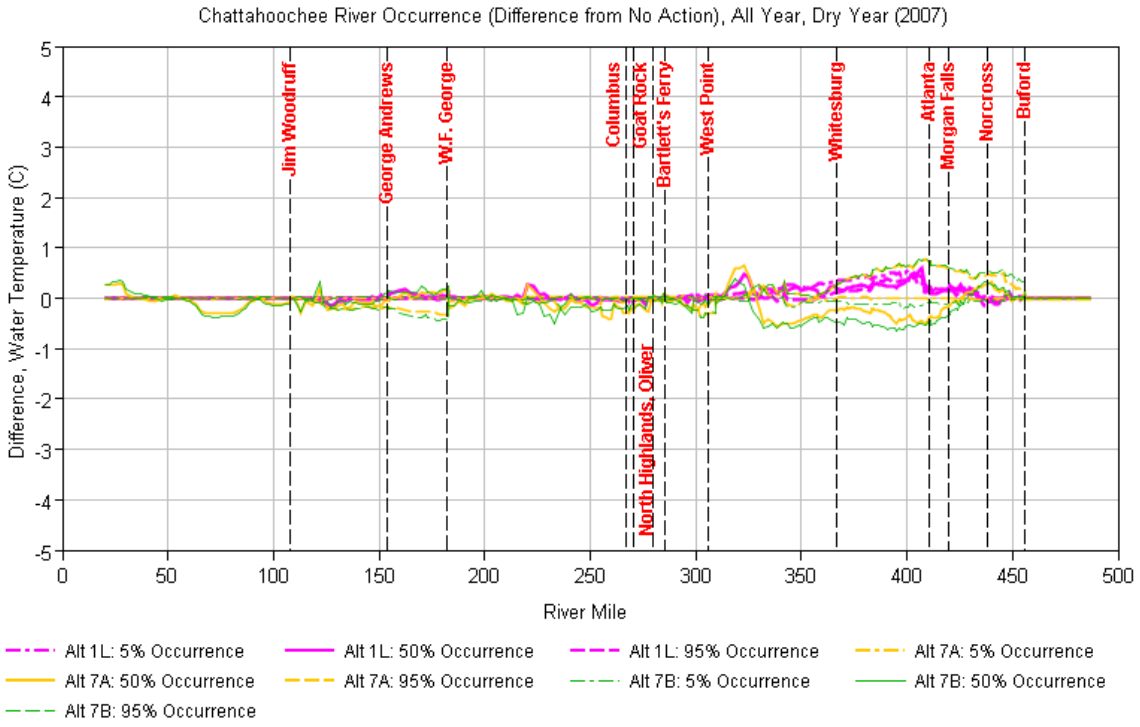


Figure 6.1-89. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

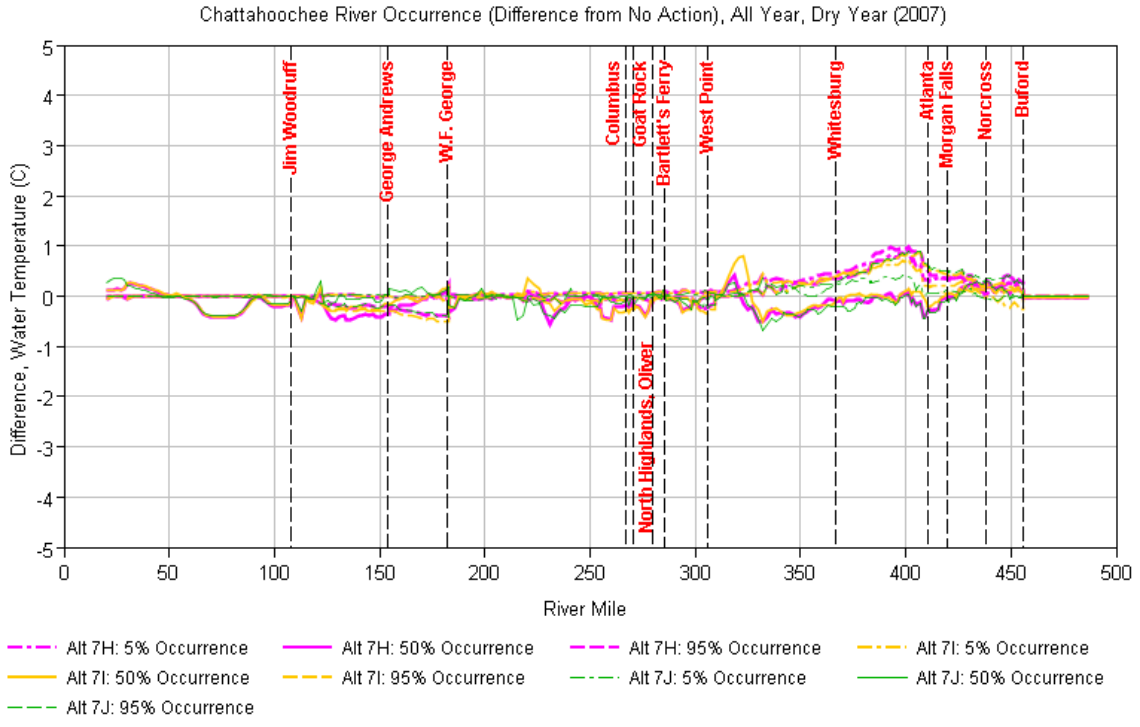


Figure 6.1-90. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

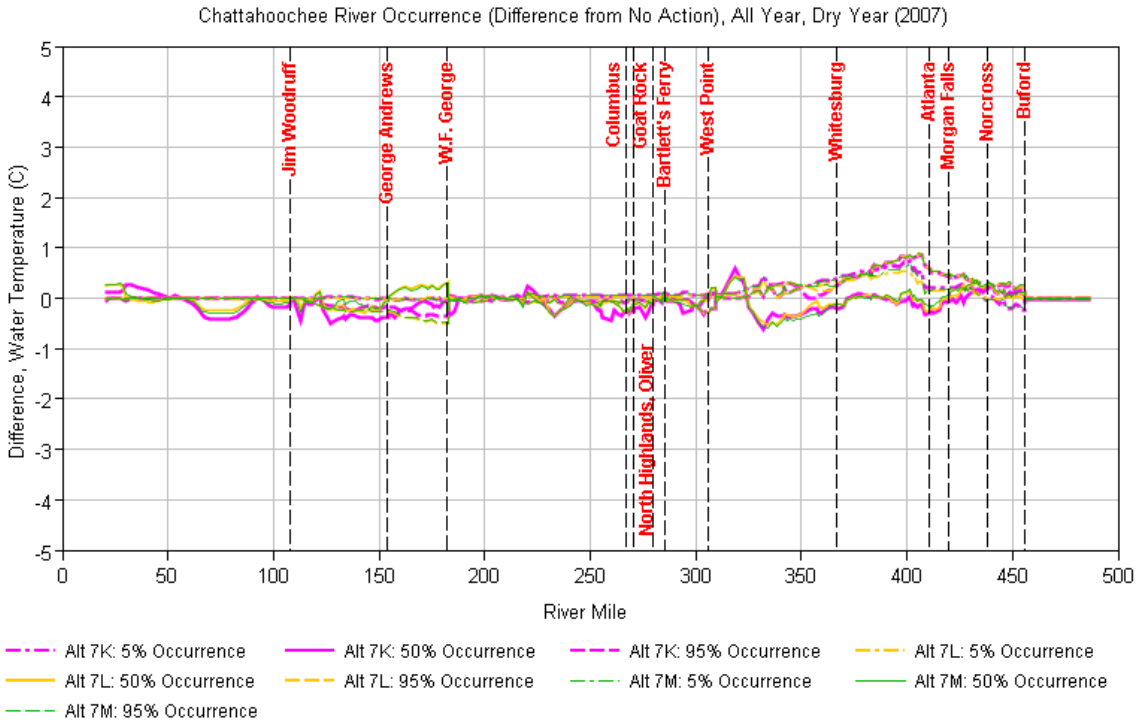


Figure 6.1-91. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

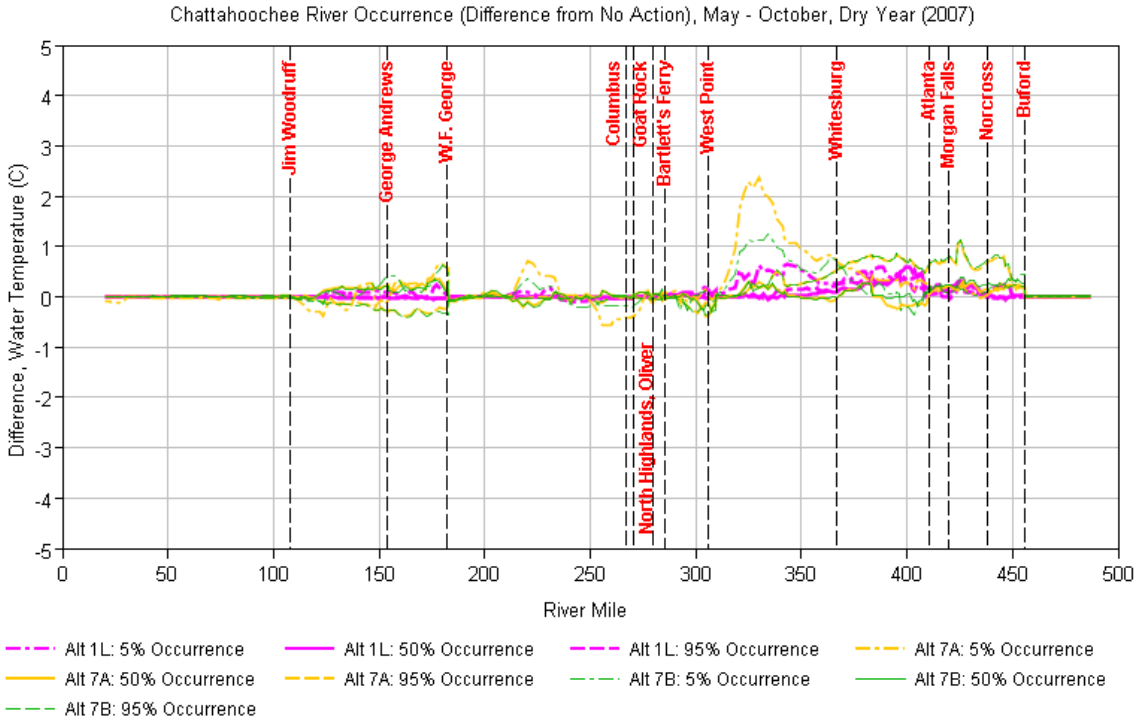


Figure 6.1-92. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct of a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

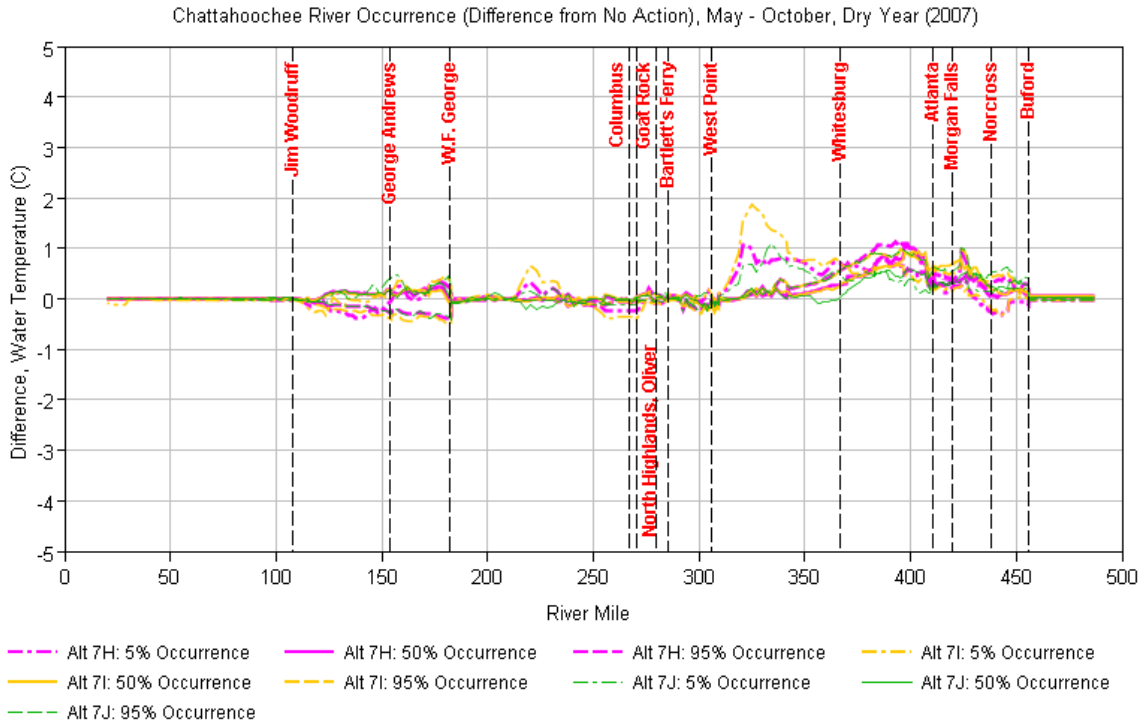


Figure 6.1-93. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct of a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

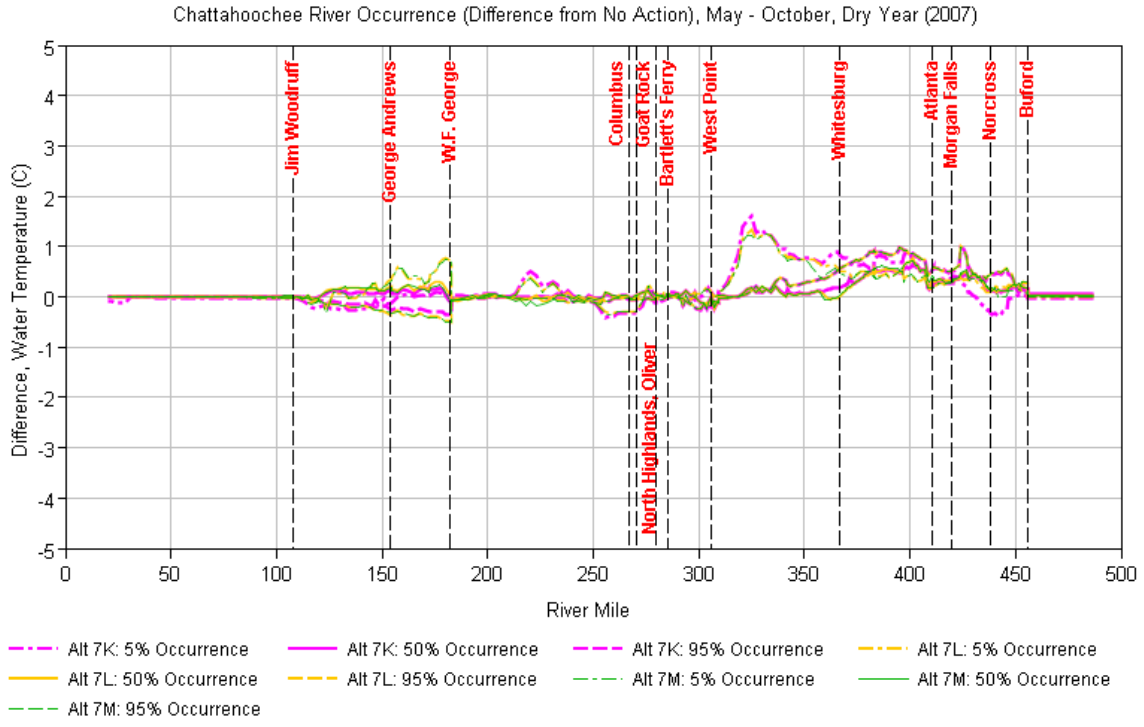


Figure 6.1-94. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct of a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

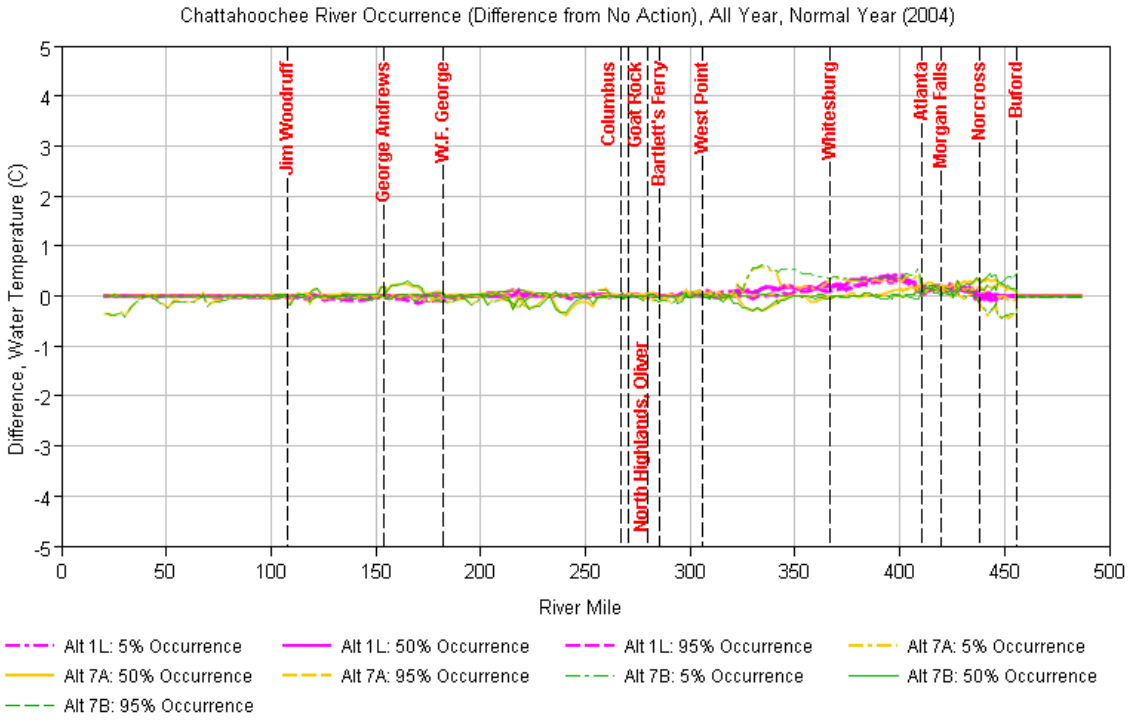


Figure 6.1-95. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for a Normal Weather Year for Alt1L, Alt7A, and Alt7B.

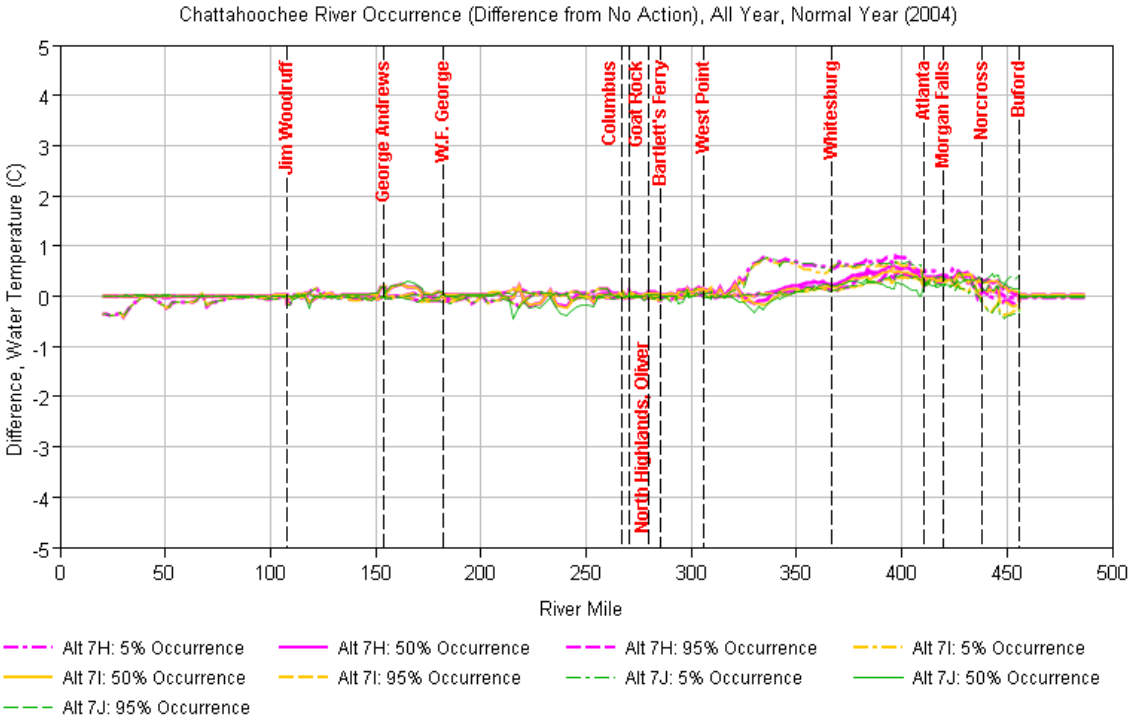


Figure 6.1-96. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for a Normal Weather Year for Alt7H, Alt7I, and Alt7J.

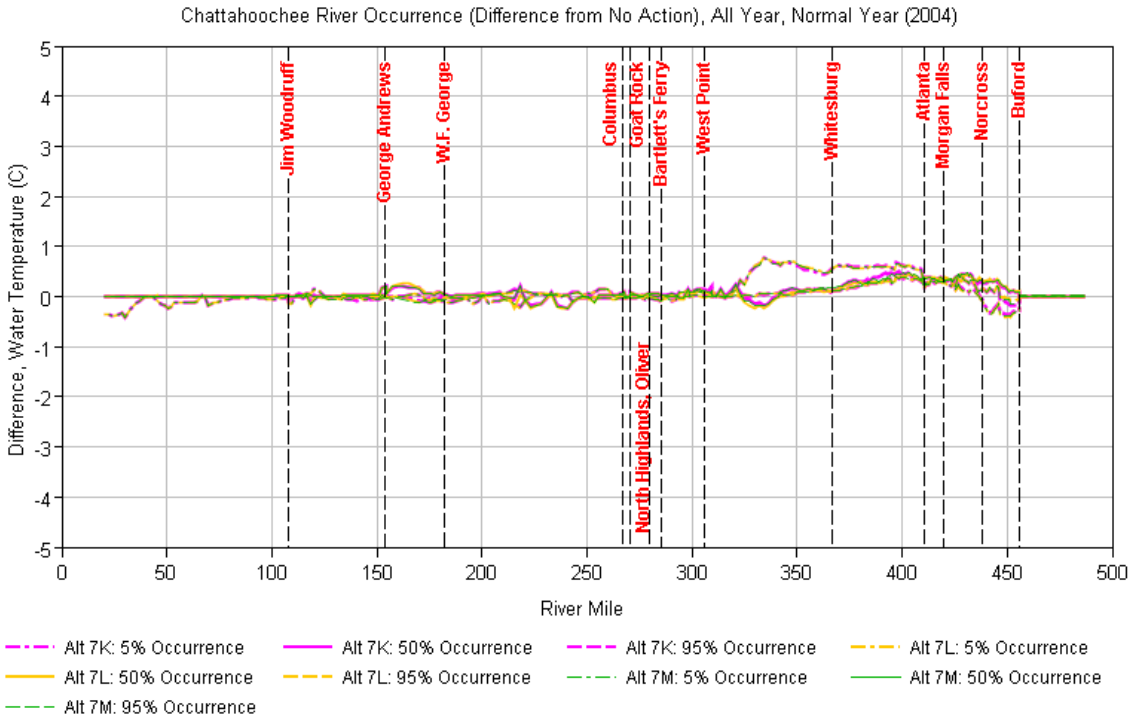


Figure 6.1-97. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin for a Normal Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

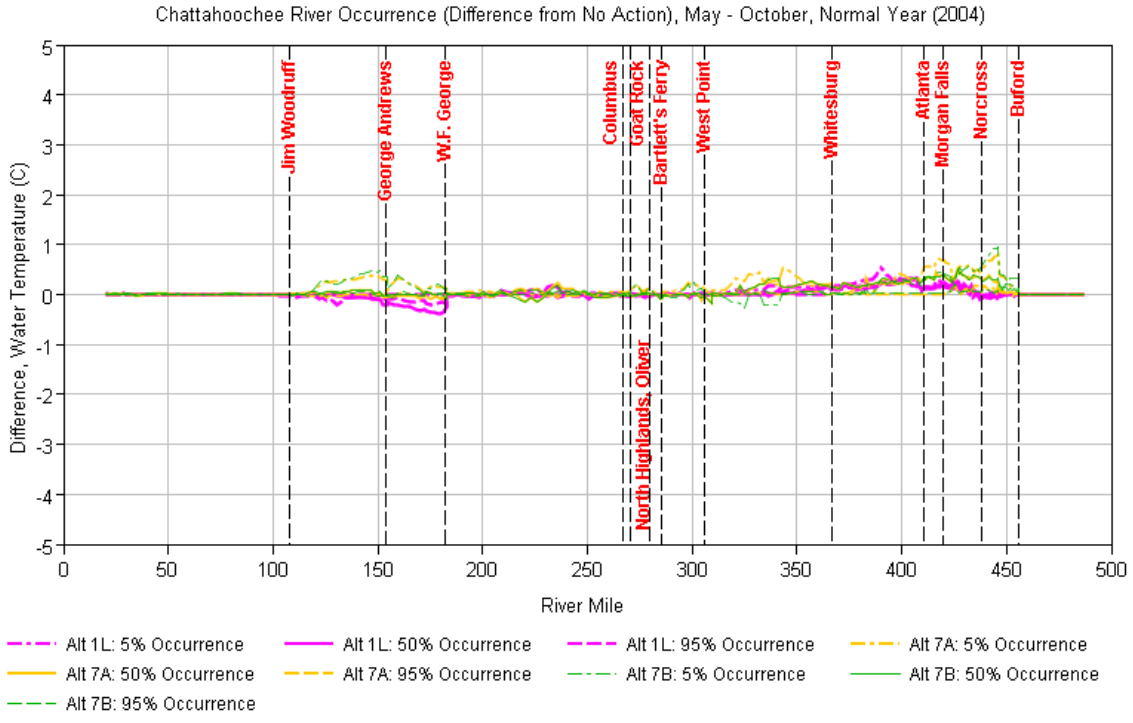


Figure 6.1-98. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct of a Normal Weather Year for Alt1L, Alt7A, and Alt7B.

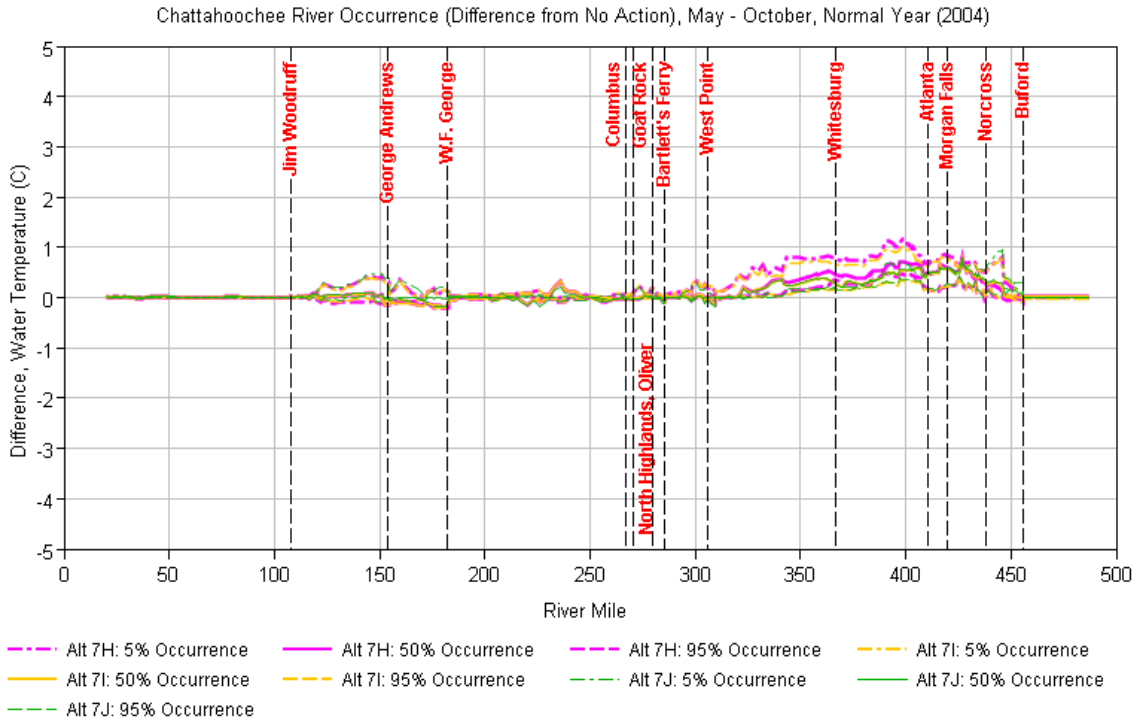


Figure 6.1-99. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct of a Normal Weather Year for Alt7H, Alt7I, and Alt7J.

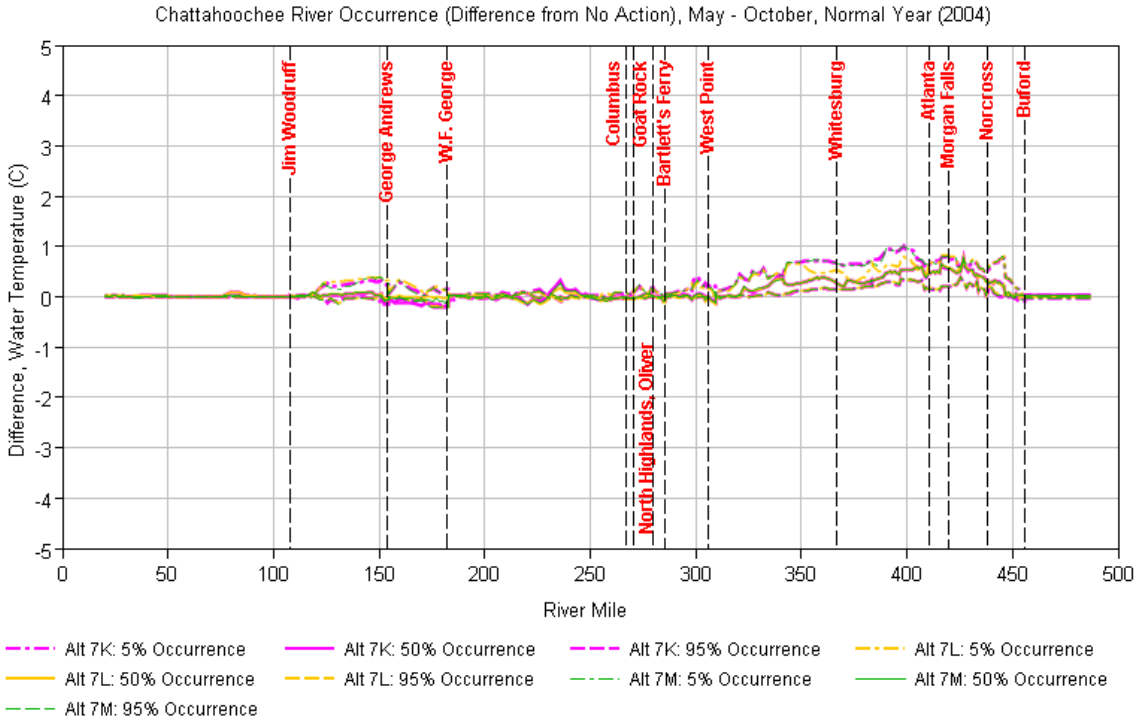


Figure 6.1-100. Longitudinal Profile of Difference in Modeled Water Temperatures from the NAA in the ACF Basin May–Oct of a Normal Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

Table 6.1-17.
Summary of the Effects on Median Water Temperature of the Alternatives from the NAA during the Modeled Period (2001–2011)

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Buford Dam to Atlanta	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Atlanta to West Point Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
West Point Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change— Negligible/No change if the change in water temperature was < 0.5 °C.

6.1.2.1.1 No Action Alternative

Under the NAA, water temperatures in the Chattahoochee River rise as the river moves downstream from Lake Lanier to Apalachicola River. Cooler water from the lower portions of the water column is released from Lake Lanier, West Point Lake, and Walter F. George Lake, cooling the water directly downstream of those dams. Water temperatures also fluctuate daily depending on atmospheric conditions. Figure 6.1-65 through Figure 6.1-82 present the annual and seasonal daily median temperature along with the daily 5th and 95th percent occurrences over the modeled period, for a dry weather year, and for a normal weather year. The median water temperature is the most representative since it would be expected to occur half the time. This section focuses on the changes in the median water temperature for the NAA at the different locations in the ACF Basin.

Georgia's state water temperature standard for water bodies designated for fishing is not to exceed 90 °F (32 °C) and at no time is the temperature of the receiving waters to be increased by more than 5 °F (2.8 °C) above intake temperature. In streams designated as primary trout or smallmouth bass waters by the Wildlife Resources Division (WRD), there shall be no elevation of natural stream temperatures. In streams designated as secondary trout waters, there shall be no elevation exceeding 2 °F (1.1 °C) of natural stream temperatures (GAEPD 2015).

Modeled results indicate that over the modeled period, the median daily water temperature would be expected to change by 10 °C from the surface water in Lake Lanier to surface waters downstream of Buford Dam in the Chattahoochee River. This change is the result of the water being released from the lower depths of Lake Lanier through Buford Dam. Water is released from the lower portion of the reservoir water column, where temperatures are much cooler than the surface layer, especially during the summer period. Figure 6.1-65 illustrates water temperatures between Lake Lanier and downstream of Buford Dam in the ACF Basin over the modeled period (2001–2011). The greatest change in surface water temperatures occurs between Lake Lanier and the tailrace of Buford Dam during the critical season for aquatic resources, as defined by USFWS, from May through October. The median daily water temperatures at the tailrace of Buford Dam are expected to decrease from the surface water in Lake Lanier by more than 15 °C (Figure 6.1-68). The cooler temperatures are beneficial for the downstream fishery.

The Chattahoochee River reach downstream of Buford Dam includes a trout fishery. It is designated a secondary trout stream from Buford Dam downstream near the Interstate 285 West Bridge, about 6 mi downstream of Morgan Falls Dam. At the tailrace of Buford Dam, the daily water temperatures for the modeled period at the 5th percent occurrence level would be about 7.0 °C (45 °F) and 13 °C (55 °F) at the 95th percent occurrence level (Figure 6.1-65). These water temperatures are ideal conditions to support the trout fishery, as mentioned in section 2.1.2.2.1.

Minimal fluctuations in median water temperature would be expected under the NAA in the area designated as a secondary trout stream when comparing the modeled period with a representative dry weather year. Differences in median annual temperature in a representative dry weather year would be expected to decrease by 0.2 °C compared with annual results from the modeled period (Figure 6.1-71 and Figure 6.1-65, respectively). The same comparisons for the more critical period for aquatic resources from May through October results in an increase of water temperature by only 0.1 °C (Figure 6.1-74).

Median water temperatures from Atlanta to West Point Lake for the modeled period experience a slow but steady increase of 4 °C, as illustrated in Figure 6.1-65. The steady increase in that reach can be attributed to both warmer downstream atmospheric conditions and wastewater being returned to the river.

In 2003, a temperature TMDL was finalized for the Chattahoochee River from Peachtree Creek to Utoy Creek in the reach from Atlanta to Whitesburg. The TMDL indicated that violations of water quality standards were due to heat sources from two conventional power plants. GPC has since made changes to those facilities as described in section 2.1.2.3.1. The TMDL concluded that the combined heat load from municipal wastewater facilities in the reach does not violate Georgia's temperature standard and no heat reductions were required for the facilities (GAEPD 2003b).

The sudden drop of median temperature for the modeled period from 22 °C to 19 °C (i.e., from 72 °F to 66 °F) (Figure 6.1-65) at the tailrace of the West Point Dam would be expected because of water being released from the depths of the water column. The modeled water temperatures at the 5th percent and 95th percent occurrence levels in the West Point Dam tailrace would be well within the range of water quality standards.

From West Point Dam to Walter F. George Lake, the trend of the median water temperatures and temperatures at 5th percent and 95th percent occurrence levels would be similar to the trend expected in the tailrace of West Point Dam (Figure 6.1-65). From RM 250, downstream of Columbus, Georgia, median water temperatures steadily increase as the water flows into Walter F. George Lake. In rare instances of the 95th percent occurrence, water temperatures could be expected to exceed water quality standards of 90 °F (32 °C) (Figure 6.1-65, Figure 6.1-68, Figure 6.1-71, Figure 6.1-74, Figure 6.1-77, and Figure 6.1-80). The median temperature in Walter F. George Lake would increase by 2 °C. The increase

could be attributed to slower moving waters caused by the George W. Andrews Lock and Dam. The temperature at the 95th percent occurrence level would be 32 °C (90 °F) (Figure 6.1-65).

Changes in water temperature along the Chattahoochee River downstream of Walter F. George Lock and Dam to Lake Seminole would be expected to decrease from Walter F. George Lake because of atmospheric conditions and releases of cooler reservoir waters (Figure 6.1-65, Figure 6.1-68, Figure 6.1-71, Figure 6.1-74, Figure 6.1-77, and Figure 6.1-80).

Water temperatures from Walter F. George downstream of Jim Woodruff Lock and Dam would be expected to have little variation. Operations at George Andrews Lock and Dam and Jim Woodruff Dam are consistent with run-of-river projects and during drought operations releases would be made to support fish and wildlife conservation (Figure 6.1-65, Figure 6.1-68, Figure 6.1-71, Figure 6.1-74, Figure 6.1-77, and Figure 6.1-80).

6.1.2.1.2 Alternative 1L

Negligible changes in water temperature would be expected from comparing median changes in Alt1L with the NAA over the modeled period (Figure 6.1-65). Comparing these alternatives illustrates the incremental effects of increased river withdrawals and increased returns downstream of Buford Dam consistent with Georgia's 2015 water supply request (GAEPD 2015a). Little difference in water temperature would be expected downstream of West Point Dam, as illustrated in Figure 6.1-83, Figure 6.1-86, Figure 6.1-89, Figure 6.1-92, Figure 6.1-95, and Figure 6.1-98.

In the reach from Buford Dam to West Point Lake, changes in water temperature from the NAA are the result of increased water withdrawals and increased water returns. Temperature changes from Buford Dam to West Point Lake at 5th, 50th, and 95th percent occurrences would be expected to be less than 0.5 °C over the modeled period (Figure 6.1-83). Median temperature changes in a dry weather year for May through October, months critical to aquatic resources, would be expected to increase 0.5 °C downstream of Atlanta around RM 400 and gradually decrease to negligable change downstream of Whitesburg (Figure 6.1-92). The location of the increase is consistent with modeled wastewater returns. Alt1L would not be expected to affect the finalized temperature TMDL for the reach, despite the change in heat load caused by wastewater returns (GAEPD 2003b). Water temperatures in this reach would be expected to remain well below water quality standards during the most extreme conditions for aquatic resources from May through October of a representative dry weather year (Figure 6.1-74).

Downstream of Walter F. George Lock and Dam, water temperatures in a representative normal weather year from May through October would be expected to decrease slightly (Figure 6.1-98). The changes would be the result of small changes in the timing of releases and decrease to negligable change in Lake Seminole.

Little change in water temperature would be expected between the NAA and Alt1L from Jim Woodruff Lock and Dam downstream into Apalachicola River (Figure 6.1-83, Figure 6.1-86, Figure 6.1-89, Figure 6.1-92, Figure 6.1-95, and Figure 6.1-98).

6.1.2.1.3 Alternative 7A

Negligible changes in water temperature would be expected over the modeled period from implementing Alt7A (Figure 6.1-65). Comparing Alt7A with the NAA illustrates changes in water temperature due to operational changes between current operations (Water Management Alternative 1) and proposed WCM updates (Water Management Alternative 7). Minimal changes in water temperature would be expected under Alt7A compared to the NAA when observing the deltas in the median water temperature over the

modeled period of 2001–2011 (Figure 6.1-83). In rare occurrences of the 95th percentile, water temperatures could increase between Morgan Falls Dam and Atlanta by nearly 0.5 °C.

Median water temperatures over the modeled period from Atlanta into West Point Lake would be expected to decrease by less than 0.2 °C. The greatest variation in water temperature under Alt7A would be expected in 5th percent occurrences, the lowest temperatures from May through October of a dry weather year in West Point Lake (Figure 6.1-92). Temperatures could be expected to increase by more than 2 °C, increasing from 15 °C (59 °F) to 17 °C (63 °F). These water temperatures are well below the water quality standard (Figure 6.1-74). Median water temperatures in West Point Lake for the same period would be similar to those under the NAA. Annual January–December median water temperature in a dry weather year would be expected to decrease by as much as 0.5 °C because of changes in reservoir operations (Figure 6.1-89).

Downstream of West Point Lake, deviations of not more than ± 0.5 °C in the lowest water temperatures (5th percent occurrences) would be expected from May through October of a dry weather year (Figure 6.1-92).

Downstream of Lake George W. Andrews into Lake Seminole, water temperature increased by less than 0.5 °C in the lowest water temperatures (5th percent occurrences) would be expected from May through October of a representative normal weather year (Figure 6.1-98).

Apalachicola River water temperatures would be expected to be consistent with the NAA, including during the critical period for aquatic resources (May–October) of a representative dry weather year (Figure 6.1-92). Annual median water temperatures for a dry weather year illustrate that median temperatures at different locations in the Apalachicola River would be expected to change by ± 0.3 °C because of changes in releases made from Jim Woodruff Lock and Dam (Figure 6.1-89).

6.1.2.1.4 Alternative 7B

Negligible changes in median water temperature would be expected from Alt7B over the modeled period (Figure 6.1-65). Alt7B compares the effects of current water management operations (the NAA) with the proposed updated water management operation, while limiting water supply withdrawals in Lake Lanier to only those currently authorized (by way of relocation contracts). Systemwide differences between Alt7B and the NAA would be similar to those between Alt7A and the NAA, with some exceptions.

Median water temperature downstream of Morgan Falls Dam would be expected to decrease over the modeled period (2001–2011) (Figure 6.1-83). More water would be available in Lake Lanier since water supply withdrawals would be limited and, therefore, water returns would be reduced compared to the NAA.

The greatest differences from the NAA occur in a representative dry weather year from May through October (Figure 6.1-92). During the periods of the highest water temperatures (95th percent occurrences) from May through October of a dry weather year, water temperature downstream of Buford Dam to Atlanta could increase by as much as 1 °C, as with Alt7A; these differences can be attributed to water management changes. For similar reasons, the lowest water temperatures (5th percent occurrences) could increase by 1 °C in West Point Lake from May through October of a representative dry weather year (Figure 6.1-92).

6.1.2.1.5 Alternative 7H

Alt7H would yield negligible differences in median water temperature over the modeled period compared to the NAA (Figure 6.1-84). This alternative was retained to allow comparison of the PAA from the draft EIS with alternatives considered in the final EIS. Alt7H includes Georgia's 2013 water supply request. During the modeled period, the median water temperature was similar to that for the NAA for much of the system with deviations from Buford Dam into West Point Lake. The deltas expected in median water temperature from Buford Dam into West Point Lake would be less than 0.5 °C over the modeled period. In a representative dry weather year from May through October, median water temperatures would be expected to increase by as much as 1 °C (Figure 6.1-93), but temperatures would remain well below the fishery standard of 90 °F (32 °C) (Figure 6.1-75).

Changes from the NAA are generally similar to differences between Alt7A and the NAA. As with other alternatives, the lowest water temperatures in West Point Lake (5th percent occurrences) would be expected to increase by as much as 1 °C from the NAA in a representative dry weather year from May through October (Figure 6.1-93). The 5th and 95th percent occurrences for the entirety of a dry weather year would be more similar to those for the NAA and the delta of median water temperatures would be expected to vary from -0.5 °C to 0.4 °C in West Point Lake (Figure 6.1-90).

Downstream of West Point Lake, changes in water temperature can generally be attributed to changes in water management. Little variation would be expected to result from changes in water withdrawals and returns. This can be inferred by comparing Alt1L with Alt7H in Figure 6.1-83 with Figure 6.1-84, Figure 6.1-86 with Figure 6.1-87, Figure 6.1-89 with Figure 6.1-90, Figure 6.1-92 with Figure 6.1-93, Figure 6.1-95 with Figure 6.1-96, and Figure 6.1-98 with Figure 6.1-99.

6.1.2.1.6 Alternative 7I

Negligible changes in median water temperature would be expected from Alt7I over the modeled period (Figure 6.1-84). Alt7I is a revised version of Alt7H that adds 40 mgd in water withdrawals from Lake Lanier to account for elimination of Glades Reservoir and uses river withdrawals downstream of Buford Dam as revised per the Georgia 2015 request. The water temperature differences of Alt7I with the NAA, for varying operational conditions, would be generally similar to those for Alt7H, as illustrated in Figure 6.1-84, Figure 6.1-87, Figure 6.1-90, Figure 6.1-93, Figure 6.1-96, and Figure 6.1-99, with the exception of conditions in West Point Lake in a representative dry weather year.

Median water temperatures in a dry weather year in West Point Lake could increase by 0.8 °C (Figure 6.1-90). During the period critical to aquatic resources, May through October, for the same dry weather conditions, the lowest water temperatures in West Point Lake (5th percent occurrences) could increase by nearly 2 °C from 16 °C to 18 °C (Figure 6.1-93). These water temperatures are well below the water quality standards and would not be expected to affect the reservoir fishery (Figure 6.1-75).

6.1.2.1.7 Alternative 7J

Negligible changes in median water temperature would be expected from Alt7J over the modeled period (Figure 6.1-84). The differences from the NAA are the result of changes in water management as well as reduced withdrawals and returns in Lake Lanier (consistent with relocation contracts) and increased withdrawals and returns downstream of Buford Dam (consistent with the Georgia 2015 water supply request). The changes in water temperature are generally similar to other alternatives with Water Management Alternative 7 water management operations.

6.1.2.1.8 Alternative 7K (PAA)

Negligible changes in median water temperature would be expected from the PAA over the modeled period (Figure 6.1-85). Comparing the PAA to the NAA illustrates the maximum effects associated with implementing the 2015 Georgia water supply request plus updated water management operations. Despite differences in water withdrawals and returns from Lake Lanier, little change would be expected when compared to other alternatives with similar water management operations. The median effect to water temperature downstream of Atlanta would be similar to that under Alt1L, which includes the same assumptions about water withdrawals and returns downstream of Buford Dam. The similarities are illustrated by comparing results from the modeled period—Figure 6.1-83 with Figure 6.1-85—and the most critical period for aquatic resources from May through October in a representative dry weather year—Figure 6.1-92 with Figure 6.1-94. The PAA would not be expected to affect the finalized temperature TMDL for the reach from Altanta to Whitesburg under the most extreme conditions for aquatic resources from May through October of a dry weather year (GAEPD 2003b). Water temperatures in this reach would be expected to remain well below water quality standards (Figure 6.1-76).

The longitudinal profile of the Chattahoochee River system during the more critical period for aquatic resources from May through October of a dry weather year illustrates how little change would be expected from these maximum water withdrawals (Figure 6.1-76). The greatest changes would be expected from Atlanta downstream to West Point Lake: From May through October of a dry weather year, the lowest water temperatures could increase by 1.6 °C from the NAA (Figure 6.1-94) for temperatures ranging between 14 °C and 18 °C (Figure 6.1-76).

6.1.2.1.9 Alternative 7L

Negligible changes in median water temperature would be expected from Alt7L over the modeled period (Figure 6.1-85). Alt7L and NAA include the same Lake Lanier water withdrawals and returns. Therefore, differences between Alt7L and the NAA compare water management operations and increased withdrawals and returns downstream of Buford Dam. The negligible effects to median water temperature over the modeled period are illustrated in Figure 6.1-67 and Figure 6.1-85. The seasonal effects, and those that would be expected under varying weather conditions, are illustrated in Figure 6.1-70, through Figure 6.1-100. The greatest deviations from the NAA would be expected in the lowest water temperatures in West Point Lake (5th percent occurrences) during May–October of a representative dry weather year (Figure 6.1-94).

Comparing Alt7L with the PAA illustrates the effects of increased withdrawals from Lake Lanier on water temperature. Despite differences in water withdrawals and returns from Lake Lanier, little change would be expected, as illustrated in the longitudinal profile of the Chattahoochee River system during the more critical period for aquatic resources from May through October of a representative dry weather year (Figure 6.1-76 and Figure 6.1-94).

6.1.2.1.10 Alternative 7M

Negligible changes in median water temperature would be expected from Alt7M over the modeled period (Figure 6.1-85). Comparing Alt7M with the NAA enables consideration of Lake Lanier withdrawals minus the 40 mgd allocated to make up for the Glades Reservoir withdrawal in Alt7I. The withdrawals and returns downstream of Buford Dam are consistent with the 2015 Georgia water supply request and with Alt1L, Alt7I, Alt7J, the PAA, and Alt7L. Figure 6.1-67 and Figure 6.1-85 illustrate the negligible effects to median water temperature over the modeled period. Figure 6.1-70, through Figure 6.1-100 illustrate the seasonal effects and those that would be expected under varying weather conditions. The greatest deviations from the NAA would be expected in the lowest water temperatures in West Point Lake (5th percent occurrence) during May–October of a representative dry weather year (Figure 6.1-94). The

changes would be more than 1 °C from the NAA for temperatures ranging between 14 °C and 18 °C (Figure 6.1-76).

6.1.2.2 Dissolved Oxygen

Figure 6.1-101 through Figure 6.1-130 present the processed HEC-5Q modeled output for DO concentrations for the NAA. Like the water temperature profiles, these figures illustrate variations between proposed revisions to the Master Manual as defined in Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M from the NAA.

The median DO concentration over the modeled period for each alternative was compared to the median concentration under the NAA and determined to have the following impacts:

- Negligible impact if the change in DO was < 0.1 mg/L
- A slightly adverse impact if DO decreased by 0.1–0.5 mg/L
- An adverse impact if DO decreased by more than 0.5 mg/L
- A substantial adverse impact if DO decreased to a level below the state water quality standards
- A slightly beneficial impact if DO increased 0.1–0.5 mg/L
- A beneficial impact if DO increased more than 0.5 mg/L
- A substantial beneficial impact if DO would meet the state water quality standards

The longitudinal plots of 5th, 50th, and 95th percent occurrences over the modeled period were calculated from modeled daily average DO. Therefore, the median, or 50th percent occurrence, is the most representative to use in evaluating the alternative changes and was used to define effects. These effects were defined based on an understanding that a 0.1 mg/L change in DO is within the margin of error of measurements and any changes less then 0.1 mg/L were assumed negligible or no change. The standard range for DO in coldwater trout streams, similar to conditions below Buford Dam, is 5 to 6 mg/L as a daily average and 4 mg/L as a minimum. Decreasing DO by 10 percent when concentrations are 4–5 mg/L is generally accepted as an adverse impact. Average modeled results were between 6 and 7 mg/L; therefore, a 0.1–0.5 mg/L change was established as a point of slight effect. Adverse impacts were defined by a negative (-) concentration change of 0.5 mg/L or more, and a beneficial impact was a positive (+) concentration change of 0.5 mg/L or more. Table 6.1-18 summarizes the effect of alternatives from NAA based on these established criteria. The effects of each alternative are discussed in detail in the following sections.

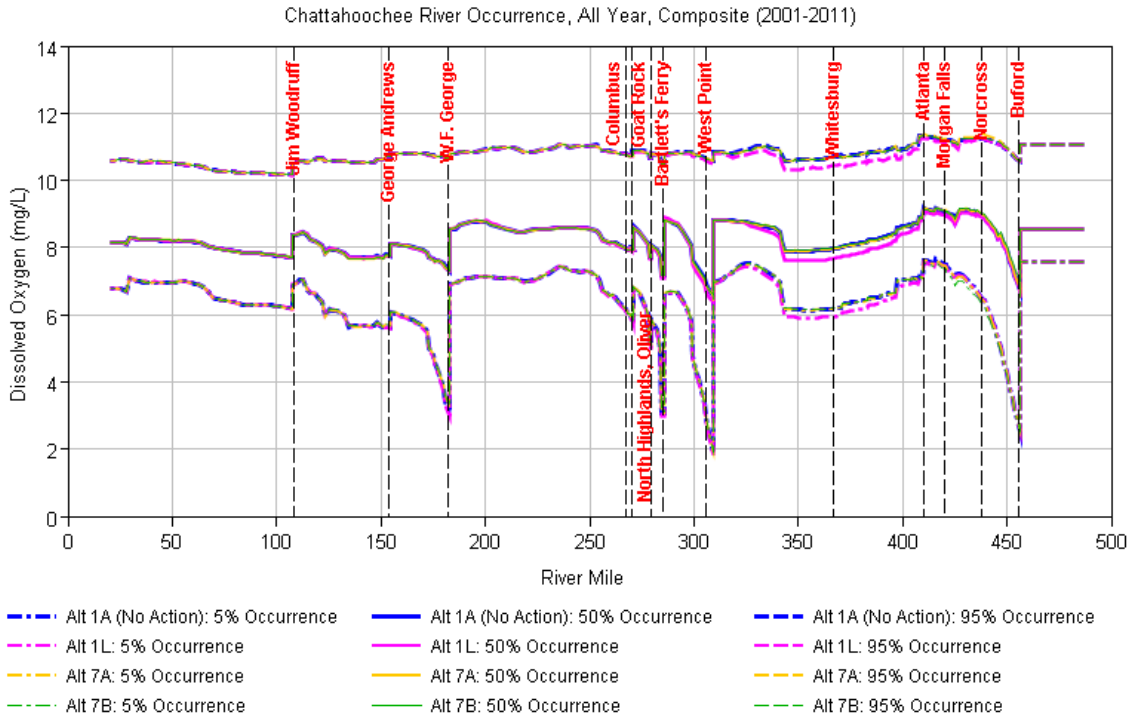


Figure 6.1-101. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and, Alt7B.

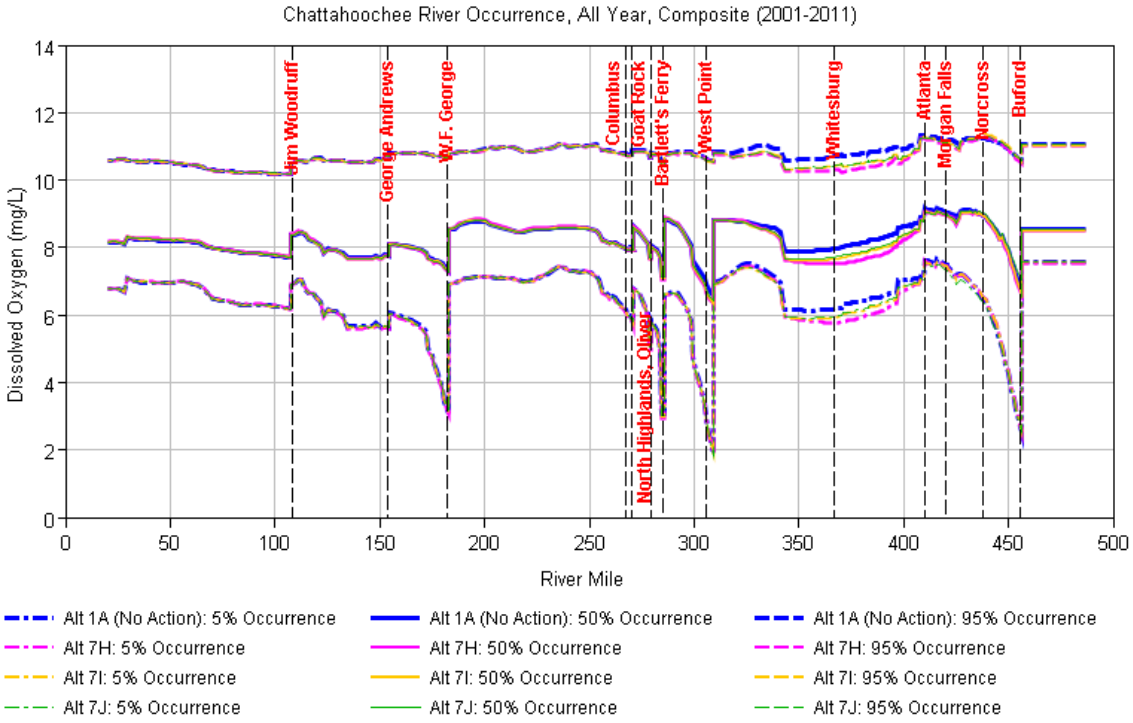


Figure 6.1-102. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

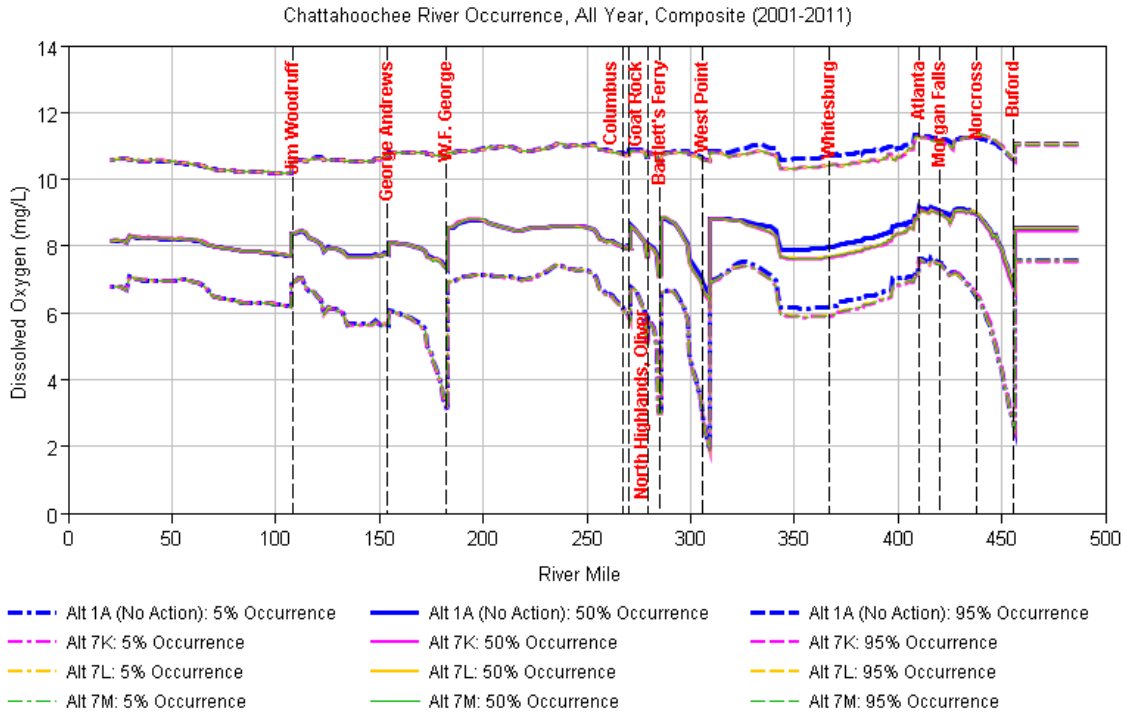


Figure 6.1-103. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

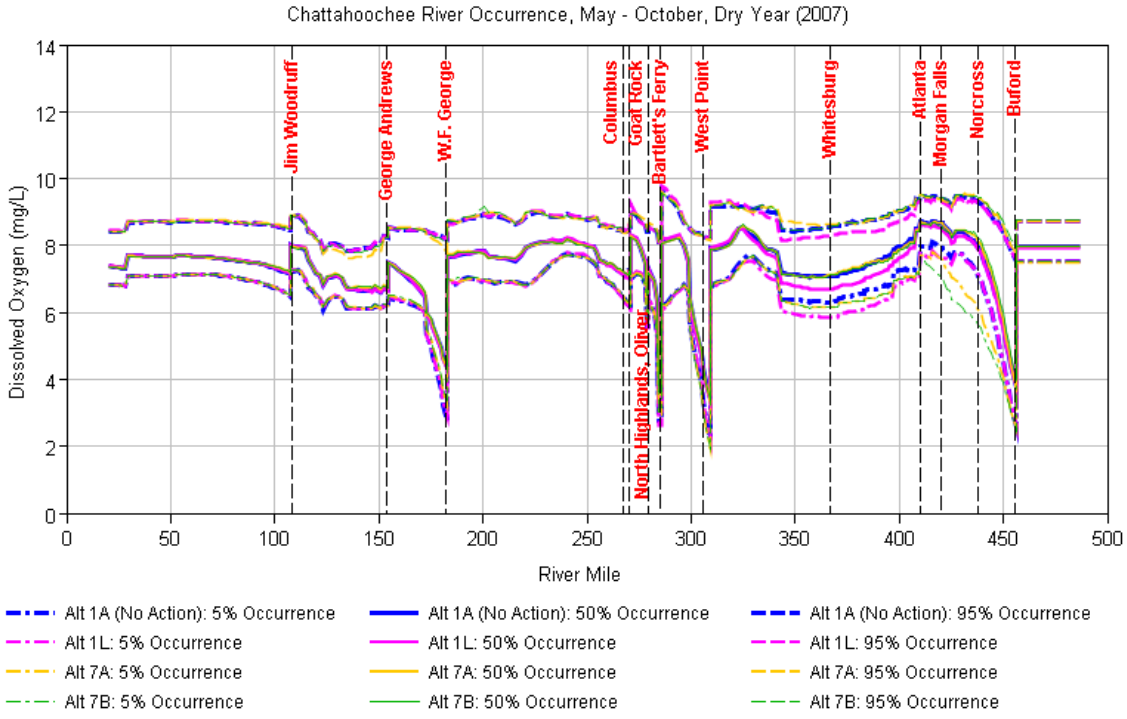


Figure 6.1-104. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during May–Oct of a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

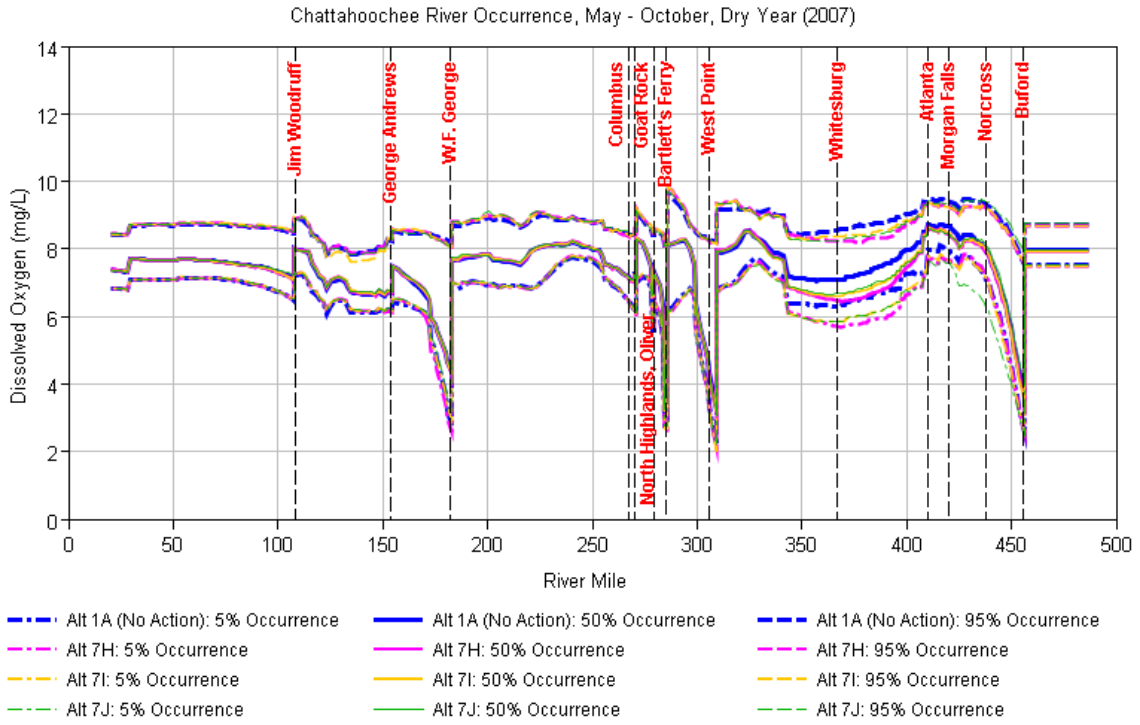


Figure 6.1-105. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during May–Oct of a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

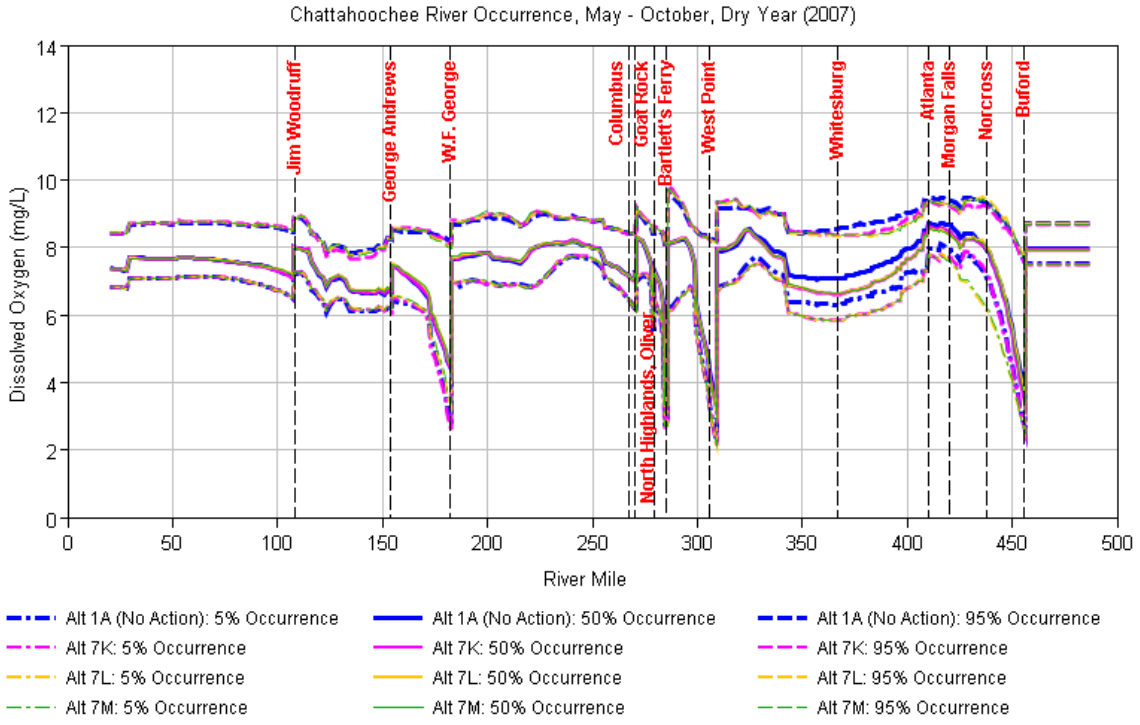


Figure 6.1-106. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during May–Oct of a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

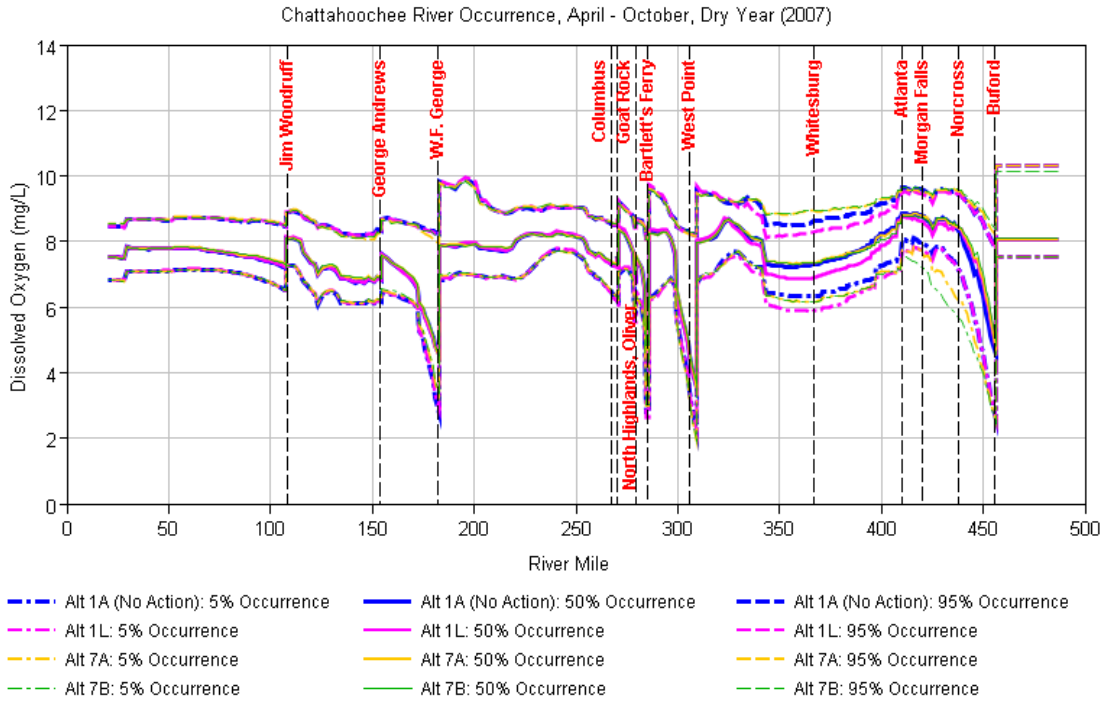


Figure 6.1-107. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

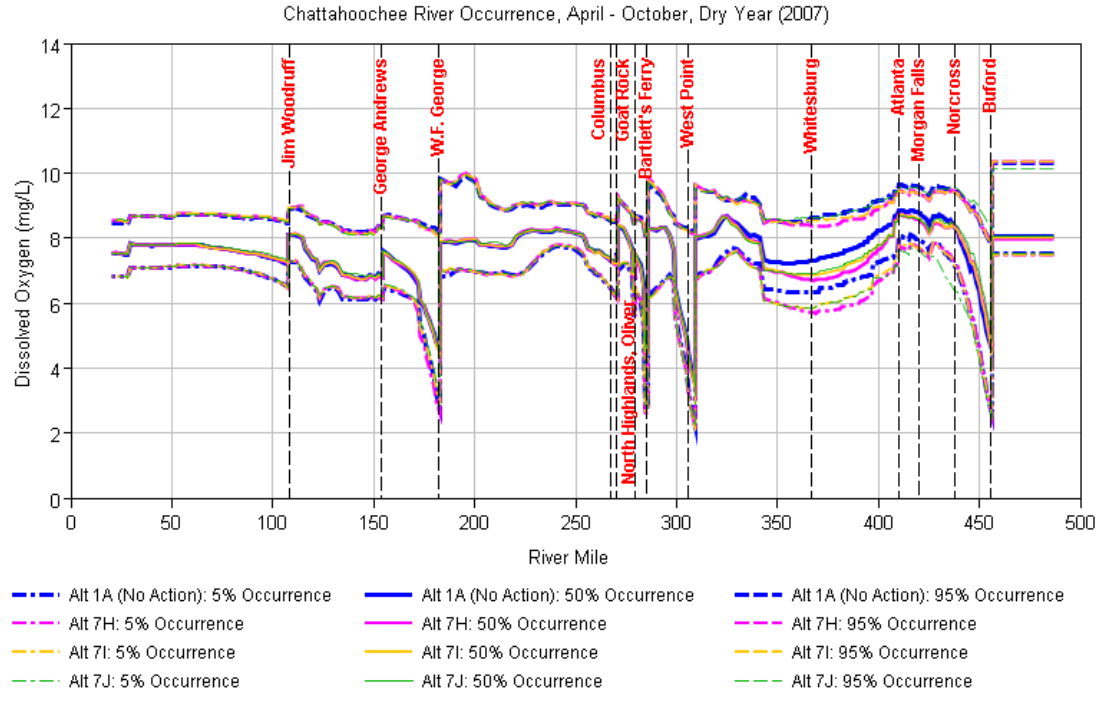


Figure 6.1-108. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

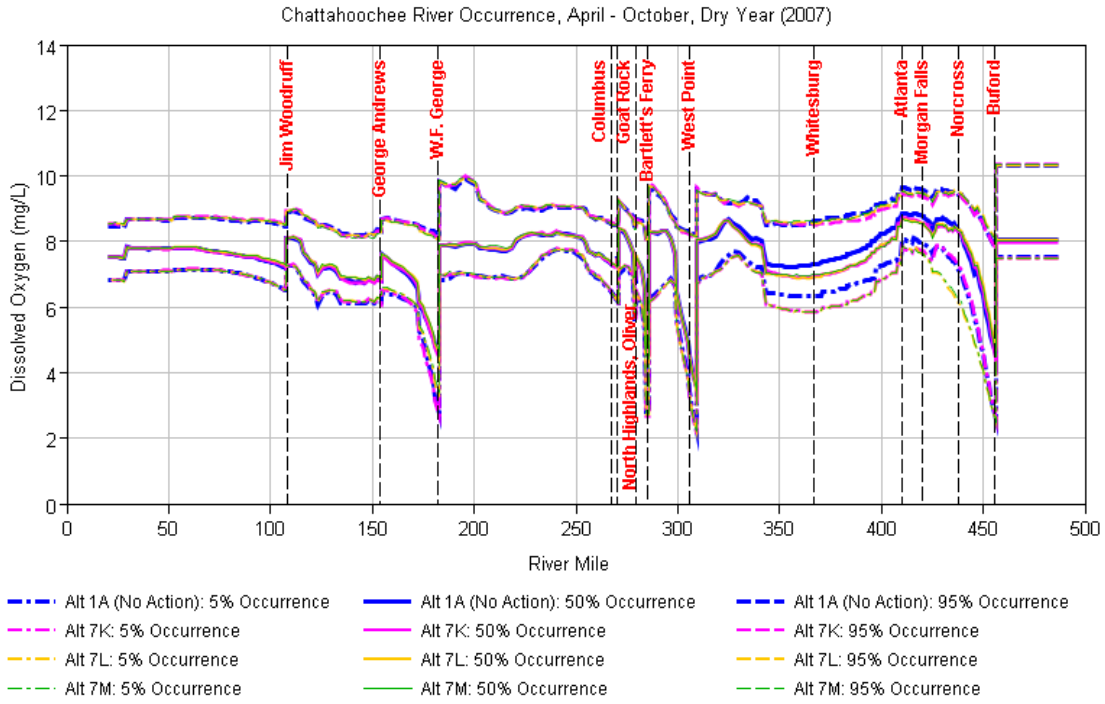


Figure 6.1-109. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

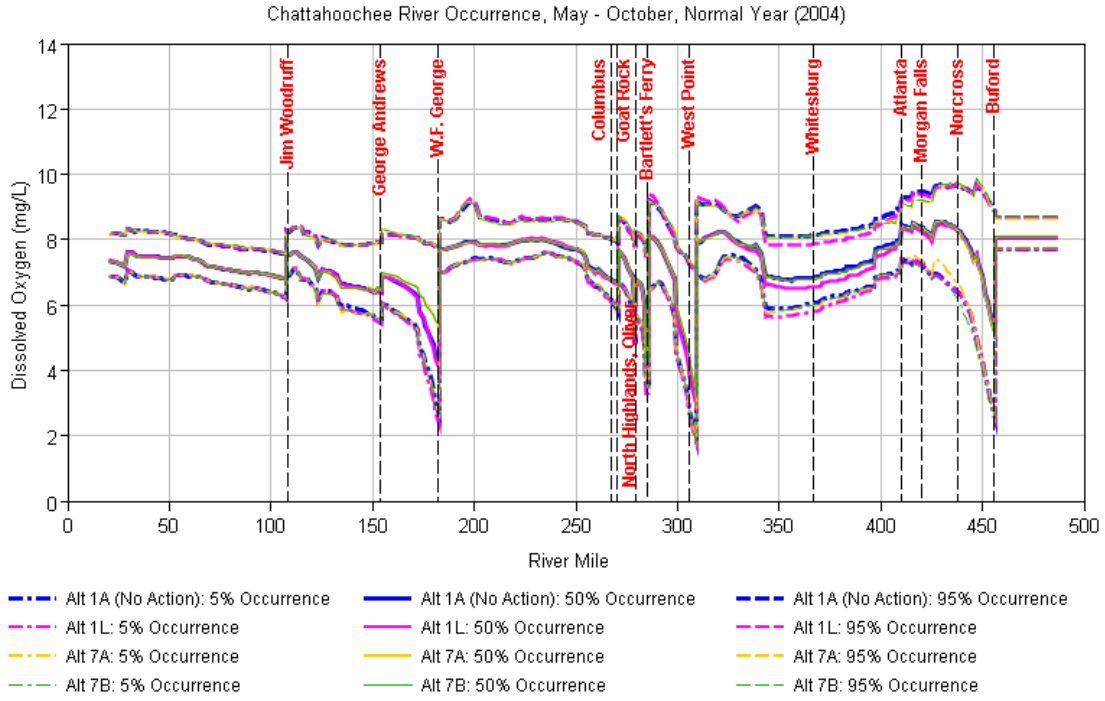


Figure 6.1-110. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during May–Oct of a Normal Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

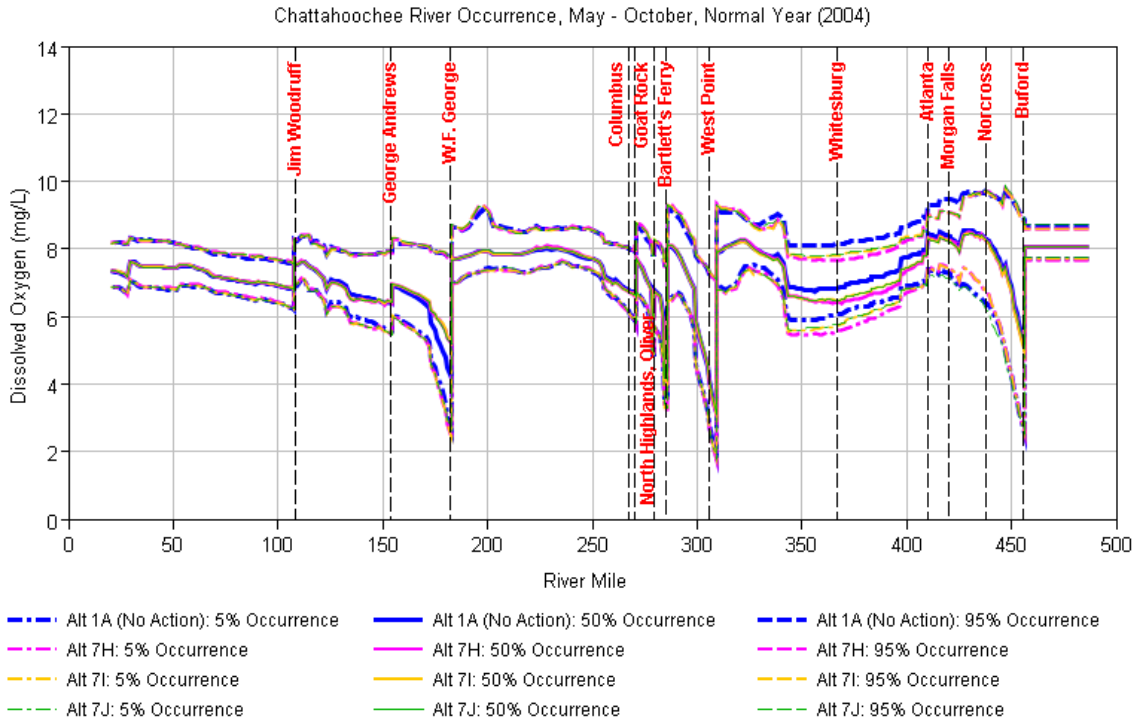


Figure 6.1-111. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during May–Oct of a Normal Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

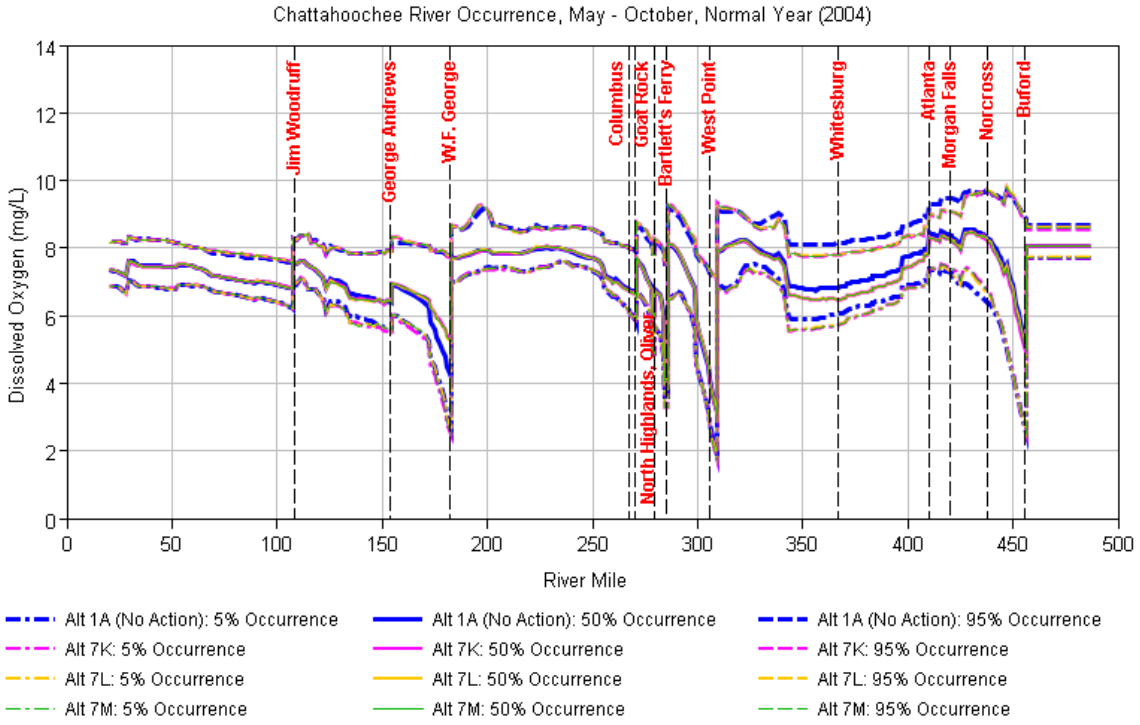


Figure 6.1-112. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during May–Oct of a Normal Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

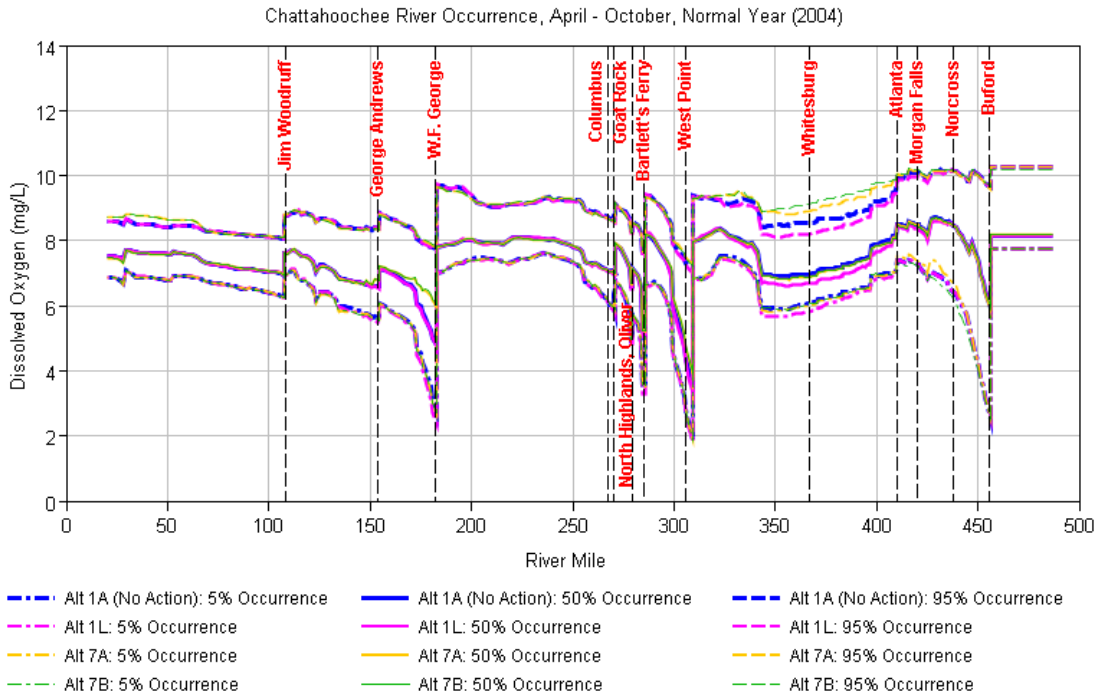


Figure 6.1-113. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during the Growing Season (Apr–Oct) of a Normal Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

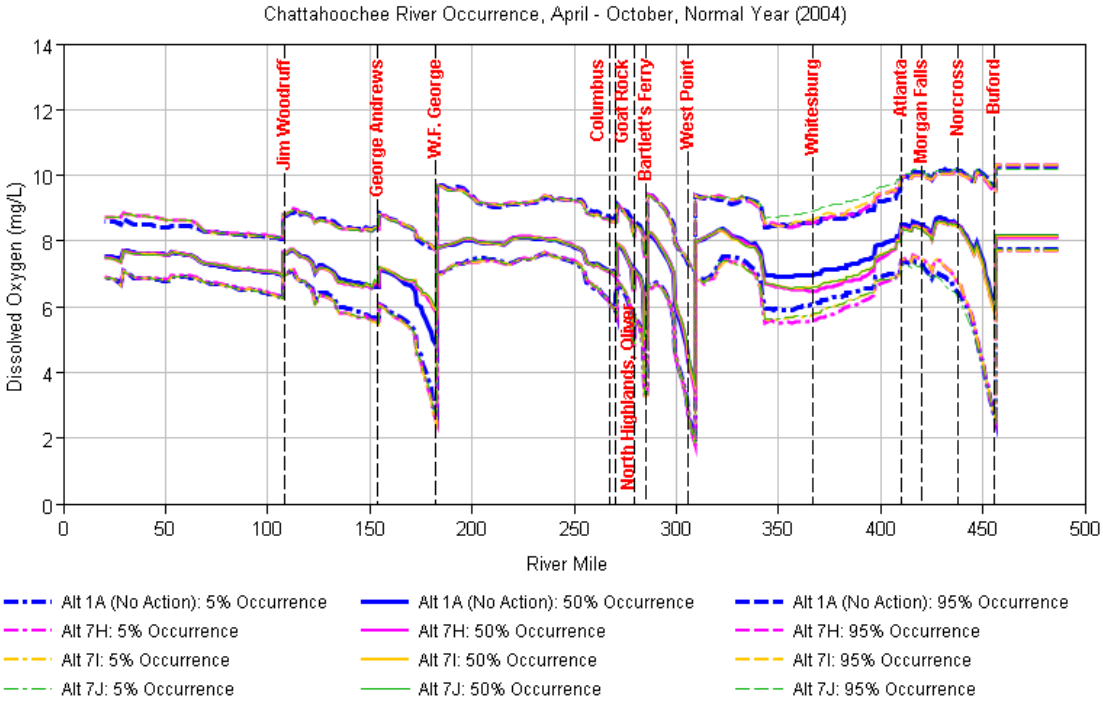


Figure 6.1-114. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during the Growing Season (Apr–Oct) of a Normal Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

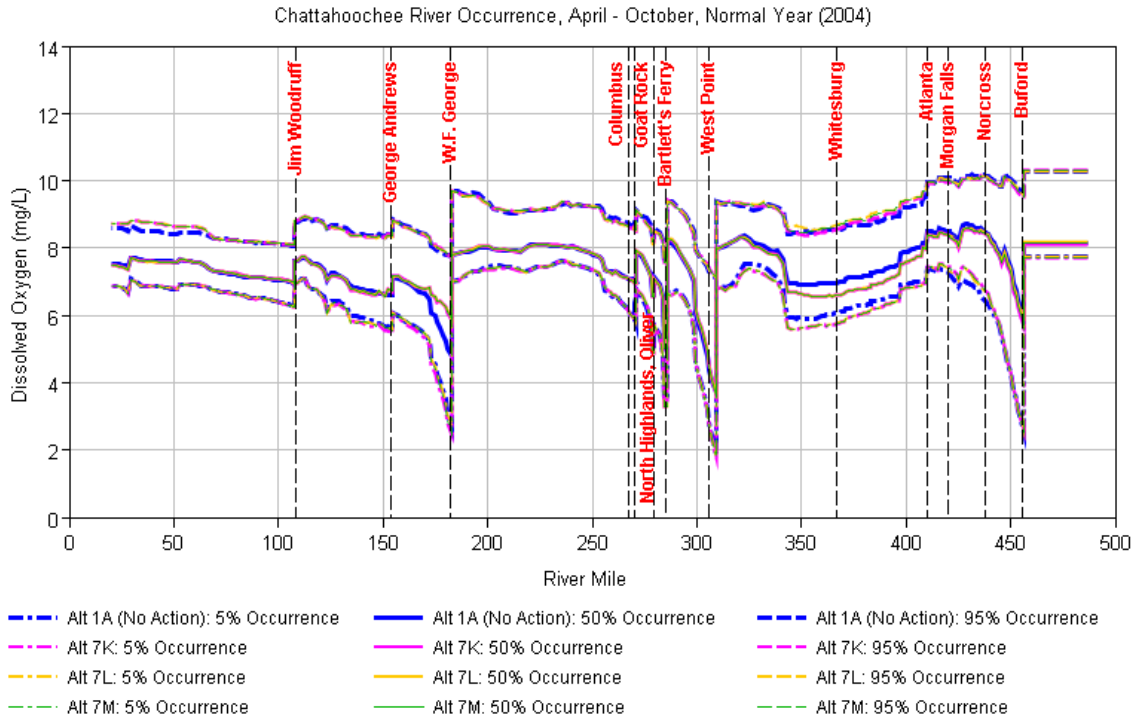


Figure 6.1-115. Longitudinal Profile Occurrence of Modeled Dissolved Oxygen in the ACF Basin during the Growing Season (Apr–Oct) of a Normal Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

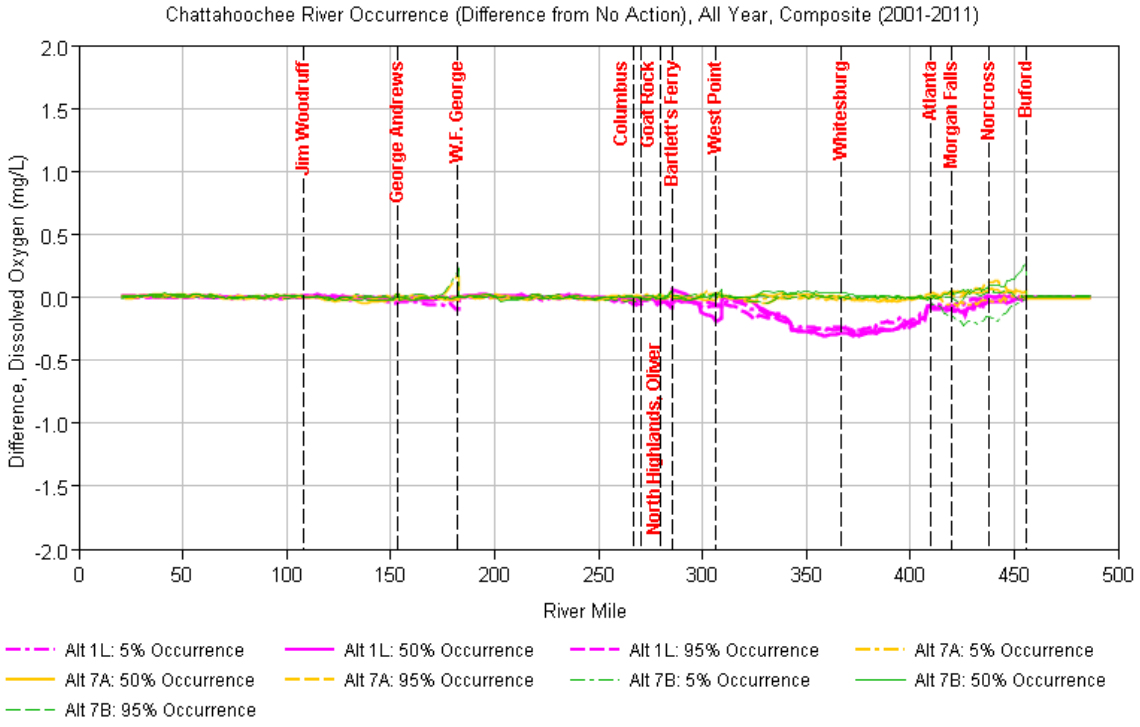


Figure 6.1-116. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

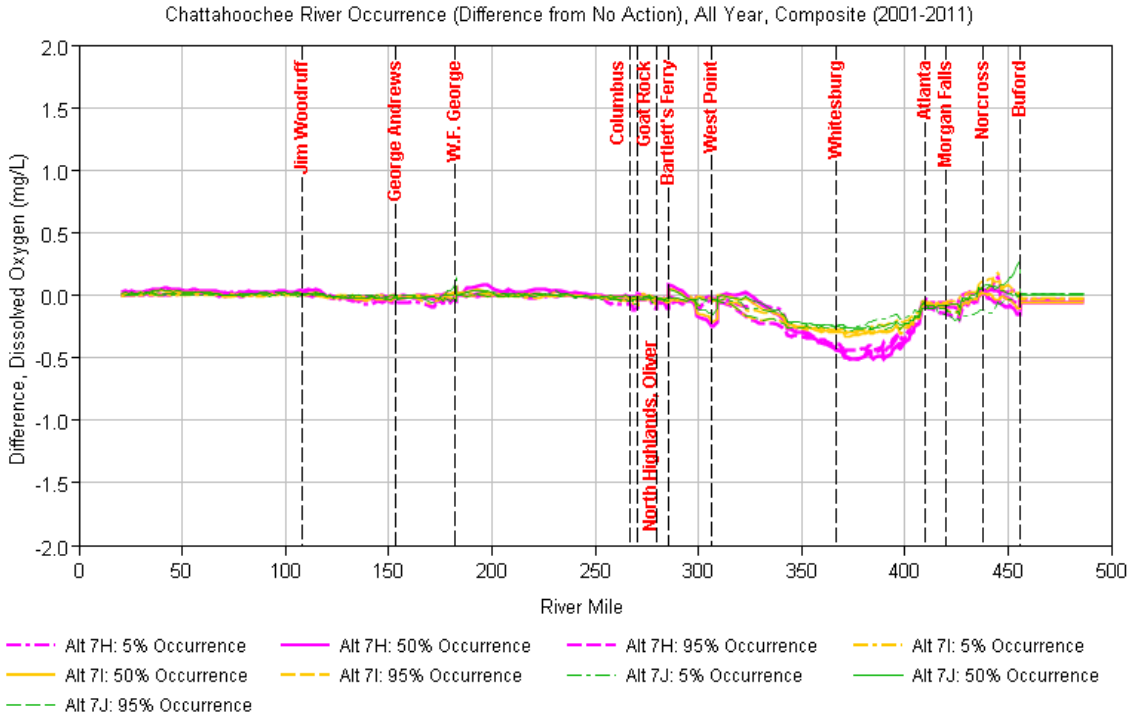


Figure 6.1-117. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

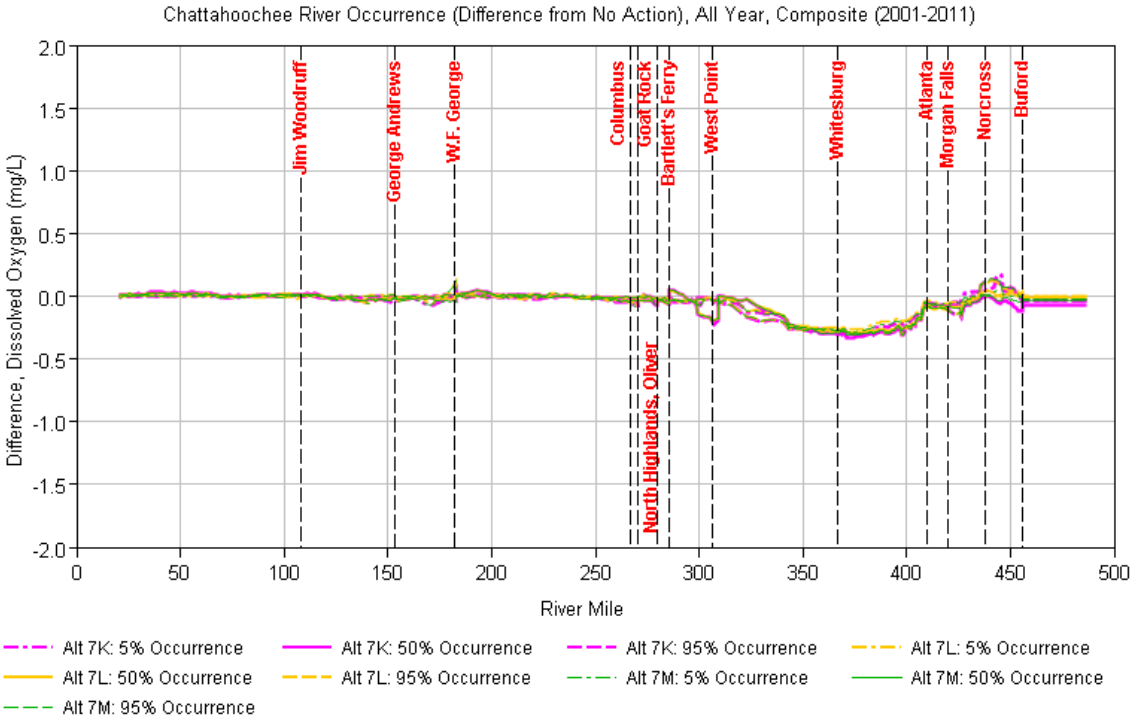


Figure 6.1-118. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

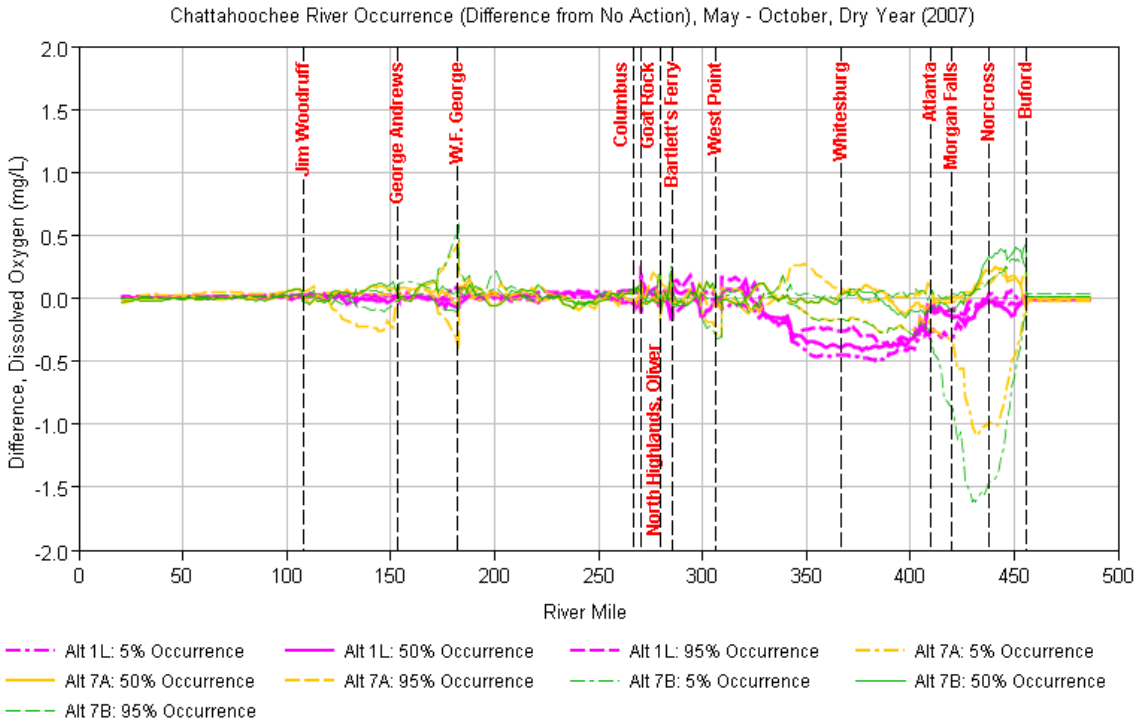


Figure 6.1-119. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during May–Oct of a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

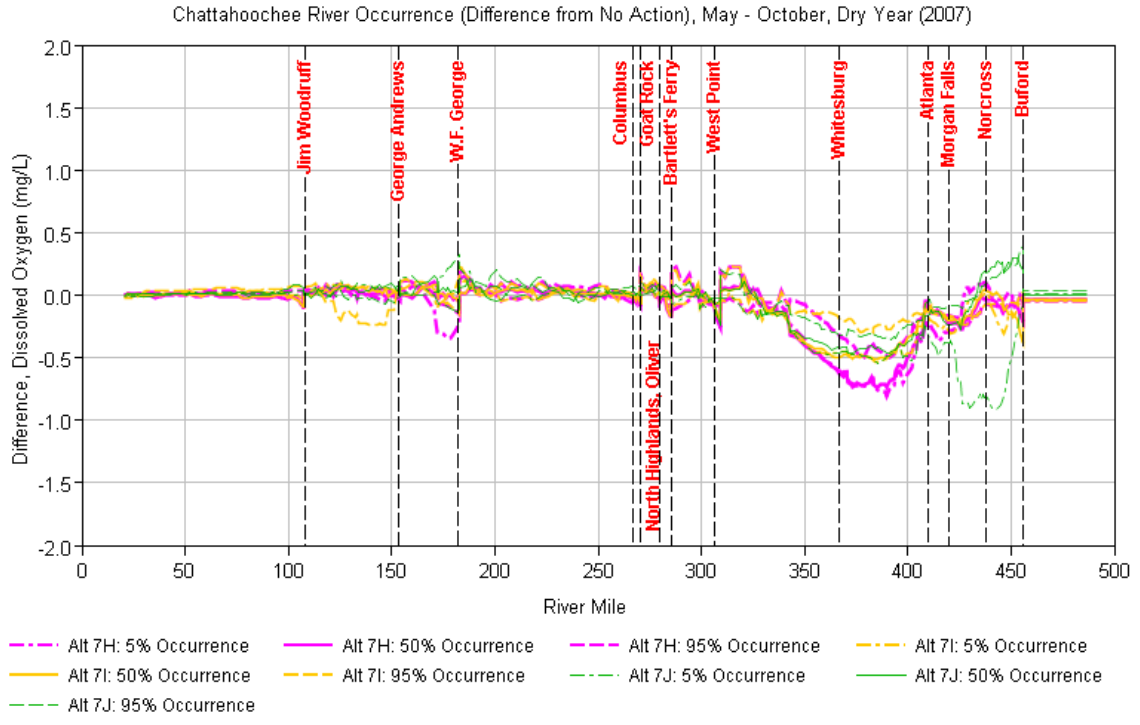


Figure 6.1-120. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during May–Oct of a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

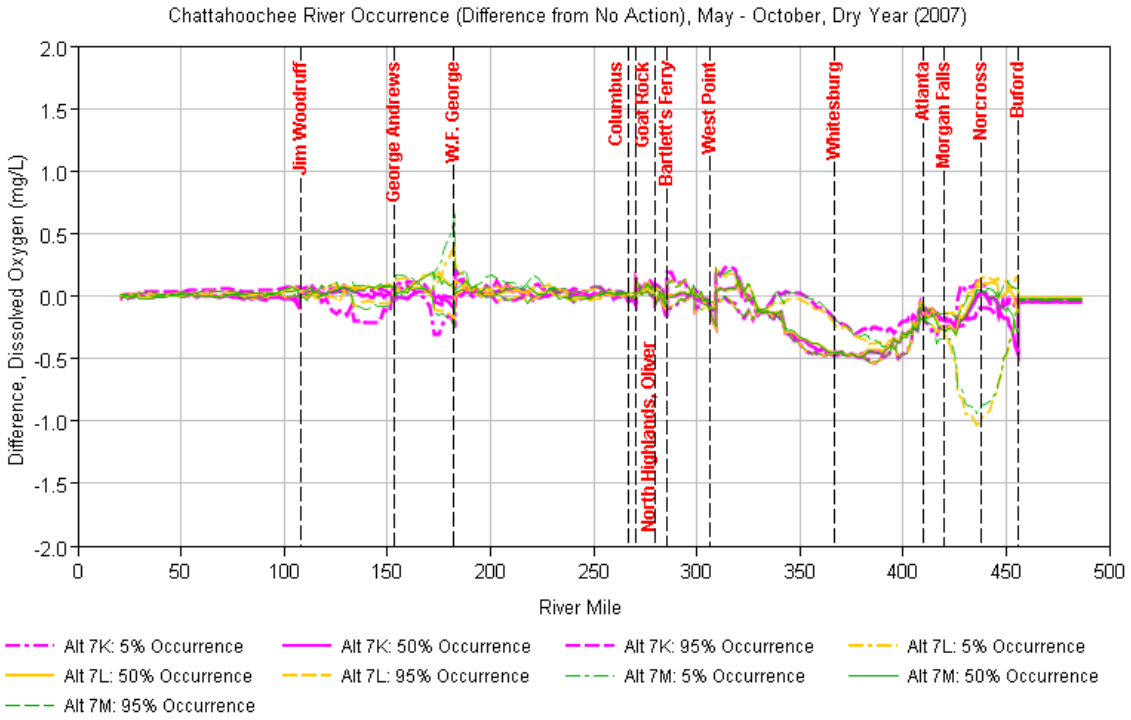


Figure 6.1-121. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during May–Oct of a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

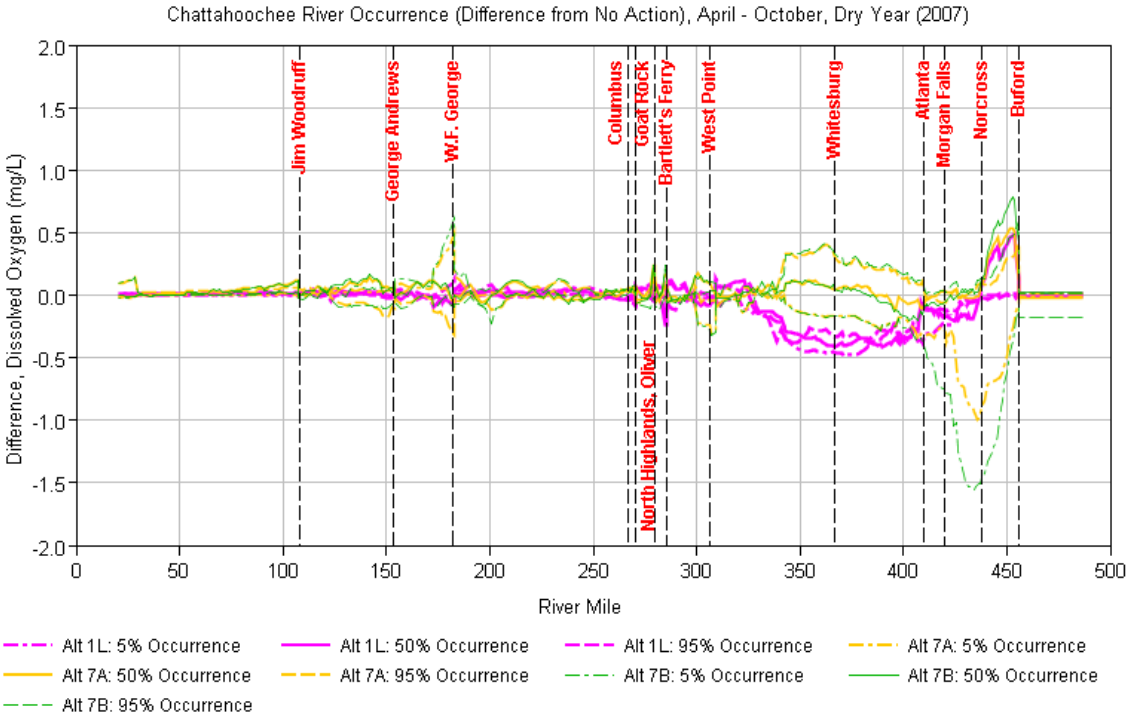


Figure 6.1-122. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

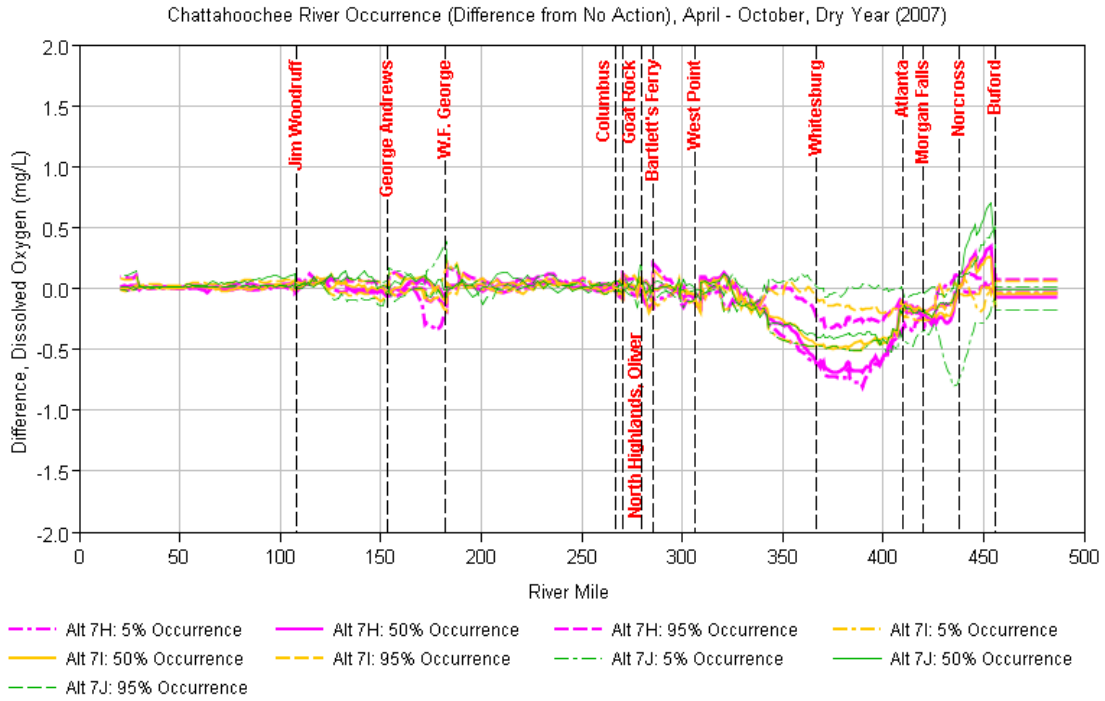


Figure 6.1-123. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

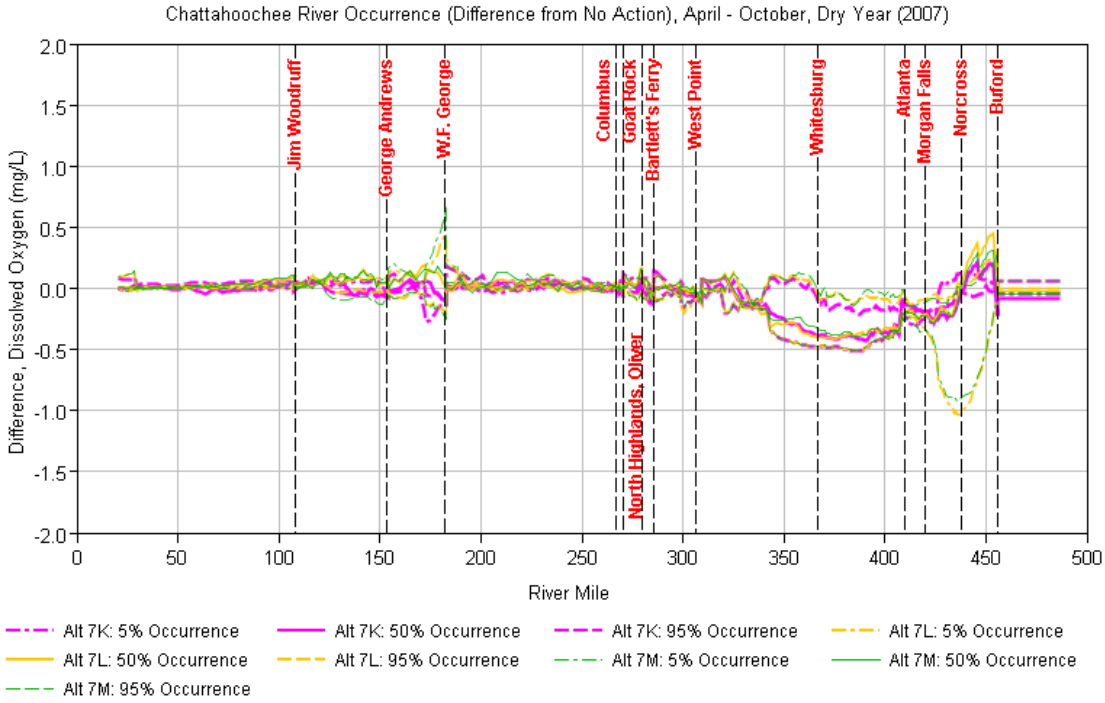


Figure 6.1-124. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

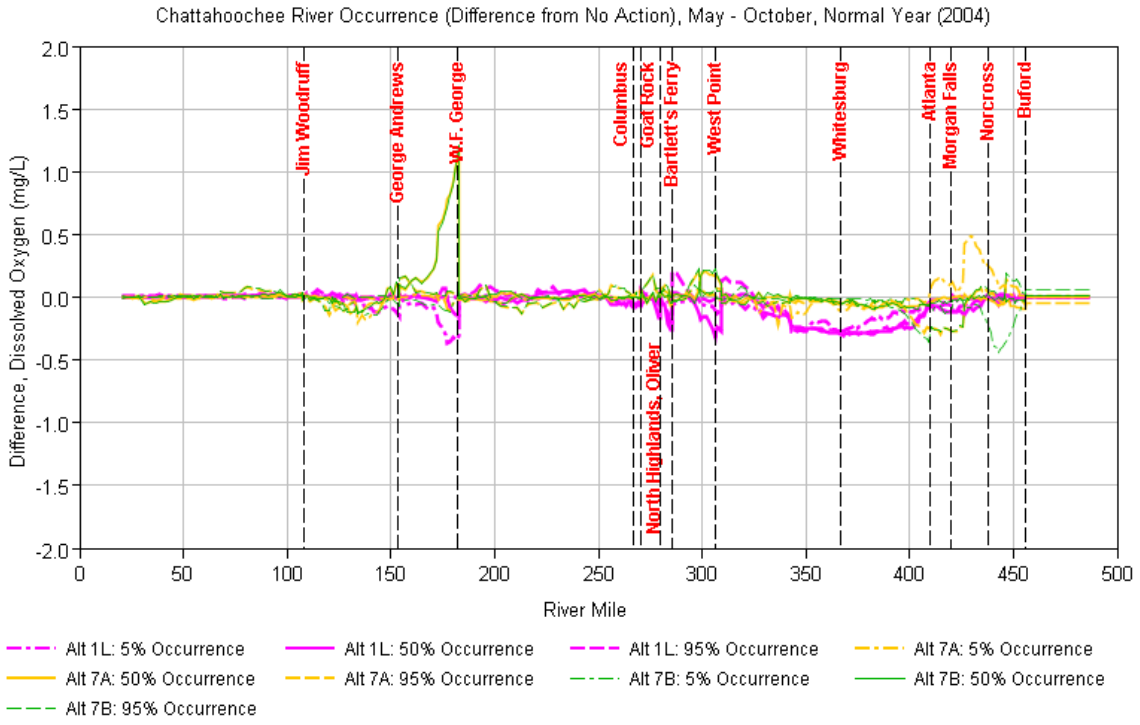


Figure 6.1-125. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin May–Oct of a Normal Weather Year for Alt1L, Alt7A, and Alt7B.

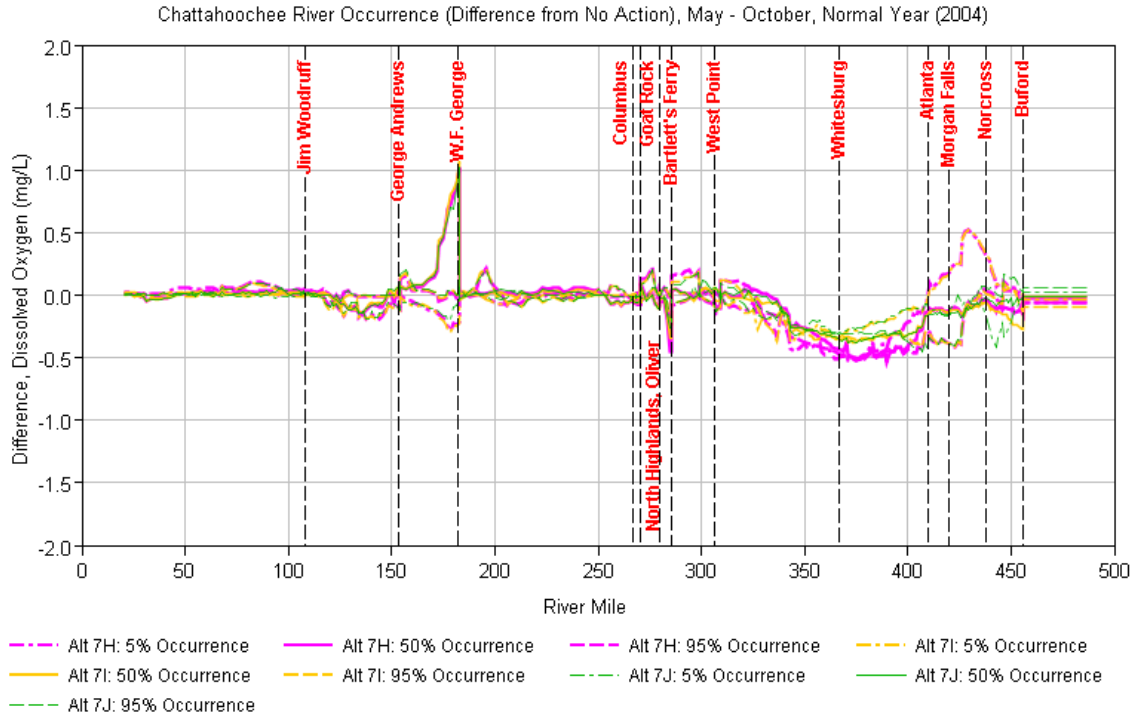


Figure 6.1-126. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin May–Oct of a Normal Weather Year for Alt7H, Alt7I, and Alt7J.

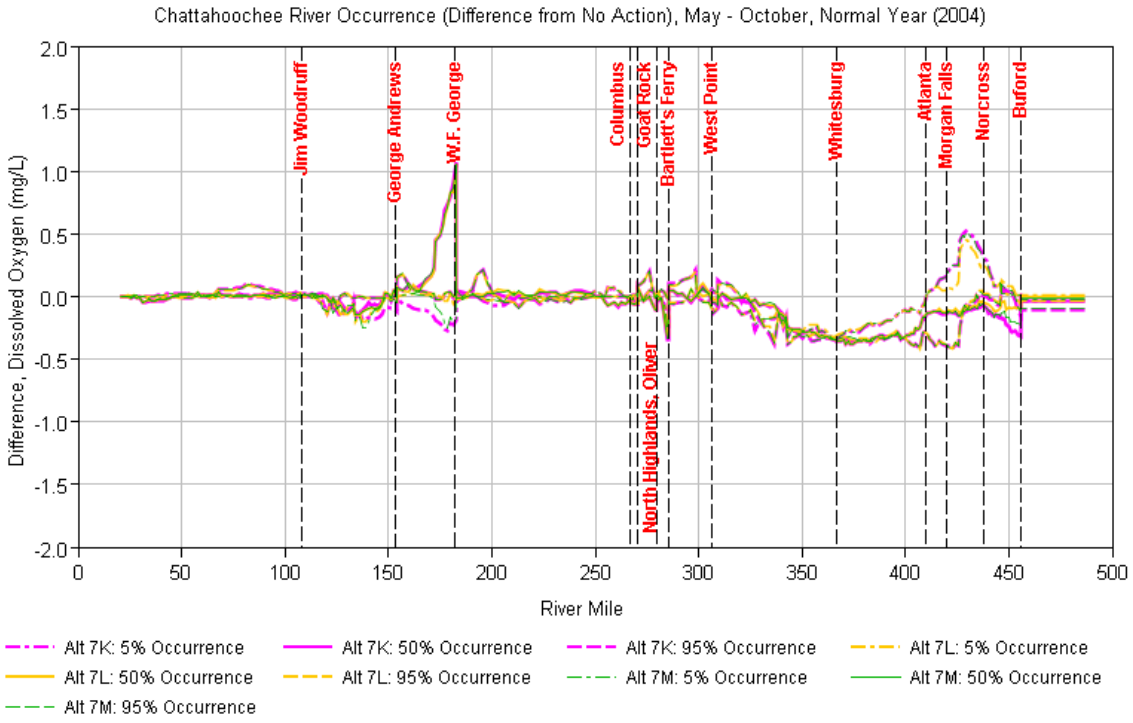


Figure 6.1-127. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin May–Oct of a Normal Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

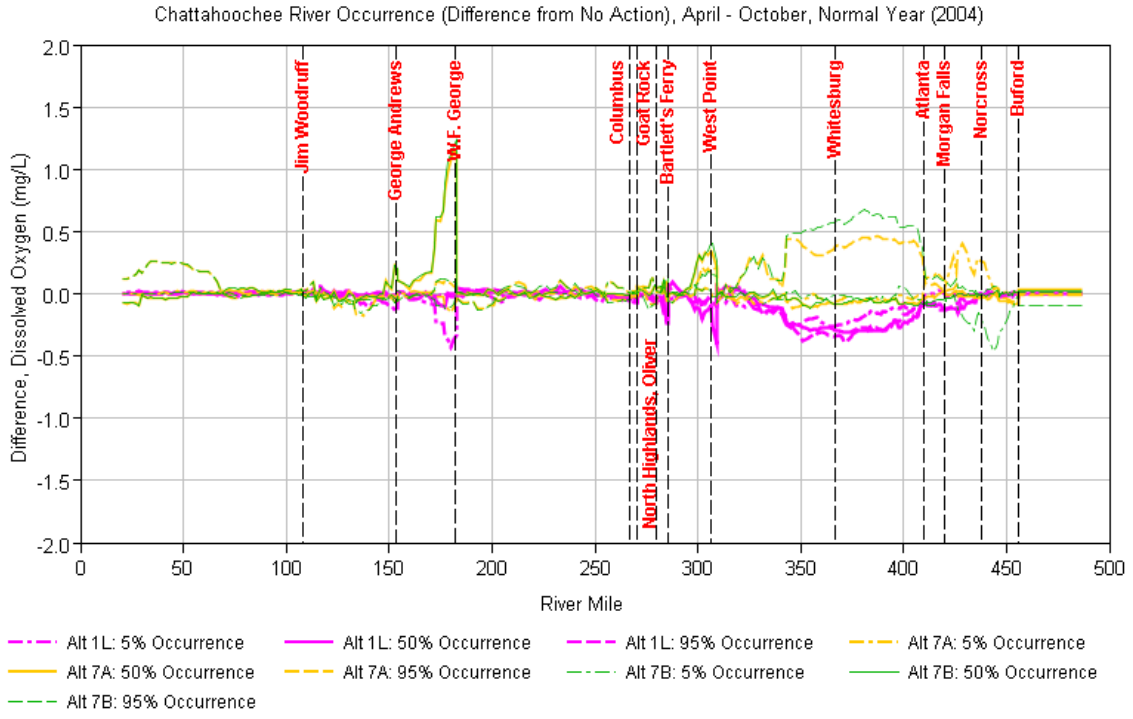


Figure 6.1-128. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Normal Weather Year for Alt1L, Alt7A, and Alt7B.

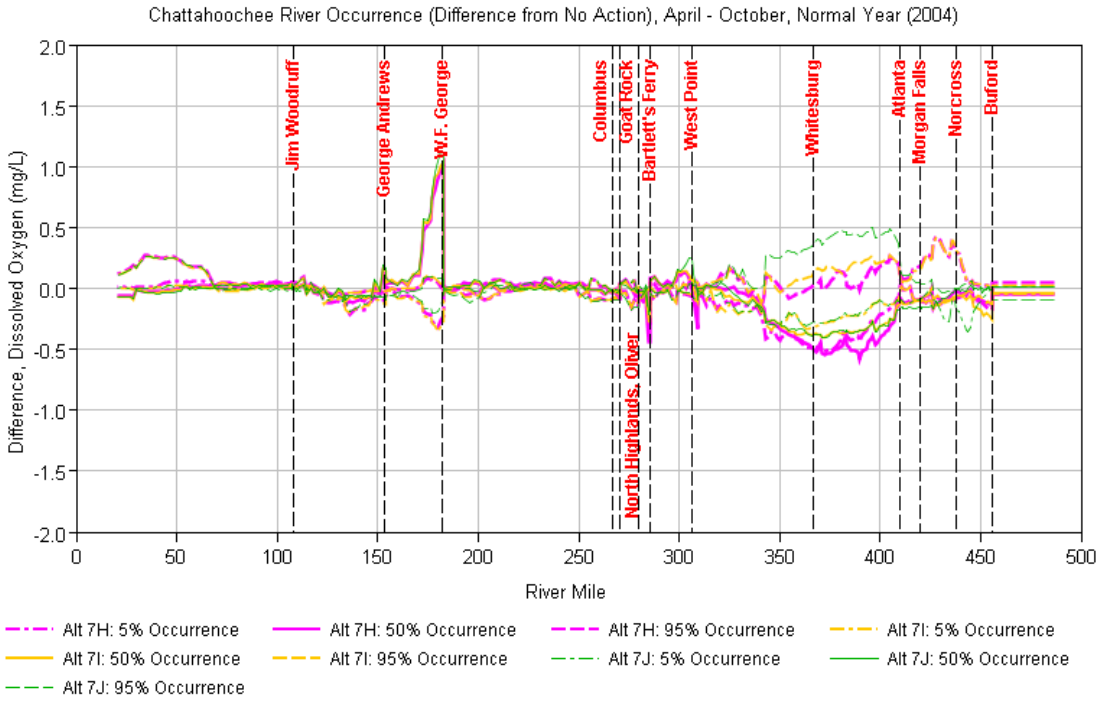


Figure 6.1-129. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Normal Weather Year for Alt7H, Alt7I, and Alt7J.

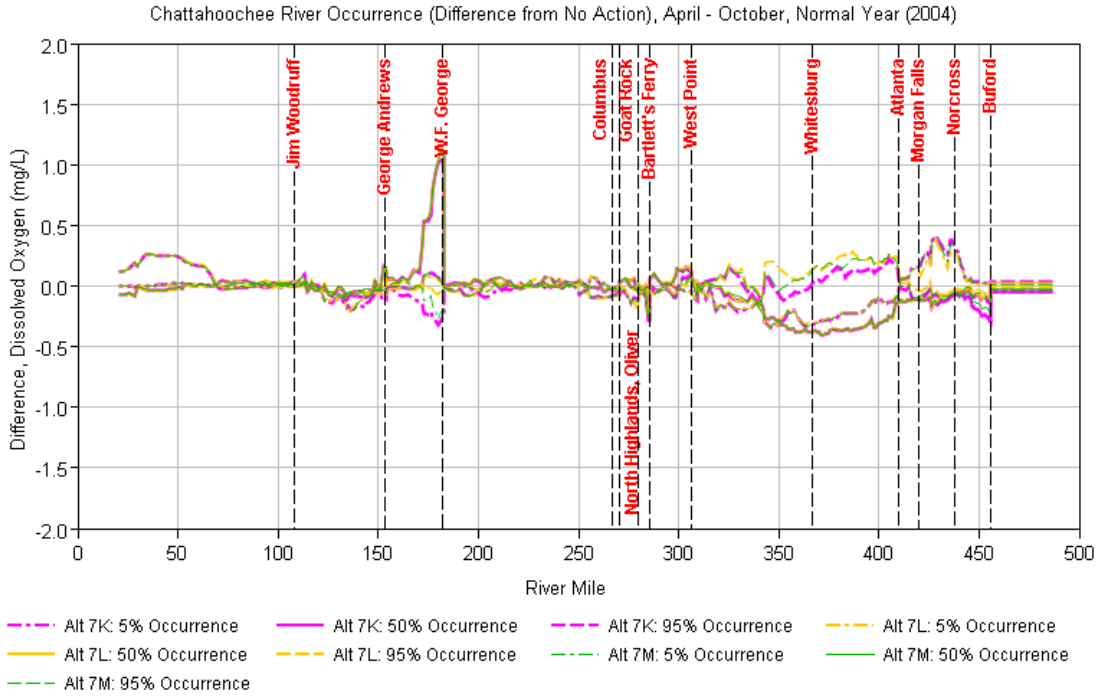


Figure 6.1-130. Longitudinal Profile of Difference in Modeled Dissolved Oxygen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Normal Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

Table 6.1-18.
Summary of the Effects on Median Dissolved Oxygen of the Alternatives from the NAA during the Modeled Period (2001–2011)

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Slightly beneficial	Slightly adverse	Negligible/ No change	Slightly beneficial	Slightly adverse	Negligible/ No change	Negligible/ No change
Buford Dam to Atlanta	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Atlanta to West Point Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
West Point Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Negligible/No change if the change in DO was < 0.1 mg/L.
Slightly adverse—Slightly adverse if DO decreased by 0.1–0.5 mg/L.
Slightly beneficial—Slightly beneficial if DO increased 0.1–0.5 mg/L.

6.1.2.2.1 No Action Alternative

Lower DO concentrations would be expected to occur below the major reservoirs under the NAA because of the low-oxygenated water being discharged from them. The concentrations found in the deeper portions of a reservoir might stay low because of stratification. As the water warms through the summer, the amount of DO would decrease to levels below 3 mg/L in the depths of a reservoir's water column. Water released from the dams comes from the deeper waters, where DO is depleted over time. But the low oxygen concentrations rebound rapidly due to high velocities and high reaeration of the water downstream of dams. Immediately downstream from a dam release, the large volume of water results in greater velocities and reaeration, increasing oxygenation. The increased oxygen concentrations will support fisheries downstream of dams.

Over the modeled period of 2001–2011, a variety of hydrologic conditions occurred that impact the DO levels. DO also fluctuates daily depending on the water temperature and atmospheric conditions. Figure 6.1-101 presents the daily average median DO concentration along with the daily average 5th and 95th percent occurrences over the modeled period. The following discussion focuses on the changes in the median DO, calculated from daily average concentrations, for the NAA at different locations in the ACF Basin.

Georgia's state water quality standards were used as a benchmark to evaluate alternatives' impacts. For streams designated as primary trout or smallmouth bass waters by the WRD, the DO water quality standards are a daily average of 6 mg/L and no less than 5 mg/L. For streams designated for warmwater species of fish, the water quality standard is a daily average of 5 mg/L and no less than 4 mg/L (GAEPD 2015b).

Modeled results indicate that over the modeled period, the median DO would be expected to change from 8.5 mg/L in the surface water of Lake Lanier to 6.8 mg/L in the surface waters downstream of Buford Dam in the Chattahoochee River. The change would be the result of the water being released from the lower portion of the reservoir, where temperatures are much cooler and DO much lower than at the lake's surface, especially during the summer period. Figure 6.1-101 illustrates DO between Lake Lanier and downstream of Buford Dam in the ACF Basin and the recovery of DO within 20 mi downstream of Buford Dam.

Differences in DO levels from Buford Dam to Norcross would be more pronounced in a representative dry weather year because of the lower flows being released from Lake Lanier (Figure 6.1-104). Modeled simulations from May through October of a respresentative dry weather year illustrate that during periods critical to aquatic resources, the median concentration of DO under the NAA in the secondary trout fishery reach between Buford Dam and Atlanta would be expected to be above the water quality standard of 6 mg/L within 5 mi of the dam. Under the NAA, lower weekend flows would be expected to occur at Norcross because hydroelectric power would not be generated from Buford Dam as it is during the week; instead, only minimal flow would be released from Buford Dam and regulated by Morgan Falls Dam from May through October to produce a minimum flow of 750 cfs at Peachtree Creek near Atlanta. Modeled results illustrate that, even during the most critical period for aquatic resources (May–October of a representative dry weather year), the lowest DO concentrations would be expected to remain above the state's water quality standard from Atlanta to West Point Lake.

The reach from Atlanta to West Point Lake experiences a complex change in DO levels around and below Metro Atlanta. The occurrences of lower DO from Atlanta into West Point Lake can be attributed to wastewater treatment discharges. The effects to DO are greater when river flows decrease, resulting in longer time of travel and lower reaeration. Median DO concentrations under seasonal low flow conditions would consistently fall from 8.7 mg/L at RM 410 to less than 7.0 mg/L at RM 355 (Figure 6.1-104 and Figure 6.1-107). GAEPD has established wasteload allocations for Metro Atlanta wastewater dischargers based on meeting the downstream DO standard of 5 mg/L using their site-specific model under critical low flow conditions. Any projected adverse impact in that reach could require GAEPD to update their wasteload allocation and more stringent Metro Atlanta NPDES permits to maintain the DO water quality standard. The DO level in West Point Lake from RM 340 to the Dam would be expected to increase by more than 1 mg/L.

DO immediately downstream of West Point Dam would be expected to drop from the preceding reach because of low-oxygenated waters released from the bottom layers of West Point Lake. Median DO over the modeled period remains well above the water quality standard (Figure 6.1-101). In the most critical conditions, the low DO releases drop below 4 mg/L and quickly reaerate to DO levels above 5 mg/L (Figure 6.1-104).

In 2000, EPA finalized a DO TMDL for the Chattahoochee River downstream of West Point Dam and downstream of Walter F. George Dam (USEPA 2000b). The TMDL recommended that agencies work together in developing a strategy to provide higher oxygenated water from dam releases. Since 2000, USACE has implemented spillage siphons, effectively spilling highly oxygenated surface water from the lake, to improve DO levels below Walter F. George Dam. Also, a minimum flow requirement downstream of West Point Dam adds to increasing DO downstream. Georgia's 2014 303(d) list of

impaired waters identifies the segment of the Chattahoochee River downstream of West Point Dam as supporting designated uses (GAEPD 2014a).

From West Point Lake to Walter F. George Lake, downstream of Bartletts Ferry Dam, DO concentrations also drop during critical periods for aquatic resources (Figure 6.1-104), but experience only small changes of less than 1 mg/L in median concentrations over the modeled period (Figure 6.1-101). Low DO concentrations in May–October of a representative dry weather year would be attributed to lower flows and less reaeration in the lake upstream of Bartletts Ferry Dam (Lake Harding) (Figure 6.1-104). Downstream of Columbus, Georgia, median DO over the modeled period would be in the range of 8–8.5 mg/L (Figure 6.1-101).

At the tailrace of Walter F. George Lock and Dam, DO would be similar-to-slightly higher than the conditions at the tailrace of West Point Dam (Figure 6.1-101 and Figure 6.1-104). Median DO concentrations during the critical period from May through October of a representative dry weather year would be expected to remain above 4 mg/L. However, the lowest concentrations (5th percent occurrences) over the modeled period (Figure 6.1-101) and in the period from May through October of a representative dry weather year would be expected to drop below 4 mg/L (Figure 6.1-104). As previously stated, USACE has implemented spillage siphons to improve low-oxygen levels below Walter F. George Dam. Georgia's 2014 303(d) list identifies the segment of the Chattahoochee River downstream of Walter F. George Dam as not supporting designated uses (GAEPD 2014a).

DO levels downstream of Walter F. George Lock and Dam into Apalachicola River would be expected to range from near 6 mg/L to over 10 mg/L. George W. Andrews Lake has been identified as not supporting the designated use for DO, but modeled results indicate that concentrations would be above the water quality standard (GAEPD 2014a). Little change in DO would be expected downstream of Jim Woodruff Lock and Dam because releases are made consistent with a run-of-river system and are relatively consistent during periods of low flow as part of operations for fish and wildlife conservation.

6.1.2.2.2 Alternative 1L

Comparing Alt1L to the NAA illustrates changes that would be expected in DO from increased water withdrawals and returns downstream of Buford Dam consistent with those presented in section 5.1.4.1.2. Alt1L includes the same water management operations and the same withdrawals and returns to Lake Lanier as the NAA.

Upstream of Atlanta and downstream of West Point Lake, little change in DO would be expected under a variety of conditions (Figure 6.1-116, Figure 6.1-119, Figure 6.1-122, Figure 6.1-125, and Figure 6.1-128).

Slightly adverse changes in DO would be expected in the reach from Atlanta to West Point Lake (Figure 6.1-101 and Figure 6.1-116). These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

In 2000, EPA finalized TMDL for low-oxygenated water in the tailrace of West Point Dam and Walter F. George Lock and Dam. Modeled results from various conditions, particularly during the growing season (April – October) (Figure 6.1-122 and Figure 6.1-128) and the period from May–October of the modeled period (Figure 6.1-116), indicated that in cases where DO already is below the water quality standard of 4 mg/L, conditions could lower DO by 0.1 mg/Land. Given that implementation of the current EPA finalized DO TMDL (2000) is based solely on USACE operations, states and federal agencies would be expected to work together to identify opportunities to improve water quality consistent with conditions identified in the TMDL (USEPA 2000b).

Negligible changes in DO levels would be expected downstream of Walter F. George Lock and Dam into the Apalachicola River in a variety of conditions (Figure 6.1-116, Figure 6.1-119, Figure 6.1-122, Figure 6.1-125, and Figure 6.1-128).

6.1.2.2.3 Alternative 7A

Comparing Alt7A with the NAA illustrates the differences in DO levels that would be expected from changes to water management operations. Negligible changes in median DO would be expected from Alt7A over the modeled period (Figure 6.1-101 and Figure 6.1-116). Water management changes would be expected to benefit median DO downstream of dams, particularly during the growing season (April–October) (Figure 6.1-122 and Figure 6.1-128).

Upstream of Atlanta and downstream of West Point Lake little change in DO would be expected under a variety of conditions (Figure 6.1-116, Figure 6.1-119, Figure 6.1-122, Figure 6.1-125, and Figure 6.1-128). The highest DO concentrations (95th percent occurences) between Atlanta and West Point Lake would be expected to increase by as much as 0.5 mg/L in the 95th percent occurrences (ranging from 8 mg/L to less than 9 mg/L).

Median DO could decrease slightly below Atlanta during the growing season (April–October) in a representative dry weather year (Figure 6.1-107 and Figure 6.1-119). These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

Downstream of Walter F. George Lock and Dam median, the level of DO would be similar to the level under the NAA; however, but the 5th percent occurrence would be expected to increase and the 95th percent occurrence would be expected to decrease. The low-oxygenated water in the tailrace of Walter F. George Lock and Dam would be expected to increase by as much as 1 mg/L (Figure 6.1-128) in the median concentrations of the growing season of a representative normal weather year.

Negligible changes in DO would be expected below Walter F. George Lock and Dam into the Apalachicola River in a variety of conditions (Figure 6.1-116 through Figure 6.1-128).

6.1.2.2.4 Alternative 7B

Comparing Alt7B to the NAA illustrate changes that would be expected by limiting water withdrawals and returns to relocation amounts. Median DO over the modeled period in Lake Lanier would be slightly beneficial but negligible changes would be expected downstream because downstream water withdrawals and returns are equal to those in the NAA (Figure 6.1-116). Changes that would be expected generally would occur from Buford Dam into West Point Lake and in the tailrace of Walter F. George Lock and Dam.

In a representative dry weather year during the growing season (April–October), median DO could decrease slightly below Atlanta and increase around Whitesburg. Conditions in that reach, Atlanta to Whitesburg, from May through October would be more similar to the NAA. Looking upstream between Buford Dam and Morgan Falls Dam, however, the lowest level of DO (the 5th percent occurrence) would be expected to decrease by more than 1.5 mg/L (Figure 6.1-119). DO in that reach would be expected to remain above water quality standards (Figure 6.1-104). These trends in DO concentration with respect to the NAA would continue to West Point Lake: The 5th percent occurrence would be expected to decrease, and the median and 95th percent occurrences would be expected to increase (Figure 6.1-122).

Downstream of Walter F. George Lock and Dam, median DO would be similar to the level for the NAA, but the 5th percent occurrence would be expected to increase and the 95th percent would be expected to decrease.

Negligible changes in DO would be expected below Walter F. George Lock and Dam into the Apalachicola River in a variety of conditions (Figure 6.1-116, Figure 6.1-119, Figure 6.1-122, Figure 6.1-125, and Figure 6.1-128).

6.1.2.2.5 Alternative 7H

Comparing Alt7H to the NAA illustrates changes that would be expected from Georgia's 2013 water supply request for Lake Lanier and downstream of Buford Dam. This alternative was retained to allow comparison of the PAA from the draft EIS with alternatives considered in the final EIS.

Alt7H would be expected to have negligible effects on median DO over the modeled period compared to the NAA for much of the system with the exception of conditions in Lake Lanier and in the Atlanta to West Point Lake reach (Figure 6.1-102). Median DO in Lake Lanier over the modeled period would be expected to decrease by 0.10 mg/L causing slightly adverse effects (Figure 6.1-117). The reach from Atlanta to West Point Lake, median DO would be expected to decrease by 0.5 mg/L over the modeled period (Figure 6.1-117). The greatest changes from the NAA would be expected seasonally in a representative dry weather year (Figure 6.1-120 and Figure 6.1-123). During the period from May through October and the growing season (April–October), median DO would be expected to decrease by 0.7 mg/L downstream of Atlanta, but would be similar to the level for the NAA in West Point Lake. These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

Downstream of West Point Lake, median DO levels would be expected to be similar to those for the NAA for much of the reach to Walter F. George Lock and Dam. Negligible changes to DO are expected in the low-oxygenated water in the tailrace of West Point Dam, particularly during the growing season (April–October) (Figure 6.1-123 and Figure 6.1-129).

Downstream of Walter F. George Lock and Dam, the lowest concentrations of DO (5th percent occurrences) in May–October of a representative dry weather year would be expected to decrease as much as 0.4 mg/L (Figure 6.1-120). USACE would be expected to continue to spill water to improve DO levels in the tailrace of Walter F. George Lock and Dam. In the growing season of a representative normal weather year median DO downstream of Walter F. George Lock and Dam would be expected to increase by as much as 1 mg/L (Figure 6.1-129). This change in the highest concentrations (95th percent occurences) of DO may be beneficial to aquatic resources in this reach.

Negligible changes in DO would be expected below Walter F. George Lock and Dam into the Apalachicola River in a variety of conditions (Figure 6.1-117, Figure 6.1-120, Figure 6.1-123, Figure 6.1-126, and Figure 6.1-129).

6.1.2.2.6 Alternative 7I

Comparing Alt7I to the NAA illustrates changes that would be expected from a revised version of Alt7H, adding 40 mgd in water withdrawals from Lake Lanier to account for elimination of Glades Reservoir and using river withdrawals downstream of Buford Dam as revised per the Georgia 2015 request.

Median DO over the modeled period under Alt7I would be expected to have a negligible effect from the NAA for much of the Chattahoochee and Apalachicola rivers with the exception of Atlanta to West Point

Lake reach where median DO levels over the modeled period would be slightly adverse (Figure 6.1-102 and Figure 6.1-117).

Over the modeled period, the median DO level decreases by 0.3 mg/L in the reach from Atlanta to West Point Lake (Figure 6.1-117). The greatest change in this reach from the NAA would be expected in a representative dry weather year when the 5th percent occurrence and median DO levels could decrease by as much as 0.5 mg/L (Figure 6.1-120 and Figure 6.1-123). Those values would be expected to remain above the daily average water quality standard of 5 mg/L (Figure 6.1-105 and Figure 6.1-108). These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

Little change would be expected downstream of West Point Dam. Under Alt7I, the 95th percent occurrence of DO downstream of Lake George W. Andrews would decrease in a representative dry year from May through October by 0.2 mg/L (Figure 6.1-120), but that change would not be expected during April through October of a representative dry year (Figure 6.1-123). This change in the highest concentrations of DO could be beneficial to aquatic resources in the reach. Other changes from the NAA downstream of West Point Dam are consistent with alternatives that include the proposed updates to water management operations.

Negligible changes to DO would be expected from the low-oxygenated water in the tailrace of West Point Dam and Walter F. George Lock and Dam, particularly during the growing season (April–October) (Figure 6.1-123 and Figure 6.1-129).

These deltas include increased DO levels downstream of Walter F. George Lock and Dam in a representative normal weather year from May through October (Figure 6.1-126) and in the Apalchicola River from April through October of a representative normal year (Figure 6.1-129).

USACE would be expected to spill highly oxygenated surface water to improve DO in the tailrace of Walter F. George Lock and Dam. Because implementation of the current DO TMDL is based solely on USACE operations, states and federal agencies would be expected to work together to identify opportunities to improve water quality consistent with conditions identified in the TMDL (USEPA 2000b).

Negligible changes in DO would be expected below Walter F. George Lock and Dam into the Apalachicola River in a variety of conditions (Figure 6.1-117, Figure 6.1-123, Figure 6.1-125, and Figure 6.1-129).

6.1.2.2.7 Alternative 7J

Comparing Alt7J to the NAA illustrates changes in water management as well as reduced withdrawals and returns in Lake Lanier (consistent with relocation contracts) and increased withdrawals and returns downstream of Buford Dam (consistent with the Georgia 2015 water supply request). The differences from Alt7I illustrate the effects of water availability from Lake Lanier a result of limiting water supply to relocation contracts in Alt7J versus current conditions with the addition of 40 mgd in Alt7I.

Under Alt7J, median DO levels over the modeled period would be expected to have a negligible change from the NAA for much of the Chattahoochee and Apalachicola rivers with the exception of slight benefits to the conditions in Lake Lanier and slightly adverse effects to the median DO level in the Atlanta to West Point Lake reach (Figure 6.1-102 and Figure 6.1-117).

The slightly adverse effects in th ereach from Atlanta to West Point Lake would also be expected in median DO during the growing season (April – October) of a representative dry weather year (Figure 6.1-102 and Figure 6.1-117). These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

Negligible changes to DO would be expected from the low-oxygenated water in the tailrace of West Point Dam and Walter F. George Lock and Dam, particularly during the growing season (April–October) (Figure 6.1-123 and Figure 6.1-129).

Negligible changes in DO would be expected below Walter F. George Lock and Dam into the Apalachicola River in a variety of conditions (Figure 6.1-117, Figure 6.1-123, Figure 6.1-125, and Figure 6.1-129).

6.1.2.2.8 Alternative 7K (PAA)

Comparing the PAA to the NAA would be expected to identify the maximum environmental effects associated with implementing the full 2015 Georgia water supply request and including the proposed updates to water management operations.

Under the PAA, the median DO concentration over the modeled period would be expected to have a negligible change from the NAA for much of the Chattahoochee and Apalachicola rivers with the exception of conditions in Lake Lanier and slightly adverse effects in the reach from Atlanta to West Point Lake (Figure 6.1-103 and Figure 6.1-118).

Figure 6.1-103 presents the daily average median DO along with the daily average 5th and 95th percent occurrences over the modeled period. Figure 6.1-103, Figure 6.1-106, Figure 6.1-109, Figure 6.1-112, and Figure 6.1-115 illustrate that annual and seasonal conditions, as well as those in representative dry and normal years, would not be expected to violate state water quality standards with two exceptions: In cases in which dams release low-oxygenated waters (as defined in the 2000 EPA TMDL) in the tailrace of West Point Dam and the Walter F. George Lock and Dam, the DO level would be expected to be less than 4 mg/L in the lowest concentrations (5th percent occurrences). Implementation of the 2000 DO TMDL is based solely on USACE operations and coordination with states and federal agencies to identify opportunities to improve water quality consistent with conditions identified in the TMDL (USEPA 2000b). Those activities would be expected to continue under this alternative.

As previously stated, deltas from the NAA would be expected to decrease by between 0.1 mg/L and 0.5 mg/L in Lake Lanier and the reach from Atlanta to West Point Lake over the modeled period (Figure 6.1-118). Median DO in Lake Lanier is affected by the rate of wastewater returns; which is greater than other alternatives. Those changes from the NAA downstream of Buford Dam are consistent with Alt1L and, therefore, assumed to be the result of increased withdrawals and returns downstream of Buford Dam. Over the modeled period, little change in DO levels would be expected downstream of West Point Dam into the Apalachicola River.

In the period critical to aquatic resources in a representative dry weather year median (May–October), DO levels decrease downstream of Buford Dam but rebound at Norcross, Georgia (Figure 6.1-121). From Norcross, DO decreases by 0.5 mg/L from the NAA into West Point Lake. Downstream of West Point Dam to the Apalachicola River, DO deltas would be expected to have negligible fluctuations from the NAA. The highest DO concentrations (95th percent occurrences) would be expected to increase in West Point Lake while the lowest concentrations (5th percent occurrences) might decrease (Figure 6.1-121). These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

The fluctuations are more consistent with other alternatives with the proposed water control operations updates and would be expected as a result of changes in operations (see Figure 6.1-119, where Alt1L is plotted with Alt7A and Alt7B). Downstream of Walter F. George Lock and Dam, the lowest DO concentrations (5th percent occurrences) would be expected to decrease, and downstream of George W. Andrews Lock and Dam, the highest concentrations (95th percent occurrences) would be expected to decrease (Figure 6.1-121). Shifting the seasonal comparison to April–October for a representative dry weather year, the changes downstream of Buford Dam and George W. Andrews Lock and Dam are not illustrated (Figure 6.1-124).

Downstream of Buford Dam into West Point Lake, DO deltas from the NAA are less (plus or minus) in a representative normal weather year during the period critical to aquatic resources, May–October (Figure 6.1-127), than in a representative dry weather year (Figure 6.1-121). During those conditions, the lowest concentrations (5th percent occurrences) could increase between Buford Dam and Atlanta from the NAA (Figure 6.1-127). Median DO in a representative normal weather year also would be expected to increase at the tailrace of Walter F. George Lock and Dam as a result of the proposed water management operations. Seasonal conditions (May–October versus April–October) would be similar during this period with the exception of conditions in the Apalachicola River, where the highest DO concentrations (95th percent occurrences) would be expected to increase (Figure 6.1-130).

6.1.2.2.9 Alternative 7L

Comparing the Alt7L to the NAA illustrates differences in water management and water returns downstream of Buford Dam. Alt7L and the NAA include the same water withdrawals and returns in Lake Lanier and Alt7L and the PAA include the same downstream water withdrawals and returns downstream of Buford Dam. Alt7L includes a different water management operation at Buford Dam from the NAA and it includes less water returned into Lake Lanier than the PAA.

Under Alt7L, median DO over the modeled period would be expected to have a negligible change from the NAA for much of the Chattahoochee and Apalachicola rivers with the exception of the reach from Atlanta to West Point Lake, where the effect to median DO would be slightly adverse (Figure 6.1-103 and Figure 6.1-118).

The greatest changes in DO from the NAA would be expected seasonally in a representative dry weather year when the lowest DO levels (5th percent occurrences) would be expected to decrease by as much as 0.5 mg/L in the reach from Atlanta to West Point Lake (Figure 6.1-121 and Figure 6.1-124). Evaluating DO from April through October (Figure 6.1-124) versus May through October (Figure 6.1-121) yielded differences in the reach from Atlanta to West Point Lake and immediately downstream of Buford Dam, but decreased concentrations of nearly 1.0 mg/L in the 5th percent occurrences around Norcross, Georgia, are consistent between the two periods (Figure 6.1-121 and Figure 6.1-124). These changes in DO might require GAEPD to reevaluate Metro Atlanta wasteload allocations to maintain water quality standards using their site specific models.

Neglible changes to DO would be expected from the low-oxygenated water in the tailrace of West Point Dam, particularly during the growing season (April–October) (Figure 6.1-124 and Figure 6.1-130). In the growing season of a representative normal weather year median DO downstream of Walter F. George Lock and Dam would be expected to increase (Figure 6.1-130). Given that implementation of the current EPA finalized DO TMDL (2000) is based solely on USACE operations, states and federal agencies would be expected to work together to identify opportunities to improve water quality consistent with conditions identified in the TMDL (USEPA 2000b).

Negligible changes in DO would be expected downstream of West Point Lake Dam into the Apalachicola River in a variety of conditions (Figure 6.1-118, Figure 6.1-124, Figure 6.1-127, and Figure 6.1-130).

6.1.2.2.10 Alternative 7M

Negligible changes in median DO over the modeled period would be expected for much of the Chattahoochee and Apalachicola rivers under Alt1L with the exception of the reach from Atlanta to West Point Lake, where the effect to median DO would be slightly adverse (Figure 6.1-101 and Figure 6.1-116). DO changes in Alt7M compared with the NAA and other alternatives are similar to the effects described in Alt7L.

6.1.2.3 Phosphorus

Alabama, Florida, and Georgia have established criteria for reservoirs and lakes in the ACF Basin for total phosphorus (TP) loads (section 2.1.2.3). The nutrient criteria for TP in major headwaters contributing to the lakes in Georgia and Alabama are based on annual loads in pounds (lbs). As tabulated in Table 2.1-29 in section 2.1.2.3 per the water quality standards set by Alabama and Georgia, the TP annual loading for West Point Lake headwaters at the Chattahoochee River at U.S. Highway 27 should not exceed 1.4 million lbs, and the TP annual loading for Walter F. George Lake headwaters at Chattahoochee River at U.S. Highway 39 should not exceed 2 million lbs (Table 2.1-29). The calculated TP loads for the NAA and the remaining alternatives are presented in Table 6.1-19 and Table 6.1-20. The loads were calculated using the HEC-5Q model outputs of TP concentrations (mg/L) and modeled flows (cfs), and proper conversion factors were applied to derive annual loads in lbs.

Florida has establish nutrient criteria for freshwater streams and site-specific criteria for Apalachicola Bay. As per Florida's standards, the final numeric nutrient criteria for TP in Florida's Panhandle West region is 0.06 mg/L for freshwater streams and 0.01 mg/L for clear lakes with a range of 0.01–0.03 mg/L (Table 2.1-30). Site-specific criteria for Apalachicola Bay are defined by segment as annual geometric means presented in Table 2.1-29.

The major effect of phosphorus on water quality is its influence on the growth of chlorophyll *a;* higher levels of phosphorus can mean higher levels of chlorophyll *a* and nutrient growth leading to degraded water quality. According to GAEPD, however, there might be positive benefits to a reservoir fishery from increases in phosphorus and chlorophyll *a.* If not at critical levels, an increase in nutrient loading could lead to increased biomass and improved fishing at Lake Lanier, West Point Lake, and Walter F. George Lake. The potential effects of TP on aquatic resources is described in section 6.4.

In addition to comparing loadings to the lakes' standards, the median concentration over the modeled period for each alternative was compared to the NAA and the potential impacts were rated as follows:

- Negligible impact if the change in TP was < 0.01 mg/L
- A slightly adverse impact if TP increased by 0.01–0.02 mg/L
- An adverse impact if TP increased by more than 0.02 mg/L
- A substantial adverse impact if the change in TP contributes to a state water quality standard exceedance
- A slightly beneficial impact if TP decreased by 0.01–0.02 mg/L
- A beneficial impact if TP decreased by more than 0.02 mg/L
- A substantial beneficial impact if the change in TP avoided any state water quality standard exceedance

Table 6.1-19.
Total Phosphorus Loads at Headwaters of West Point Lake and Walter F. George Lake for 11-year Modeled Period (2001–2011) for NAA and Alt1L, Alt7A, Alt7B, and Alt7H

Year	Location	Annual Total Phosphorus Loads (lbs)				
		NAA	Alt1L	Alt7A	Alt7B	Alt7H
2001	West Point Lake headwaters	754,935	857,865	739,622	762,091	843,924
	Walter F. George Lake headwaters	1,422,036	1,528,407	1,409,084	1,430,254	1,526,650
2002	West Point Lake headwaters	697,443	793,727	713,777	724,033	826,407
	Walter F. George Lake headwaters	1,106,039	1,201,109	1,121,904	1,134,217	1,229,652
2003	West Point Lake headwaters	1,283,557	1,394,078	1,299,987	1,318,549	1,445,418[a]
	Walter F. George Lake headwaters	1,965,005	2,078,424[a]	1,978,243	1,996,715	2,135,048[a]
2004	West Point Lake headwaters	897,763	1,002,040	896,117	910,950	1,020,282
	Walter F. George Lake headwaters	1,465,636	1,576,899	1,464,188	1,477,248	1,597,801
2005	West Point Lake headwaters	1,129,805	1,233,648	1,131,608	1,144,253	1,265,768
	Walter F. George Lake headwaters	2,017,151[a]	2,134,067[a]	2,020,533[a]	2,030,050[a]	2,181,822[a]
2006	West Point Lake headwaters	720,284	821,300	709,809	709,873	824,021
	Walter F. George Lake headwaters	1,210,894	1,310,330	1,199,277	1,199,128	1,315,773
2007	West Point Lake headwaters	478,531	558,972	484,872	510,530	588,474
	Walter F. George Lake headwaters	931,830	1,010,267	945,732	971,780	1,049,054
2008	West Point Lake headwaters	452,391	536,624	438,358	436,302	539,860
	Walter F. George Lake headwaters	1,172,838	1,279,215	1,163,884	1,159,380	1,286,855
2009	West Point Lake headwaters	1,261,733	1,373,144	1,270,066	1,298,190	1,386,419
	Walter F. George Lake headwaters	2,413,272[a]	2,559,518[a]	2,422,951[a]	2,444,422[a]	2,605,069
2010	West Point Lake headwaters	858,573	952,663	852,809	863,644	964,649
	Walter F. George Lake headwaters	1,555,842	1,652,828	1,550,688	1,560,805	1,672,748
2011	West Point Lake headwaters	641,421	734,509	651,831	658,690	763,766
	Walter F. George Lake headwaters	1,059,169	1,149,649	1,072,163	1,078,794	1,180,736

Note:
[a.] An exceedance of the water quality standard.

Table 6.1-20.
Total Phosphorus Loads at Headwaters of West Point Lake and Walter F. George Lake for 11-year Modeled Period (2001–2011) for the NAA and Alt7I, Alt7J, PAA, Alt7L, and Alt7M

Year	Location	Annual Total Phosphorus Loads (lbs)					
		NAA	Alt7I	Alt7J	PAA	Alt7L	Alt7M
2001	West Point Lake headwaters	754,935	833,670	854,938	832,053	846,845	840,358
	Walter F. George Lake headwaters	1,422,036	1,510,320	1,528,072	1,509,983	1,518,674	1,513,536
2002	West Point Lake headwaters	697,443	809,311	827,720	810,360	814,154	816,284
	Walter F. George Lake headwaters	1,106,039	1,213,784	1,235,408	1,213,543	1,220,077	1,221,157
2003	West Point Lake headwaters	1,283,557	1,407,471[a]	1,432,474[a]	1,408,302[a]	1,407,989[a]	1,406,610[a]
	Walter F. George Lake headwaters	1,965,005	2,090,738[a]	2,113,682[a]	2,090,889[a]	2,090,356[a]	2,089,519[a]
2004	West Point Lake headwaters	897,763	999,825	1,015,234	1,000,136	1,000,017	1,001,514
	Walter F. George Lake headwaters	1,465,636	1,573,442	1,589,403	1,573,490	1,574,371	1,575,632
2005	West Point Lake headwaters	1,129,805	1,240,245	1,249,183	1,241,756	1,235,777	1,239,239
	Walter F. George Lake headwaters	2,017,151[a]	2,145,198[a]	2,146,112[a]	2,147,607[a]	2,137,384[a]	2,141,760[a]
2006	West Point Lake headwaters	720,284	804,098	809,432	805,049	809,963	804,647
	Walter F. George Lake headwaters	1,210,894	1,294,313	1,298,004	1,295,033	1,298,720	1,295,440
2007	West Point Lake headwaters	478,531	568,029	586,221	568,821	569,529	576,001
	Walter F. George Lake headwaters	931,830	1,027,016	1,046,486	1,027,777	1,029,163	1,036,317
2008	West Point Lake headwaters	452,391	526,650	523,354	527,146	523,946	525,476
	Walter F. George Lake headwaters	1,172,838	1,270,421	1,264,305	1,270,781	1,266,276	1,268,207
2009	West Point Lake headwaters	1,261,733	1,363,668	1,409,564[a]	1,361,653	1,371,241	1,366,451
	Walter F. George Lake headwaters	2,413,272[a]	2,561,962[a]	2,592,346[a]	2,561,774[a]	2,561,664[a]	2,560,941[a]
2010	West Point Lake headwaters	858,573	942,163	958,183	942,654	945,518	946,455
	Walter F. George Lake headwaters	1,555,842	1,643,313	1,657,101	1,644,284	1,646,254	1,647,525
2011	West Point Lake headwaters	641,421	743,791	750,093	744,398	739,334	743,488
	Walter F. George Lake headwaters	1,059,169	1,158,956	1,166,493	1,159,505	1,156,083	1,159,102

Note:
[a.] An exceedance of the water quality standard.

Table 6.1-21 shows the summary of effects of alternatives from the NAA based on the specified criteria. Any systemwide increase in TP in the Apalachichola and Chattahoochee rivers would be expected to require additional controls to point and nonpoint sources. Therefore, breakpoints in effects were defined using best professional judgement and an understanding that a 10–20-percent change in TP in the Chattahoochee River is a slight change but changes greater than 20 percent, or 0.02 mg/L, would be adverse. Substantial effects were dependent on water quality standards being met or violated in the NAA and the opposite occurring for an alternative (i.e., an alternative violating or meeting the standard), similar to other water quality parameters. Table 6.1-19 denotes several instances in which water quality standards for TP loads would be violated by the NAA and alternatives; since both are in violation, conditions would not be considered substantially adverse in those years. The results obtained in the alternatives are discussed in detail in the following sections. Each section discusses whether violations of standards would be attributed to water management activities (by comparing the NAA with Alt7A) or wastewater returns (by comparing Alt1L, Alt7B, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M). Any increase in the TP load from the water quality standards could be mitigated by the States' by decreaseing TP concentrations from point and nonpoint sources.

Table 6.1-21.
Summary of the Effects on Median Total Phosphorus of the Alternatives from the NAA during the Modeled Period (2001–2011)

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Buford Dam to Atlanta	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change
Atlanta to West Point Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse
West Point Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse
West Point Dam to Walter F. George Lake	Baseline	Substant-ially adverse	Negligible/ No change	Negligible/ No change	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse
Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Negligible/No change if the change in TP was < 0.01 mg/L.

Slightly adverse—Slightly adverse if TP increased by 0.01–0.02 mg/L.

Substantially adverse—Substantial adverse impact if the change in TP contributes to a state water quality standard exceedance.

Various regulatory agencies have authority over water quality in the ACF Basin. USACE has the authority to manage water quality conditions associated with reservoir operations. State agencies have regulatory authority to establish water quality standards and to issue NPDES permits to facilities for point source discharges. The EPA has regulatory authority to review water quality standards and to issue NPDES permits to facilities for point source discharges. For planning purposes and to consider the cumulative effects of USACE operations on resources in the basin, a system of models was developed to compare various operational changes and water supply options with the NAA. USACE does not have the regulatory authority to establish water quality standards or manage NPDES permittees and, therefore, only used the HEC-5Q model to evaluate the changes between NAA and the other alternatives. If necessary, the states and EPA should use their site-specific three-dimensional models to confirm whether any changes are needed to either the water quality standards or NPDES dischargers' permits.

Substantially adverse—Substantially adverse if the change in TP contributes to a state water quality standard exceedance.Longitudinal profiles were used as an initial indication of changes that would be expected between the NAA and the other alternatives. Figure 6.1-131 through Figure 6.1-142 illustrate the response of TP to changes between the NAA and the alternatives for the period of 2001–2011. Figure 6.1-143 through Figure 6.1-148 illustrate the response of TP to changes from the NAA under each of the alternatives. The figures and discussion in the following sections focus on annual modeled output since the effects of various alternatives are generally related to violations of water quality standards based on annual loadings.

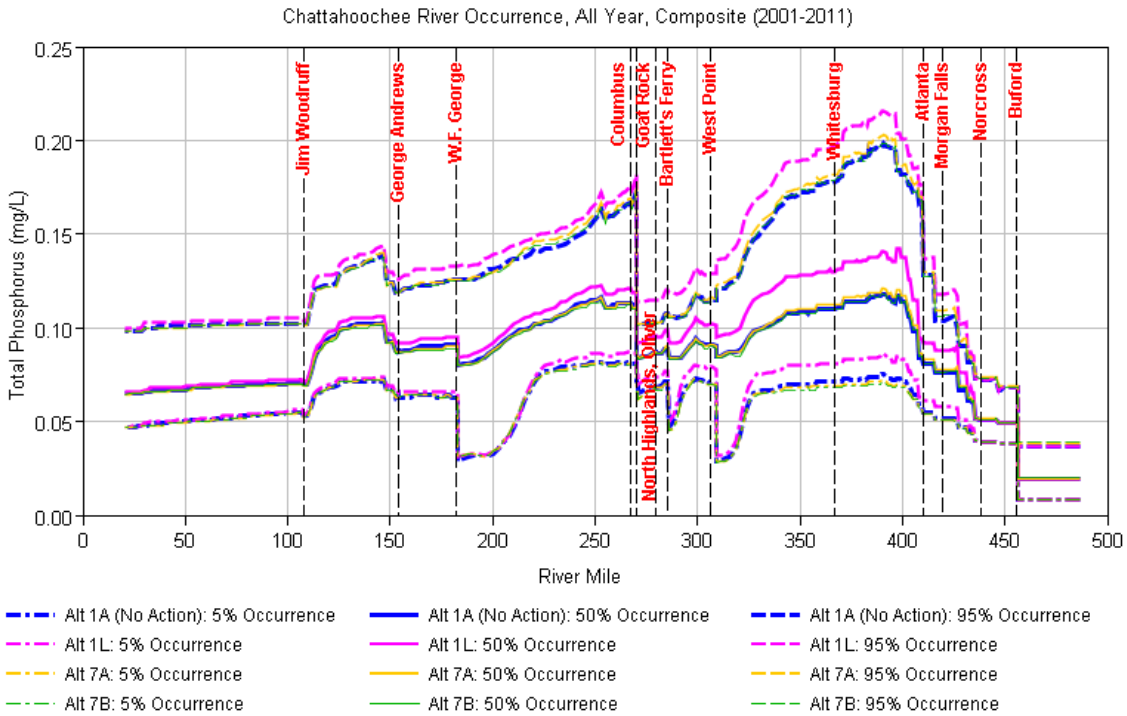


Figure 6.1-131. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

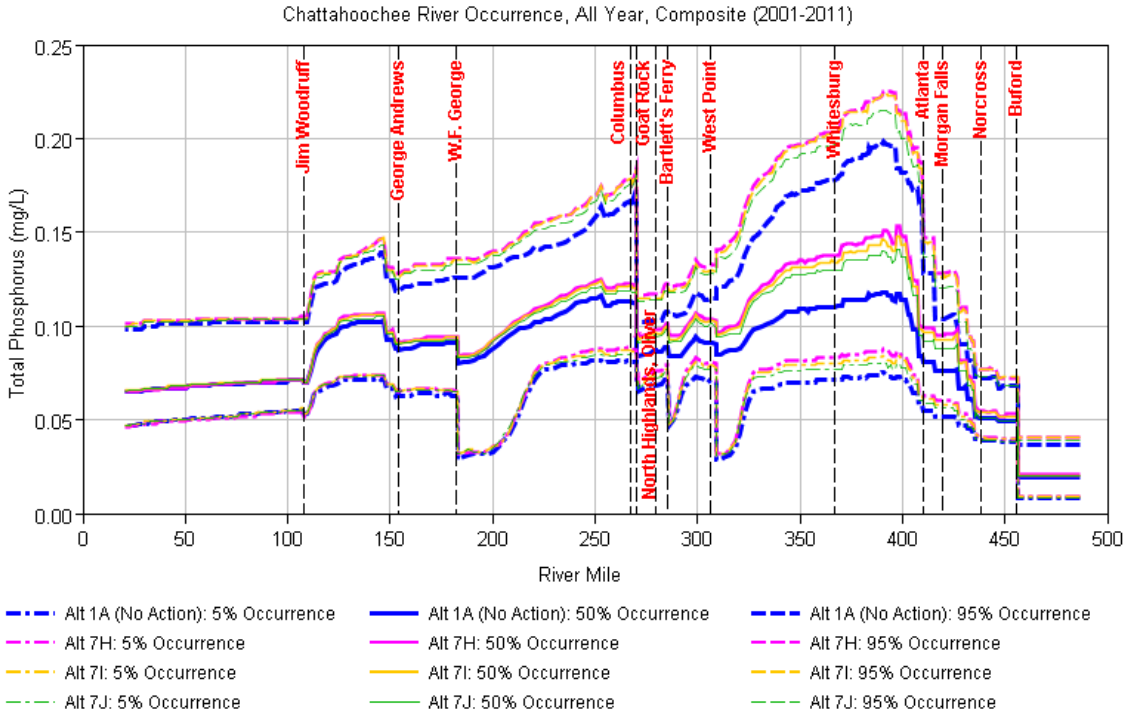


Figure 6.1-132. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

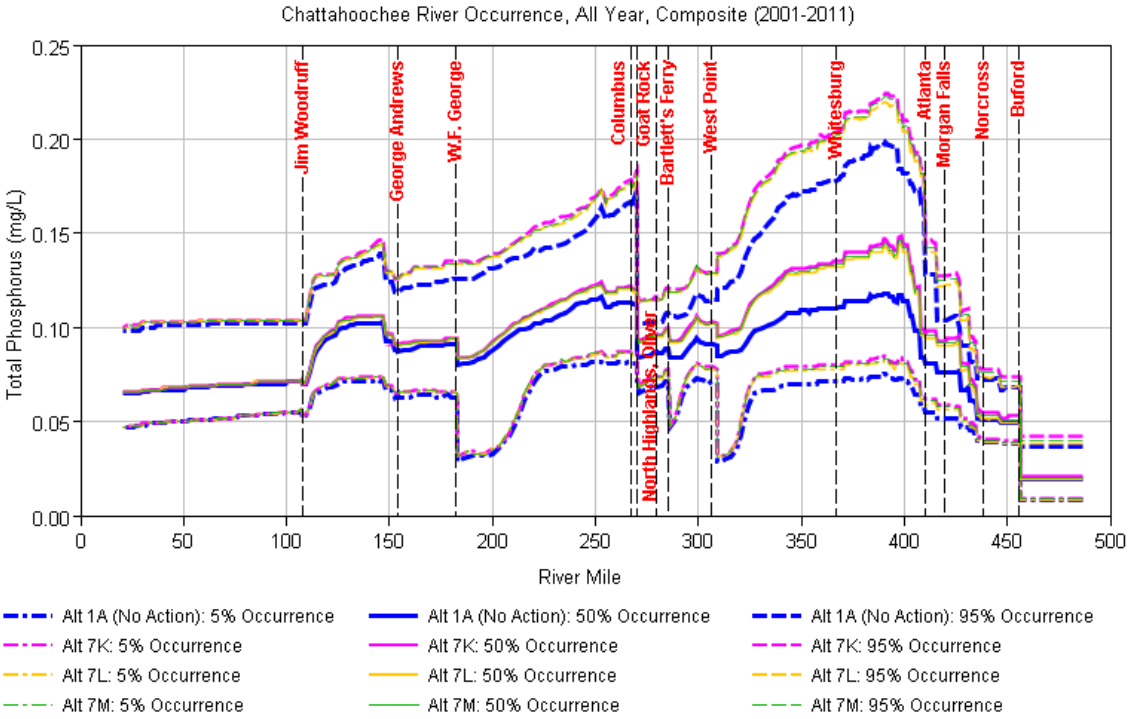


Figure 6.1-133. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

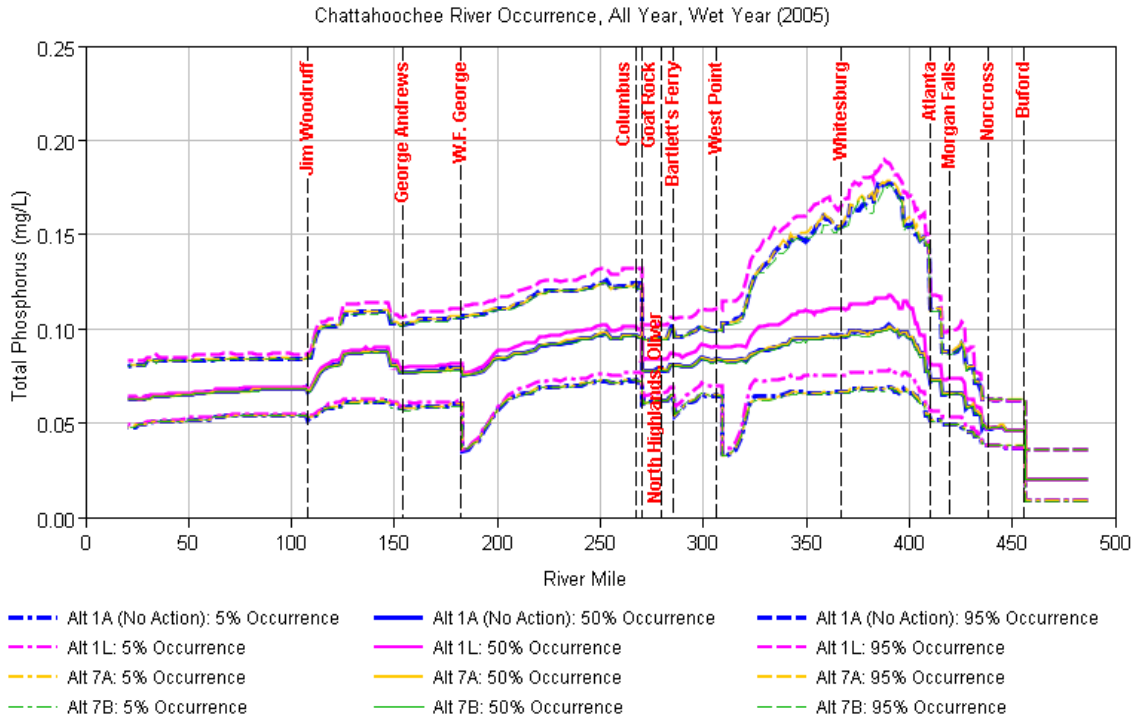


Figure 6.1-134. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for a Wet Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

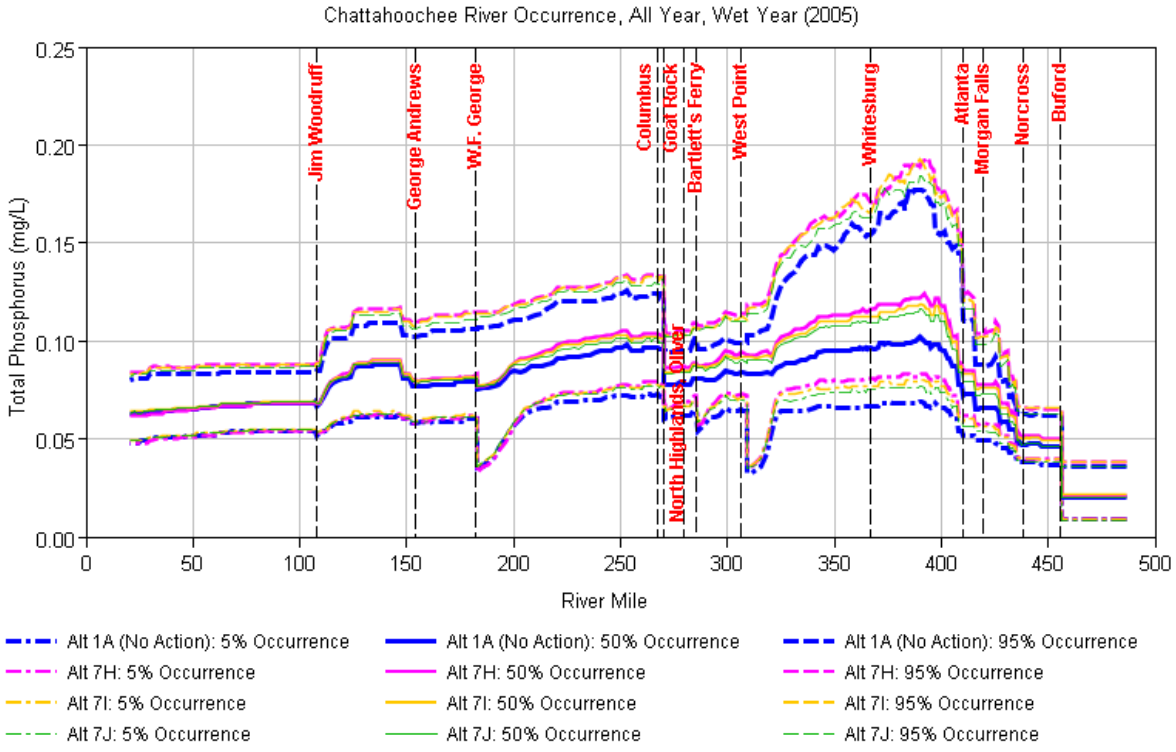


Figure 6.1-135. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for a Wet Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

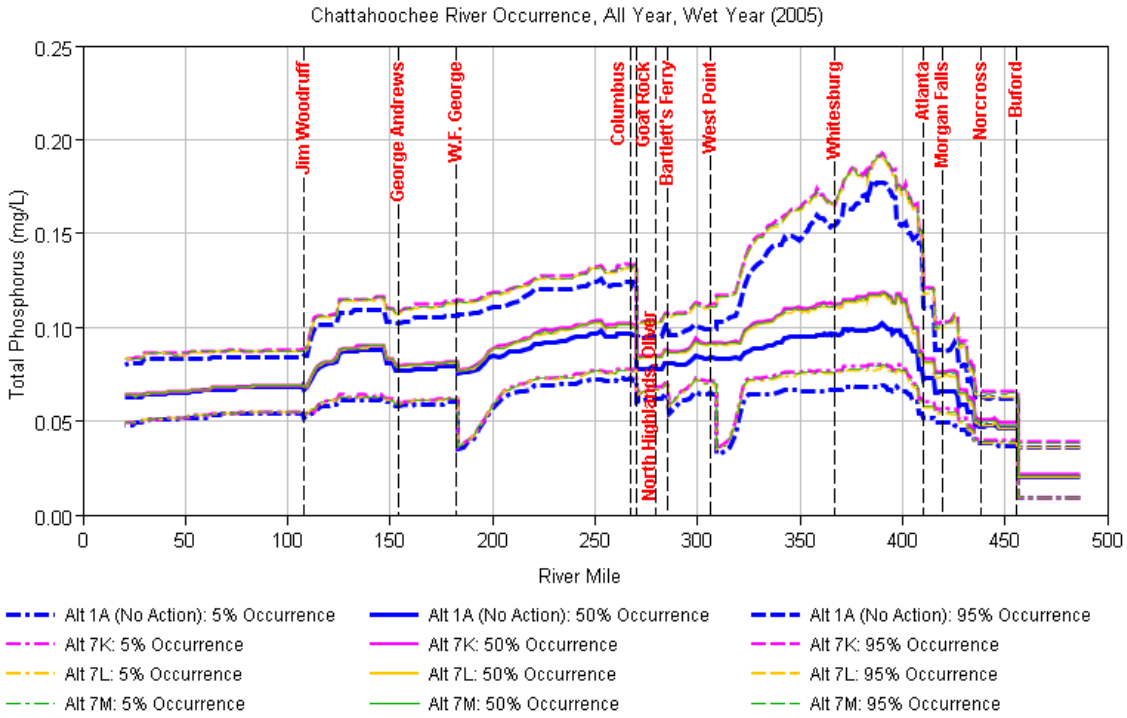


Figure 6.1-136. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for a Wet Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

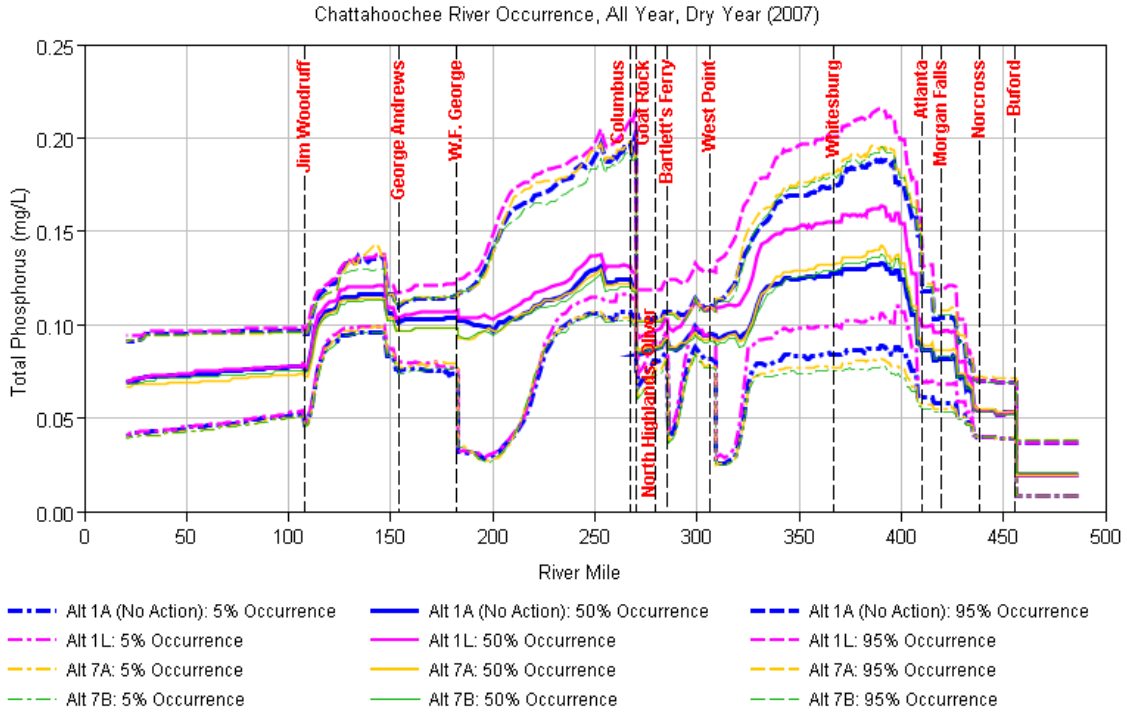


Figure 6.1-137. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

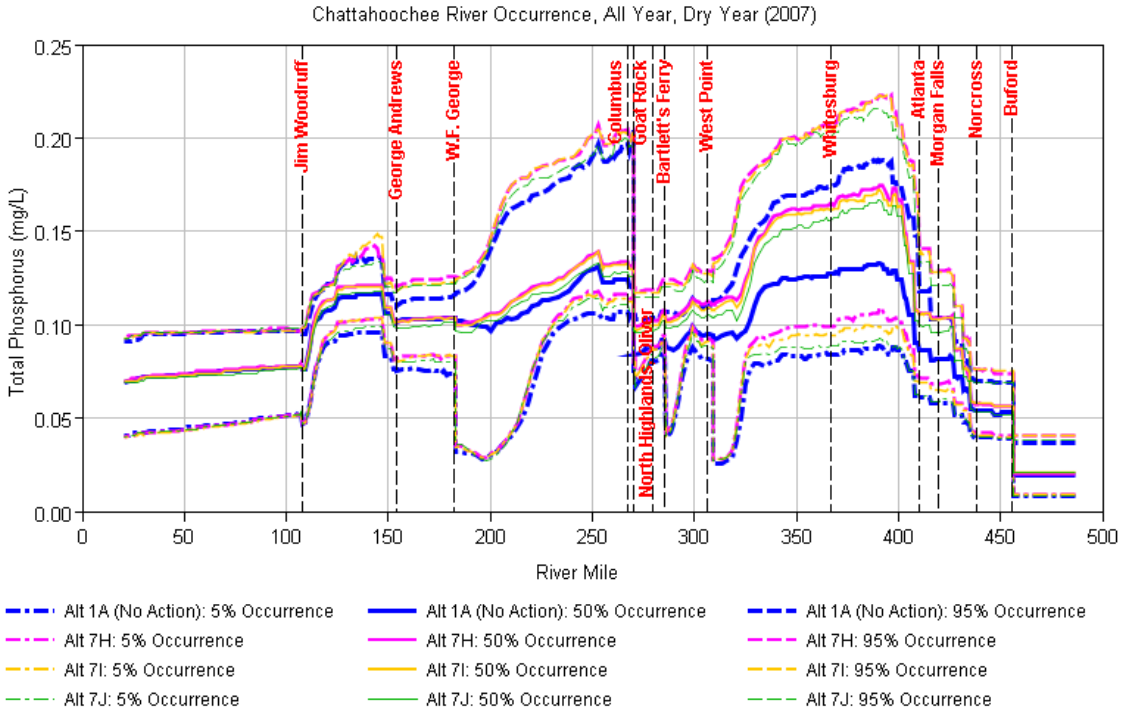


Figure 6.1-138. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

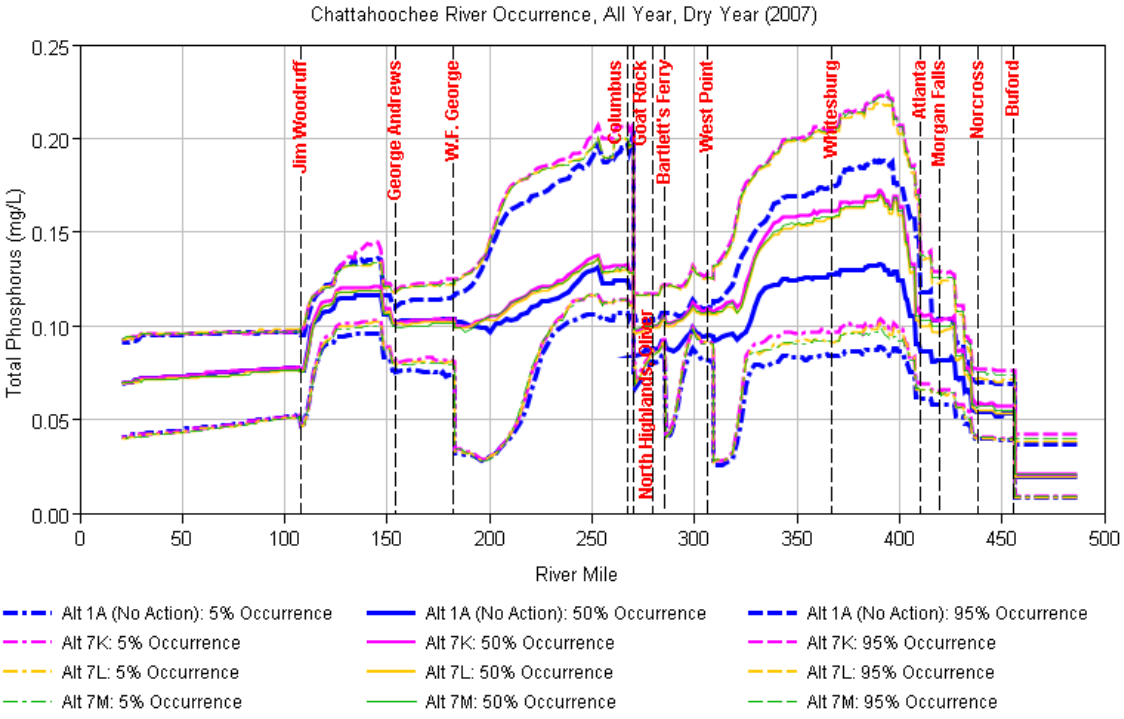


Figure 6.1-139. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

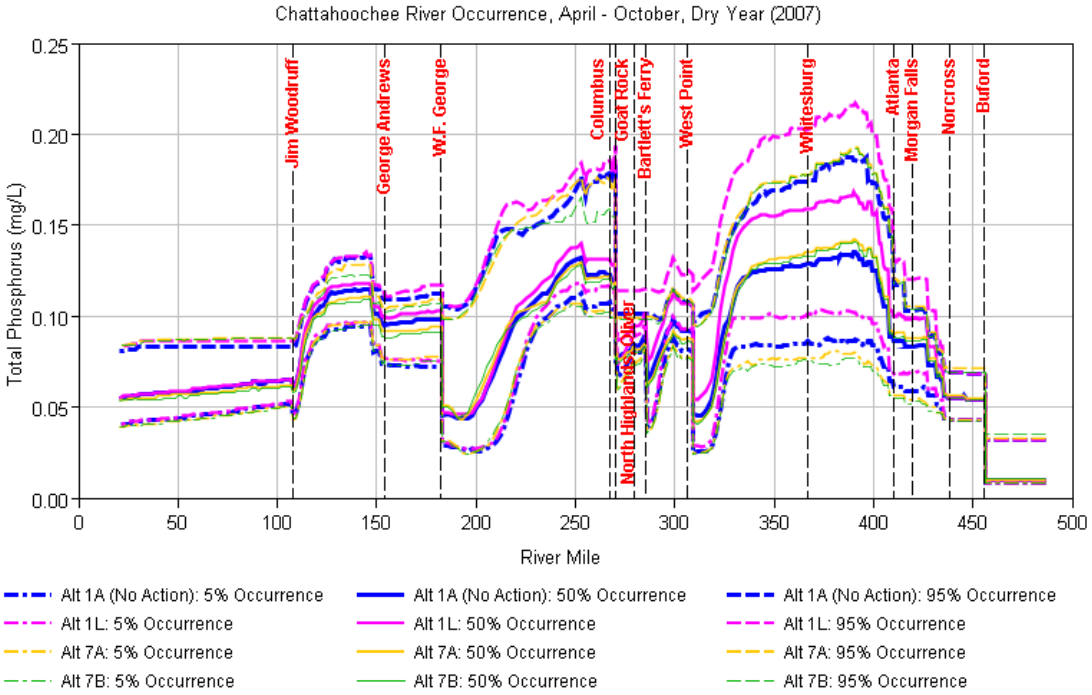


Figure 6.1-140. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

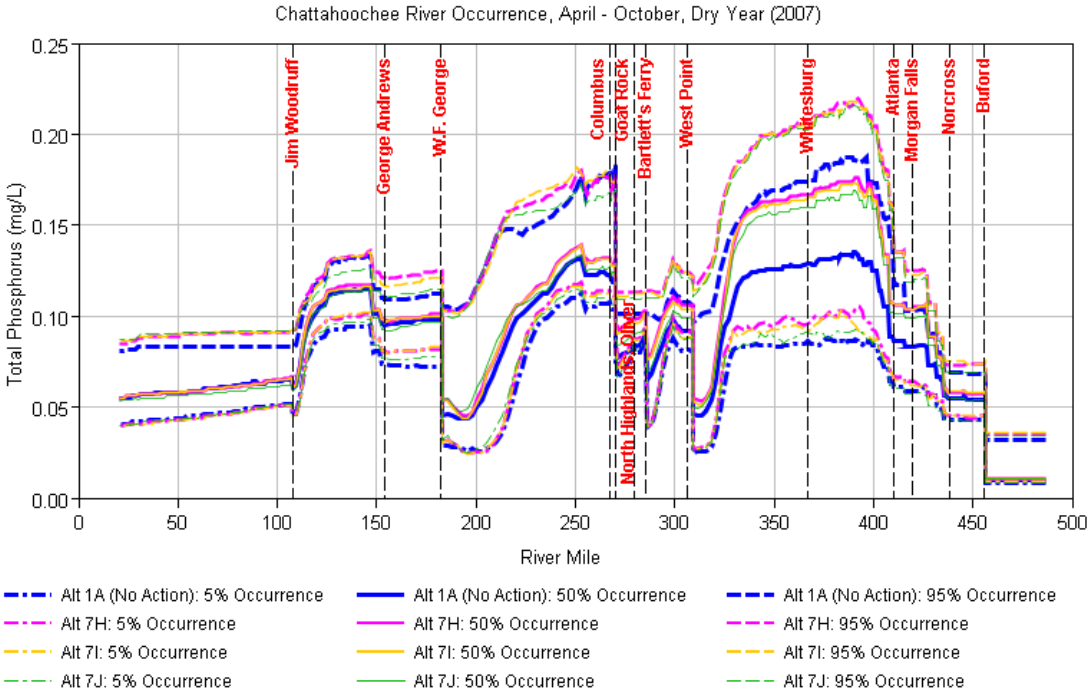


Figure 6.1-141. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

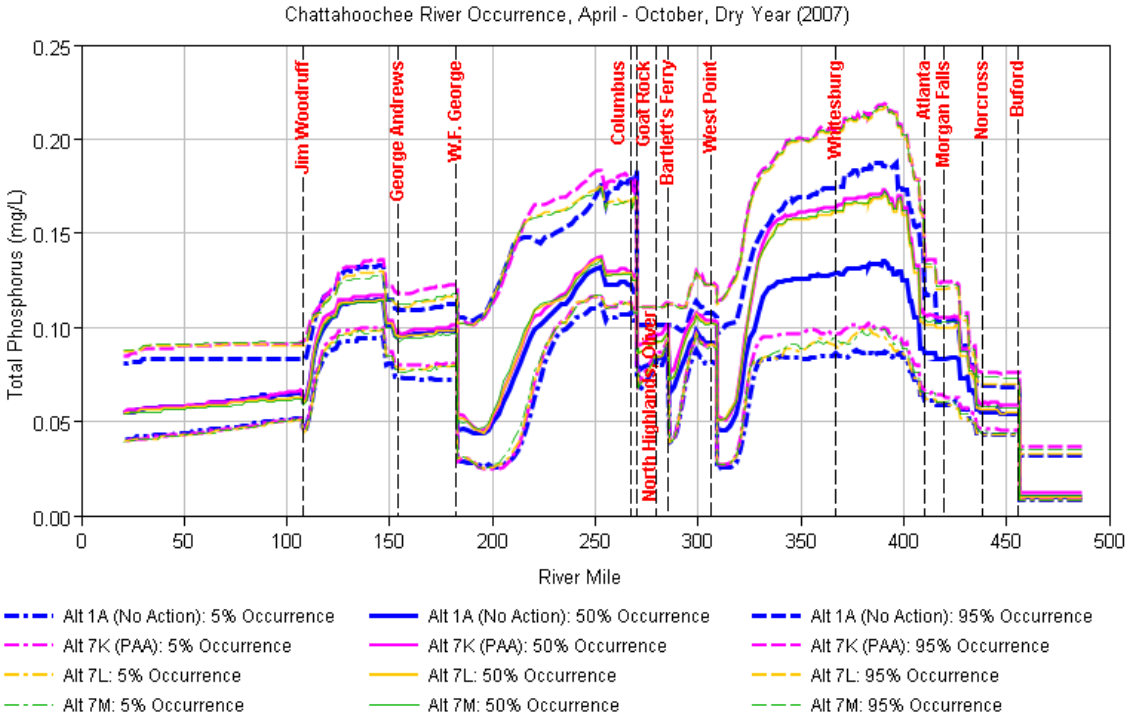


Figure 6.1-142. Longitudinal Profile Occurrence of Modeled Total Phosphorus in the ACF Basin for the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

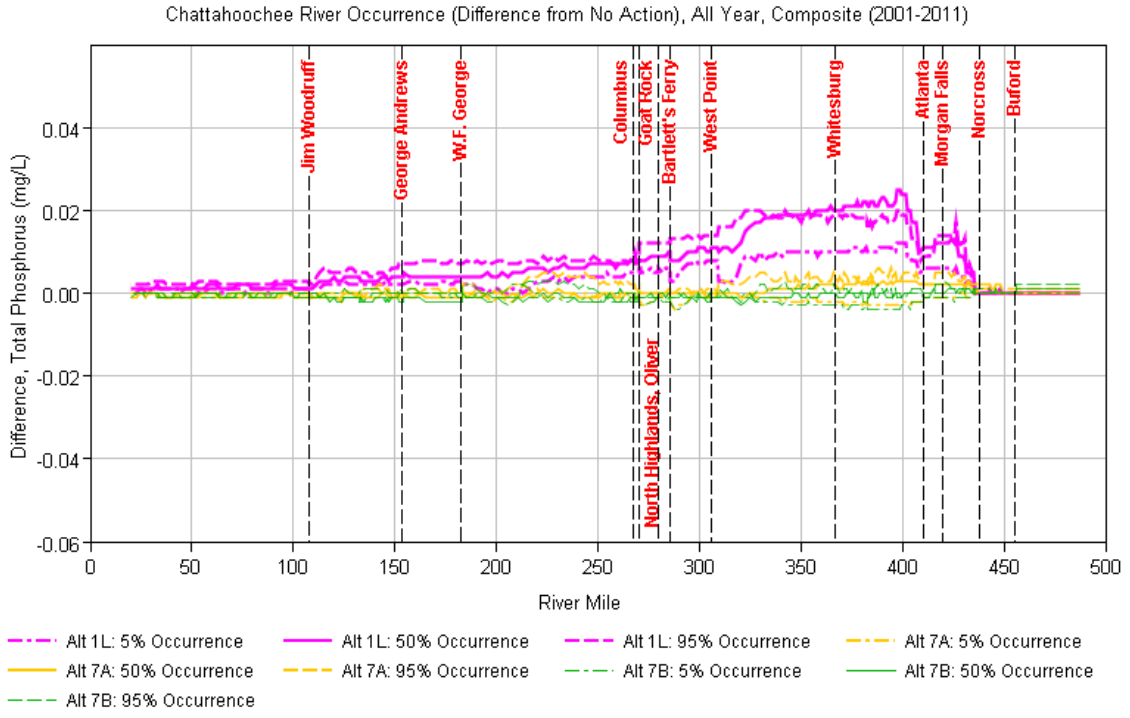


Figure 6.1-143. Longitudinal Profile of Difference in Modeled Total Phosphorus for the Period 2001-2011 from the NAA in the ACF Basin for Alt1L, Alt7A, and Alt7B.

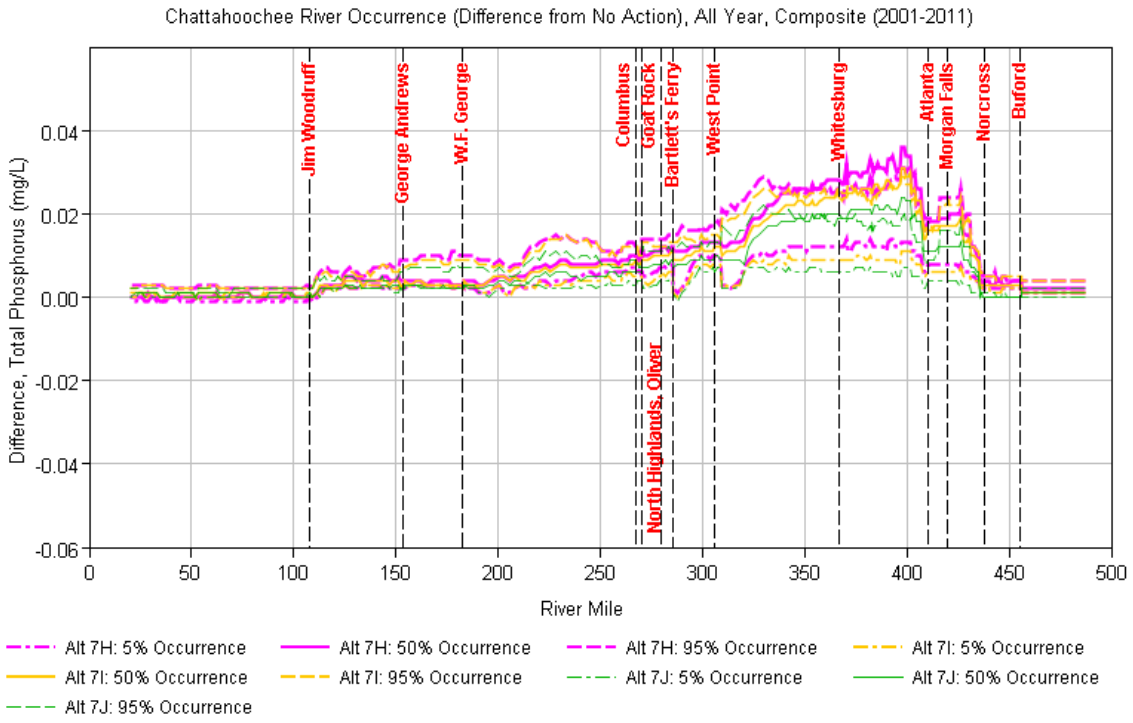


Figure 6.1-144. Longitudinal Profile of Difference in Modeled Total Phosphorus for the Period 2001-2011 from the NAA in the ACF Basin for Alt7H, Alt7I, and Alt7J.

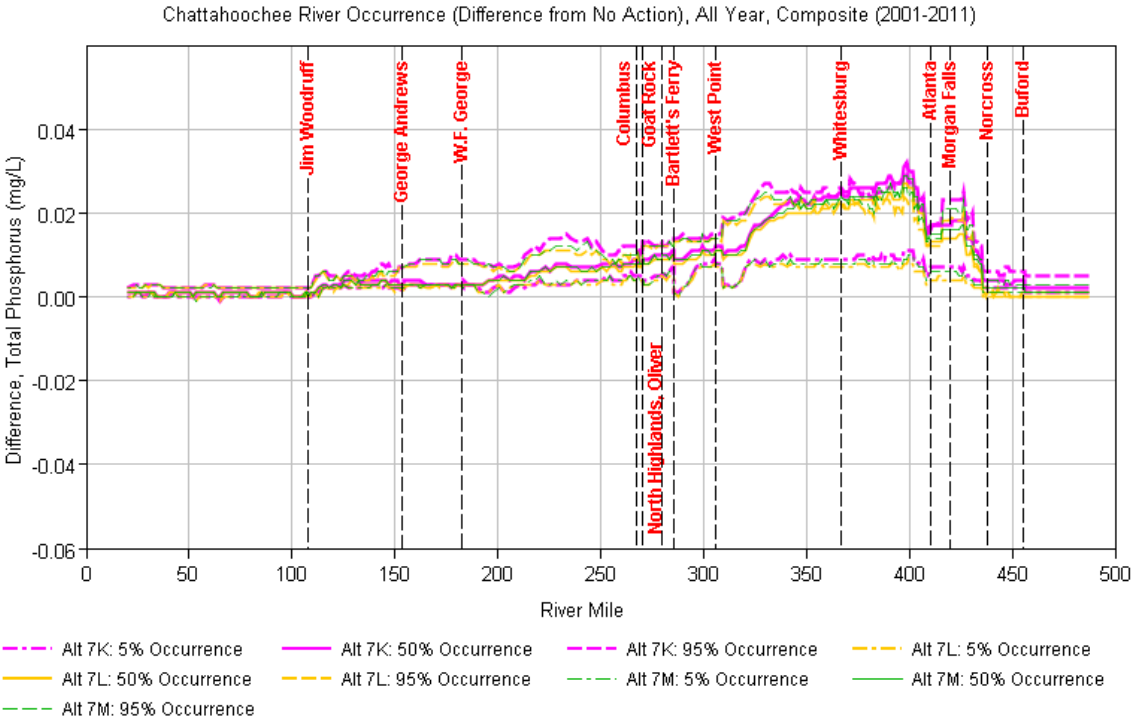


Figure 6.1-145. Longitudinal Profile of Difference in Modeled Total Phosphorus for the Period 2001-2011 from the NAA in the ACF Basin for Alt7K (the PAA), Alt7L, and Alt7M.

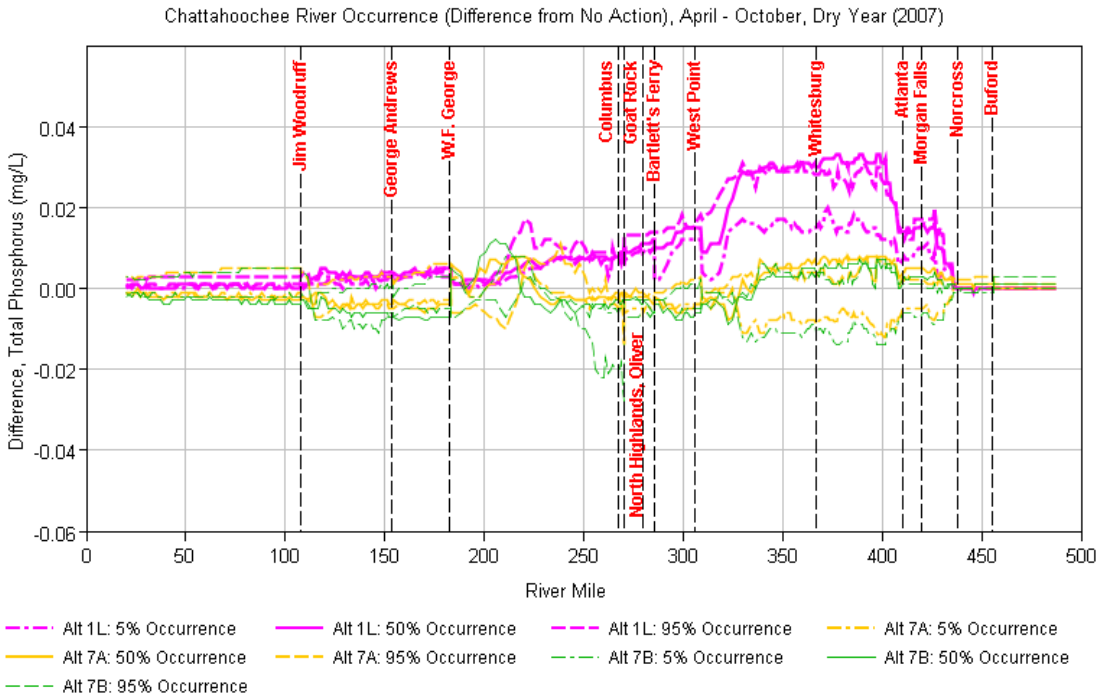


Figure 6.1-146. Longitudinal Profile of Difference in Modeled Total Phosphorus from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

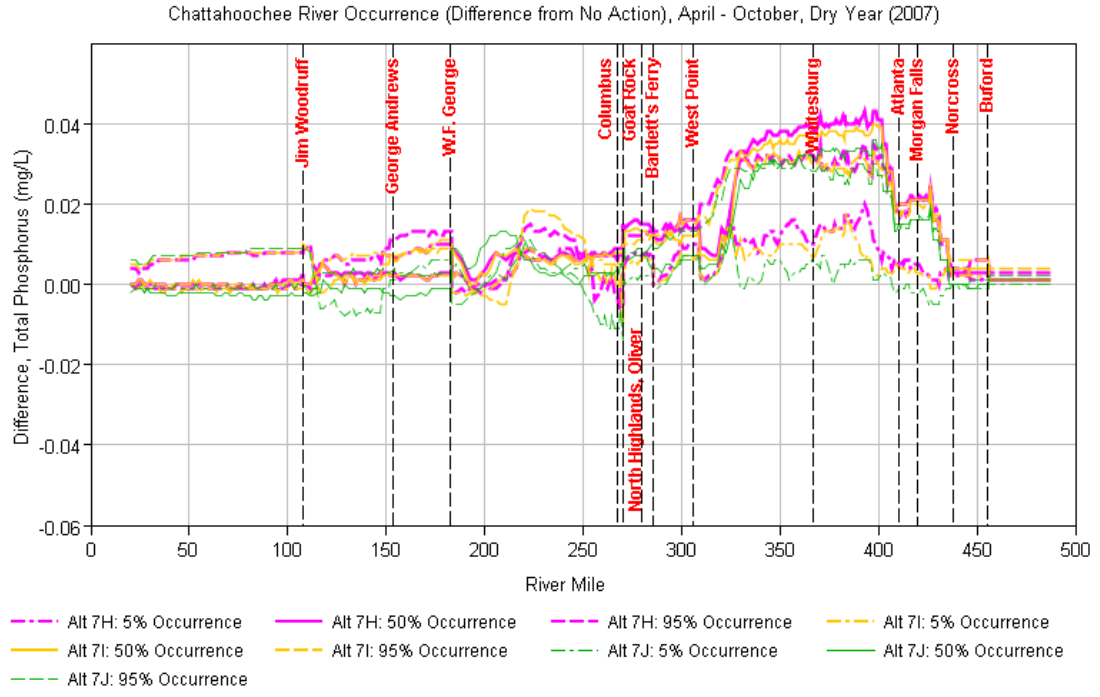


Figure 6.1-147. Longitudinal Profile of Difference in Modeled Total Phosphorus from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

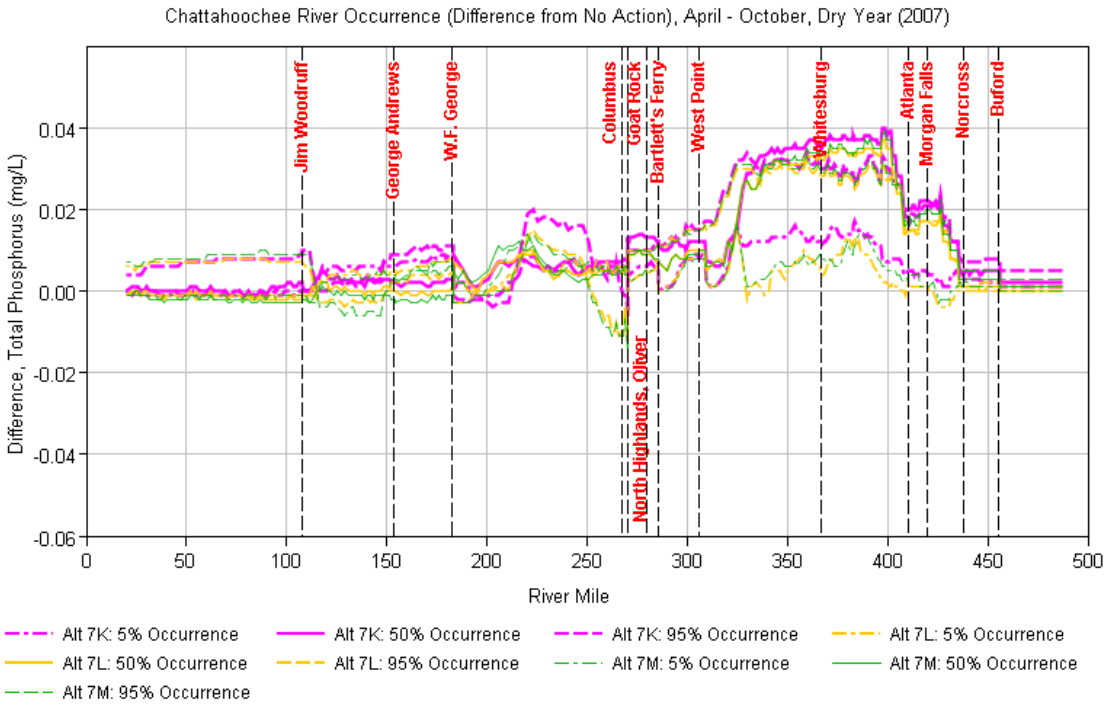


Figure 6.1-148. Longitudinal Profile of Difference in Modeled Total Phosphorus from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

6.1.2.3.1 No Action Alternative

Lake Lanier's modeled results indicate that over the modeled period, the median TP concentrations and the 5th and 95th percent occurrences would be expected to be at 0.019 mg/L, 0.008 mg/L, and 0.037 mg/L, respectively (Figure 6.1-131).

From the tailrace of Buford Dam to Atlanta, the daily median TP concentration increases from 0.05 mg/L to 0.08 mg/L. The rare event of a 95th percent occurrence of TP concentrations would be in the range of 0.068–0.128 mg/L (Figure 6.1-131). A similar trend and magnitudes can be expected for median TP levels for representative dry and wet weather years (Figure 6.1-134 and Figure 6.1-137).

As presented in Figure 6.1-131, the increase in median TP from 0.08 mg/L to 0.12 mg/L from Atlanta to West Point Lake could be attributed to the wastewater treatment dischargers, with the 95th percent occurrence ranging from 0.128 to 0.20 mg/L. Similar trends and ranges of TP were modeled in respresentative wet and dry weather years (Figure 6.1-134 and Figure 6.1-137). As tabulated in Table 6.1-19 from modeled results, the TP loads in several years are close to the water quality standard of 1.4 million lbs into West Point Lake but an exceedance would not be expected.

The range of modeled results for median TP in the reach from West Point Dam to Walter F. George Lake is 0.08–0.12 mg/L (Figure 6.1-131). According to Table 6.1-19, at Walter F. George Lake at Chattahoochee River and U.S. Highway 39, the TP loads are expected to exceed the 2 million lbs state standard in the years 2005 and 2009, but are representative of wet weather conditions in the basin.

For comparison purposes, the HEC-5Q NAA model TP concentration and loadings results can be considered to represent meeting the TP water quality standards for both West Point and Walter F. George lakes. Any increase in the TP loads will be considered an adverse impact; any decrease in the TP loads

will be considered a benefit. Also, if an alternative increases the TP load to West Point Lake or Walter F. George Lake, then reductions in point and/or nonpoint source TP will be required to meet the TP water quality standard.

The median TP concentrations at the Walter F. George Lock and Dam would be expected at 0.08 mg/L. The TP at the 95th percent occurrence level would be 0.13 mg/L (Figure 6.1-131). The highest concentrations of TP (95th percent occurrences) would increase downstream of George W. Andrews Lock and Dam to 0.14 mg/L (Figure 6.1-131).

Changes in median TP concentrations along the Chattahoochee River for the reach downstream of Walter F. George Lock and Dam to Lake Seminole for the entire modeled period would be expected to range from 0.10 mg/L to 0.07 mg/L (Figure 6.1-131).

The modeled median TP concentration in the Apalachicola River would be expected to be 0.07 mg/L, similar to concentrations discharged from Jim Woodruff Lock and Dam.

6.1.2.3.2 Alternative 1L

Comparing Alt1L with the NAA isolates the incremental effects of future increased river withdrawals downstream of Buford Dam, assuming current water management practices and current withdrawals from Lake Lanier. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reach from West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when the NAA meets water quality standards (Table 6.1-19). As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP loads in the river, which under limited circumstances could result in substantial adverse changes to water quality. Slightly adverse conditions would be expected from Atlanta into West Point Lake because median TP concentrations over the modeled period would be expected to increase by 0.02 mg/L. Negligible changes would be expected upstream of Atlanta or downstream of Walter F. George Lake, although differences in TP concentrations from the NAA over the modeled period would be expected throughout the system (Figure 6.1-143). In the Apalachicola River, the median TP level over the modeled period would be expected to increase by 0.001 mg/L from the NAA.

The concentrations of TP would be expected to be higher in the growing season of a representative dry weather year (Figure 6.1-140). Median TP in the growing season of a representative dry weather year might be expected to increase to 0.17 mg/L between Atlanta and Whitesburg and to decrease to median concentrations near the NAA's 95th percent occurrence at West Point Dam of 0.11 mg/L (Figure 6.1-140). The growing season of a dry weather year would be expected to have the greatest increase in TP concentrations (Figure 6.1-146). The delta of median concentrations would be greatest between Atlanta into West Point Lake—a 0.03 mg/L change from the NAA—and would be expected to decrease to levels never the NAA in the Apalachicola River (Figure 6.1-143).

6.1.2.3.3 Alternative 7A

Comparing Alt7A with the NAA illustrates that negligible effects would be expected from proposed water management operations (Figure 6.1-131, Figure 6.1-134, Figure 6.1-137, and Figure 6.1-140).

The change from the NAA shown in Table 6.1-19 quantifies the change in load that would be expected from proposed changes in water management operations. The differences between Alt7A and Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M in Table 6.1-19 represent the changes in water quality that would be expected from changes to return flows from various water supply options.

The greatest changes from the NAA would be expected in the growing season of a representative dry weather year (Figure 6.1-146). Median TP concentrations would be expected to increase between Atlanta and Whitesburg by 0.007 mg/L from the NAA. During the same period, the lower concentrations of TP (5th percent occurrence) would be expected to decrease by more than 0.01 mg/L.

The changes in TP concentrations are within ranges defined previously for negligible change, and the TP loadings are similar to those for the NAA. Therefore, negligible change from the NAA would be assumed in these reaches.

6.1.2.3.4 Alternative 7B

Negligible change in TP would be expected from Alt7B. This alternative would maintain water withdrawals and returns downstream of Buford Dam consistent with the NAA; therefore, little change from the NAA would be expected over the modeled period and in a representative wet weather year (Figure 6.1-131 and Figure 6.1-134).

Changes from the NAA would be expected during a dry weather year similar to the changes seen under Alt7A that result in updates to the proposed water management operations (Figure 6.1-137 and Figure 6.1-140). Differences between Alt7A and Alt7B illustrate the effects of changes in water withdrawals and returns in Lake Lanier (Figure 6.1-140).

6.1.2.3.5 Alternative 7H

Comparing Alt7H with the NAA illustrates the effects of Georgia's 2013 water supply request as presented in the draft EIS. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reaches from Atlanta to West Point Lake and from West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when compared to the NAA TP loads (Table 6.1-19). As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP loads in the river, which under limited circumstances could result in substantial adverse changes to water quality. Slightly adverse conditions would be expected from Buford Dam to Atlanta and in West Point Lake because median TP concentrations over the modeled period would be expected to increase by 0.01 mg/L (Figure 6.1-132). Negligible changes would be expected in Lake Lanier and downstream of Walter F. George Lake, although differences in TP concentrations from the NAA over the modeled period would be expected throughout the system (Figure 6.1-144). In the Apalachicola River, the median TP over the modeled period would be expected to be the same as for the NAA.

Alt7H was the PAA in the draft EIS, but is no longer a viable alternative. The HEC-5Q model was updated following comments received on the draft EIS, and Alt7H has been retained in this final EIS only to enable comparison of its results with the NAA as well as with Alt7M to illustrate differences in withdrawals and returns downstream of Buford Dam between Georgia's 2013 and 2015 water supply requests.

6.1.2.3.6 Alternative 7I

Comparing Alt7I with the NAA illustrates the effects of Georgia's 2013 water supply request with the addition of 40 mgd requested from Glades Reservoir and Georgia's 2015 water supply request downstream of Buford Dam. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reaches from Atlanta to West Point Lake and from West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when compared to the NAA TP loads (Table 6.1-20). Slightly adverse conditions would be expected from Buford Dam to Atlanta and in West Point Lake because median TP concentrations over the modeled

period would be expected to increase by 0.01 mg/L (Figure 6.1-132). Negligible changes would be expected in Lake Lanier and downstream of Walter F. George Lake, although differences in TP concentrations from the NAA over the modeled period would be expected throughout the system (Figure 6.1-144). In the Apalachicola River, the median TP over the modeled period would be expected to increase by 0.001 mg/L from the NAA.

6.1.2.3.7 Alternative 7J

Alt7J would generally be expected to have negligible effects when compared with the NAA except in two reaches—Atlanta to West Point Lake and West Point Dam to Walter F. George Lake—where TP loads would be expected to be exceeded when compared to the NAA TP loads (Table 6.1-20). The differences between Atl7J and the NAA are the result of changes in water management as well as reduced withdrawals and returns in Lake Lanier (consistent with relocation contracts) and increased withdrawals and returns downstream of Buford Dam (consistent with the Georgia 2015 water supply request). The changes in TP concentrations from the NAA are generally less in Alt7J than in Alt7I, illustrating the effects of comparing current relocation contracts in Lake Lanier with Georgia's 2013 water supply request plus Glades Reservoir (Figure 6.1-144); Alt7J and Alt7I include the same water withdrawals and returns downstream of Buford Dam.

6.1.2.3.8 Alternative 7K (PAA)

The PAA illustrates the effects of implementing Georgia's 2015 water supply request and proposed updates to water management operations when compared with the NAA. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reaches from Atlanta to West Point Lake and from West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when compared to the NAA TP loads (Table 6.1-20). As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP loads in the river, which under limited circumstances could result in substantial adverse changes to water quality. Slightly adverse conditions would be expected from Buford Dam to Atlanta and in West Point Lake because median TP concentrations over the modeled period would be expected to increase by 0.01 mg/L (Figure 6.1-133). Negligible changes would be expected in Lake Lanier and downstream of Walter F. George Lake, although differences in TP concentrations from the NAA over the modeled period would be expected throughout the system (Figure 6.1-145). In the Apalachicola River, the median TP over the modeled period would be expected to increase by 0.001 mg/L from the NAA.

The TP change from the NAA would be expected to be greatest in the growing seaon of a representative dry weather year. TP concentrations at Buford Dam would be expected to be similar to those for the NAA and increase as wastewater is returned into the Chattahoochee River. TP changes at Morgan Falls Dam would be expected to increase to a 0.02 mg/L delta and peak downstream of Atlanta at a 0.038 mg/L change from the NAA (Figure 6.1-148). In West Point Lake, changes in median TP concentrations from the NAA would be expected to decrease to less than 0.02 mg/L at the dam and continue to decrease downstream into Apalachicola River, where median TP concentrations would be similar to those for the NAA (Figure 6.1-148).

6.1.2.3.9 Alternative 7L

Comparing Alt7L with the NAA illustrates the effects of proposed increased river withdrawals downstream of Buford Dam and updated water management operations. Alt7L includes the same water withdrawals and returns from Lake Lanier as the NAA. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reaches from Atlanta to West Point Lake and

West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when compared to the NAA TP loads (Table 6.1-20). Slightly adverse conditions would be expected in West Point Lake because median TP concentrations over the modeled period would be expected to increase by 0.01 mg/L (Figure 6.1-133). Negligible changes would be expected upstream of Atlanta or downstream of Walter F. George Lake, although differences in TP concentrations from the NAA over the modeled period would be expected throughout the system (Figure 6.1-145). In the Apalachicola River, the median TP over the modeled period would be expected to increase by 0.001 mg/L from the NAA. These changes from the NAA would be expected to be similar to those under the PAA, with the greatest differences in the growing season of a representative dry weather year (Figure 6.1-148).

6.1.2.3.10 Alternative 7M

As with Alt7L, comparing Alt7M with the NAA illustrates the effects of proposed increased river withdrawals downstream of Buford Dam, updated water management operations, and water withdrawals and returns from Lake Lanier proposed in Alt7H. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reaches from Atlanta to West Point Lake and West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when compared to the NAA TP loads (Table 6.1-20). Slightly adverse conditions would be expected in West Point Lake because median TP concentrations over the modeled period would be expected to increase by 0.01 mg/L (Figure 6.1-133). Negligible changes would be expected upstream of Atlanta or downstream of Walter F. George Lake, although differences in TP concentrations from the NAA over the modeled period would be expected throughout the system (Figure 6.1-145). In the Apalachicola River, the median TP over the modeled period would be expected to increase by 0.001 mg/L from the NAA. These changes from the NAA would be expected to be similar to those under the PAA, with the greatest differences in the growing season of a representative dry weather year (Figure 6.1-148). During the growing season of a representative dry weather year, the availability of water from Lake Lanier is illustrated by differences between Alt7I, the PAA, and Alt7L.

6.1.2.4 Nitrogen

Total nitrogen (TN) is an important parameter to look at because it affects the growth of chlorophyll *a;* the effects of chlorophyll *a* are discussed in section 6.1.2.5. Longitudinal profiles were used as an initial indication of changes that would be expected between the NAA and the other alternatives. Figure 6.1-149 through Figure 6.1-172 illustrate the response of TN to changes between the NAA and the alternatives in ways similar to other parameters. Also included for informational purposes are the figures comparing ammonia concentrations and nitrate concentrations for the NAA to the other alternatives.

The median TN over the modeled period for each alternative was compared to the NAA and the potential impacts were rated as follows:

- Negligible impact if the change in TN was < 0.1 mg/L
- A slightly adverse impact if TN increased by 0.1–0.5 mg/L
- An adverse impact if TN increased by more than 0.5 mg/L
- A substantial adverse impact if the change in TN contributes to a state water quality standard exceedance
- A slightly beneficial impact if TN decreased by 0.1–0.5 mg/L
- A beneficial impact if TN decreased by more than 0.5 mg/L
- A substantial beneficial impact if the change in TN avoided any state water quality standard exceedance

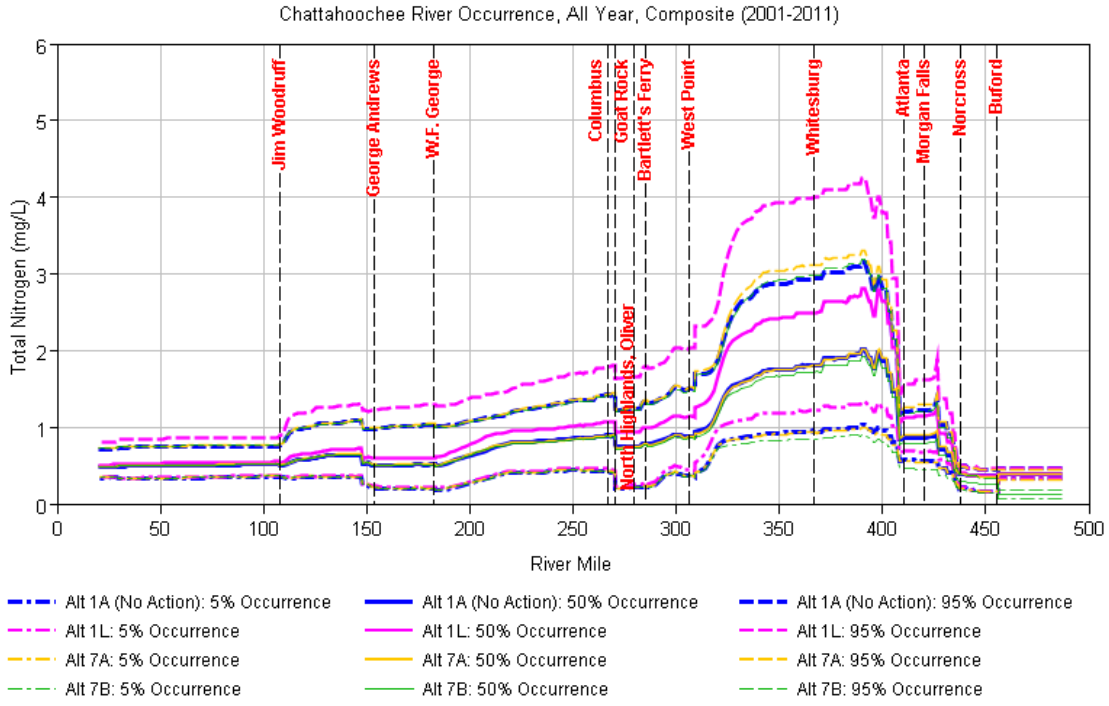


Figure 6.1-149. Longitudinal Profile Occurrence of Modeled Total Nitrogen in the ACF Basin for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

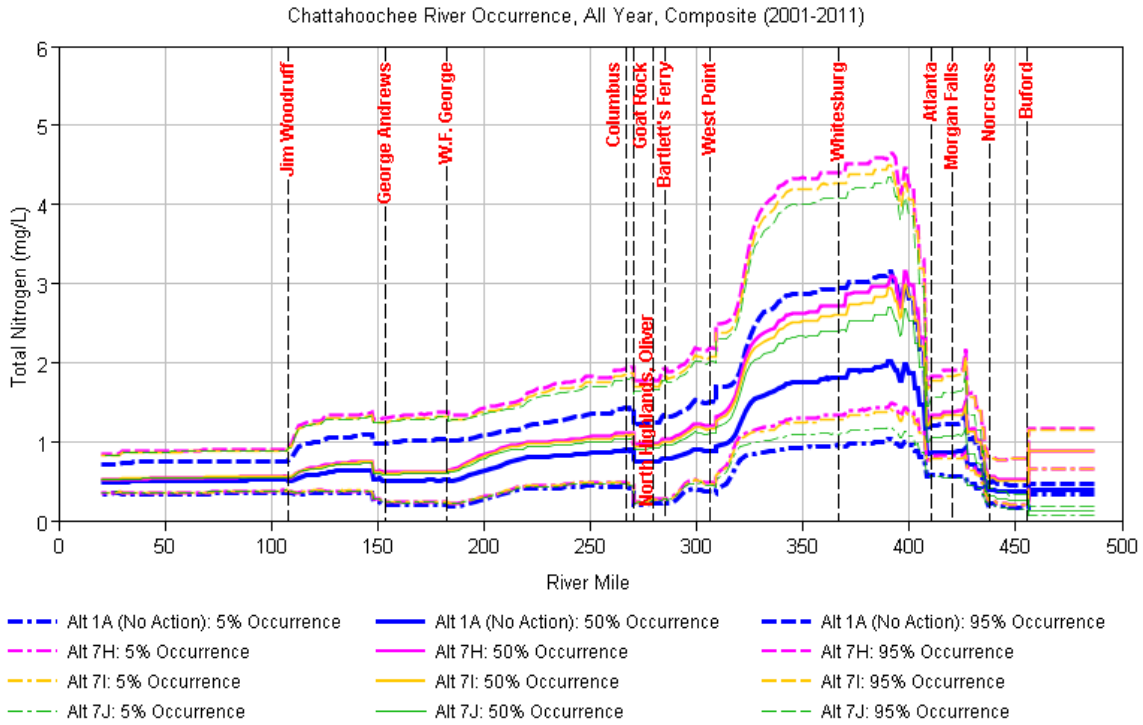


Figure 6.1-150. Longitudinal Profile Occurrence of Modeled Total Nitrogen in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

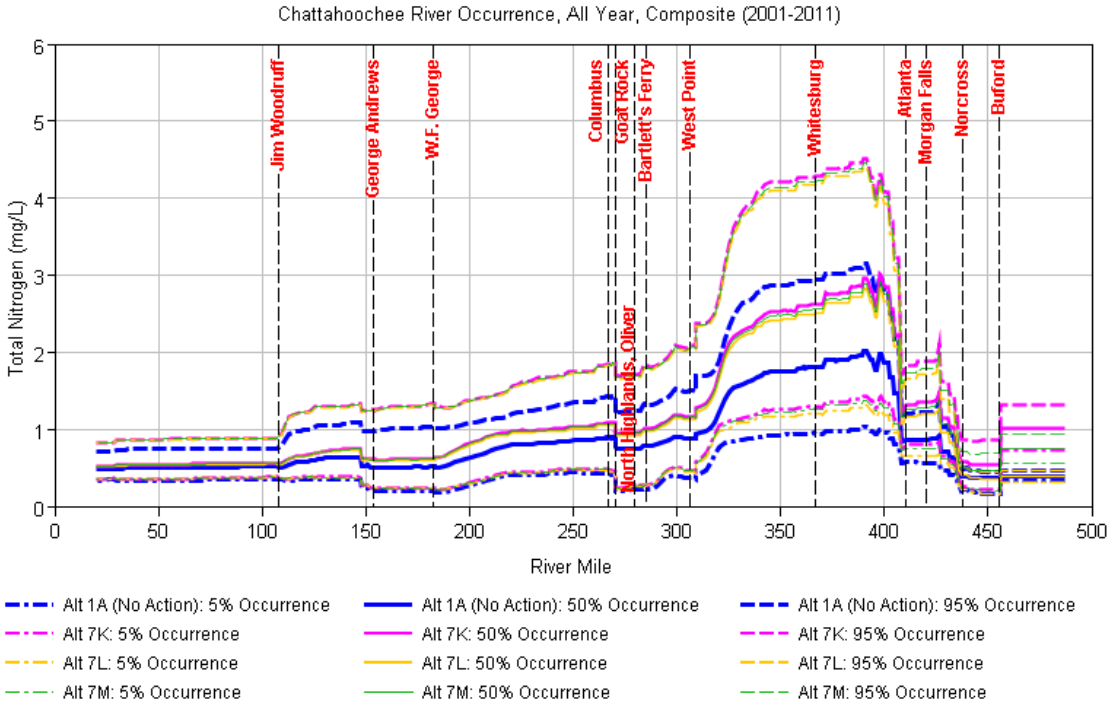


Figure 6.1-151. Longitudinal Profile Occurrence of Modeled Total Nitrogen in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

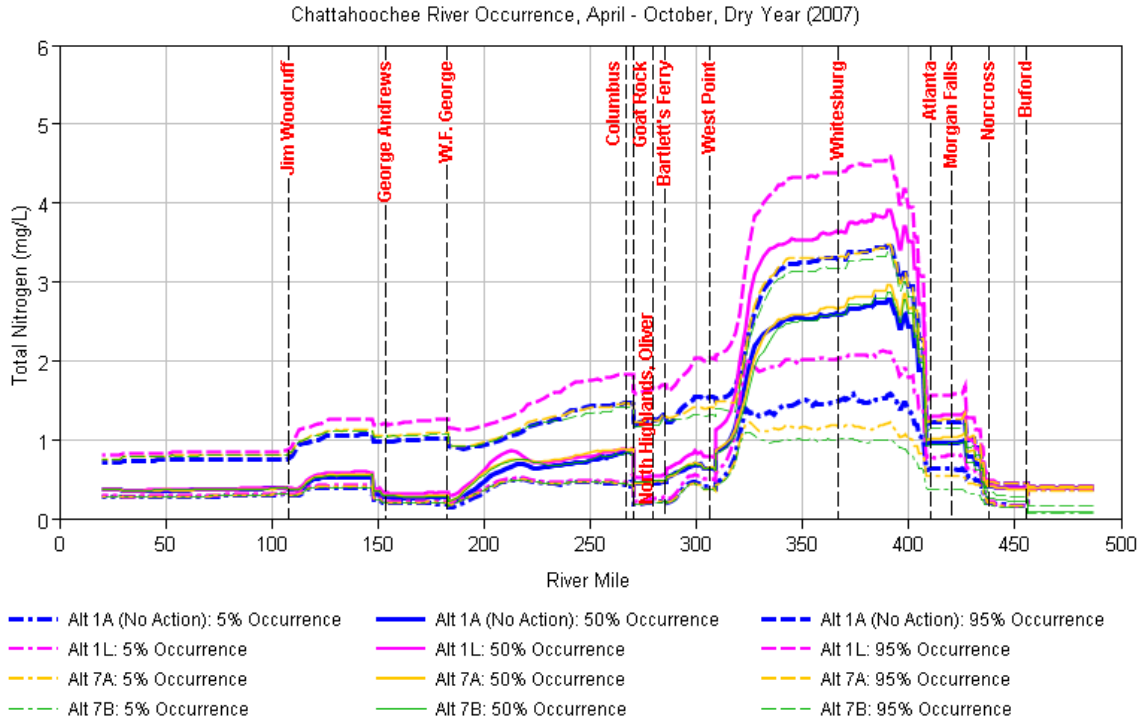


Figure 6.1-152. Longitudinal Profile Occurrence of Modeled Total Nitrogen in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

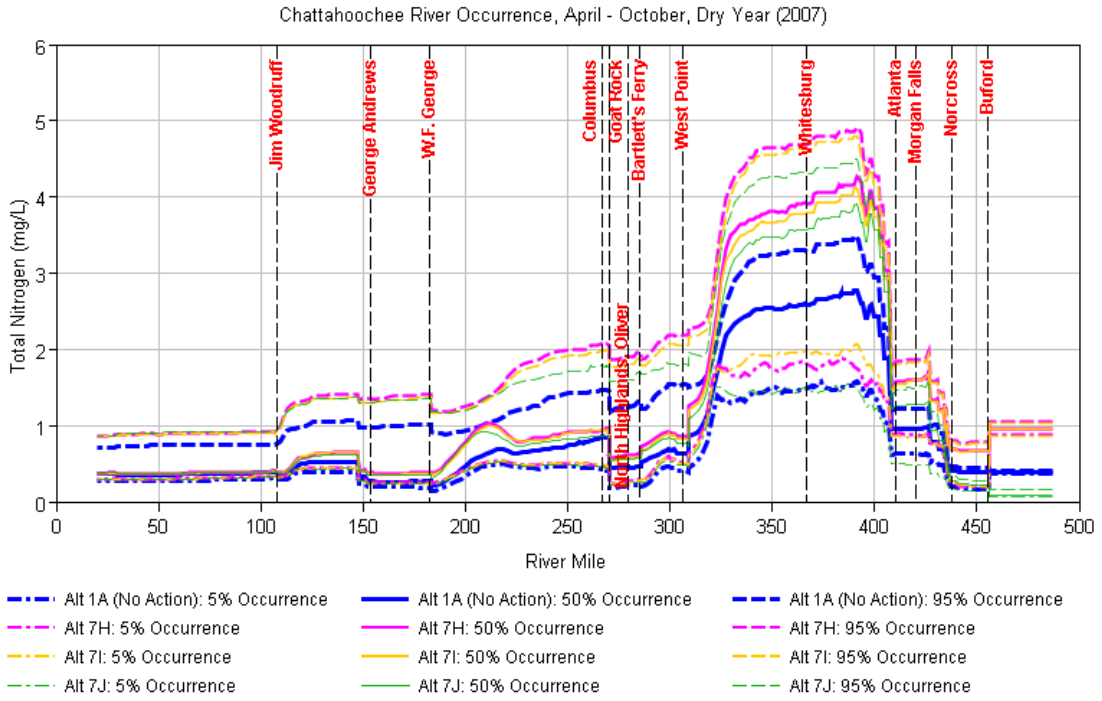


Figure 6.1-153. Longitudinal Profile Occurrence of Modeled Total Nitrogen in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

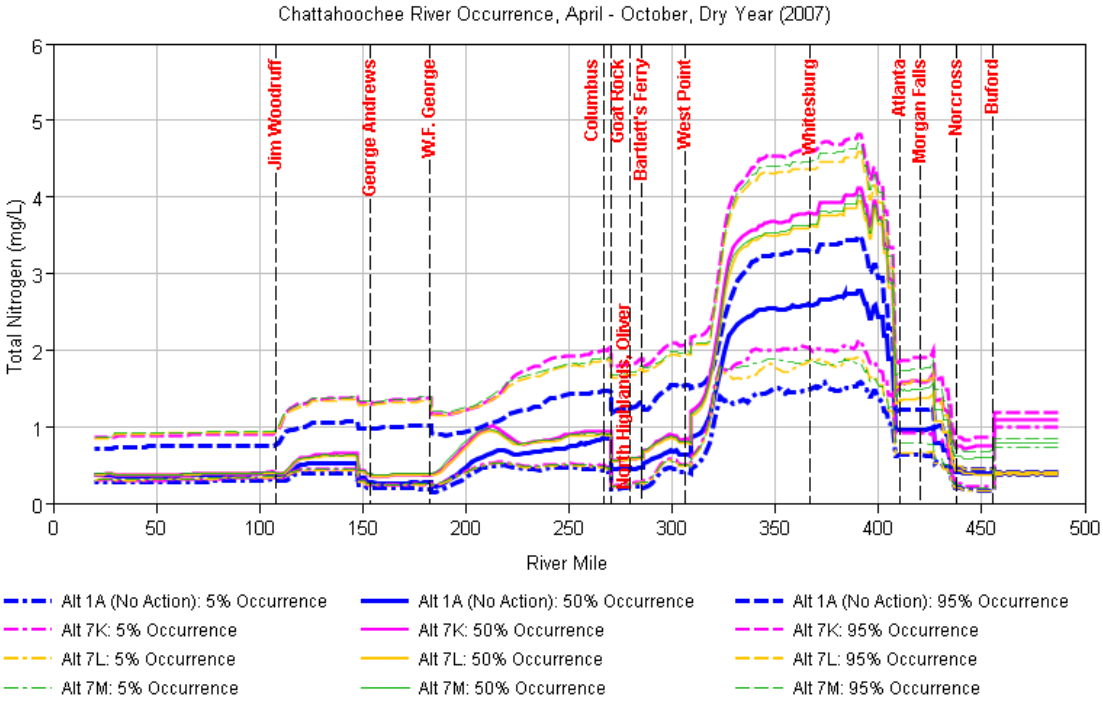


Figure 6.1-154. Longitudinal Profile Occurrence of Modeled Total Nitrogen in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

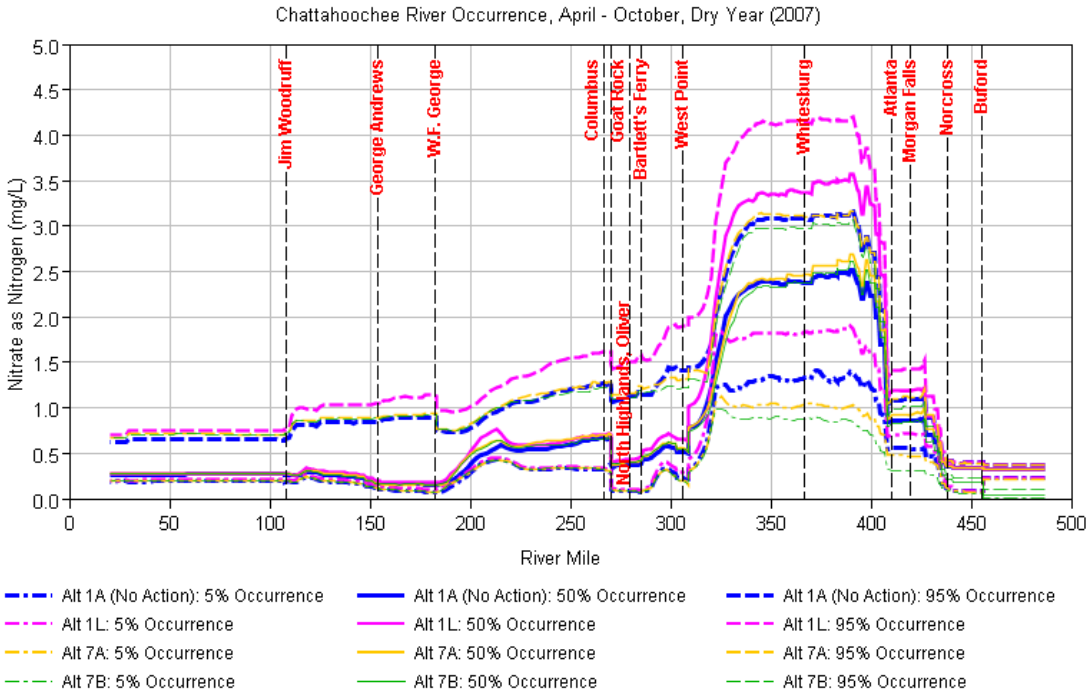


Figure 6.1-155. Longitudinal Profile Occurrence of Modeled Nitrate in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

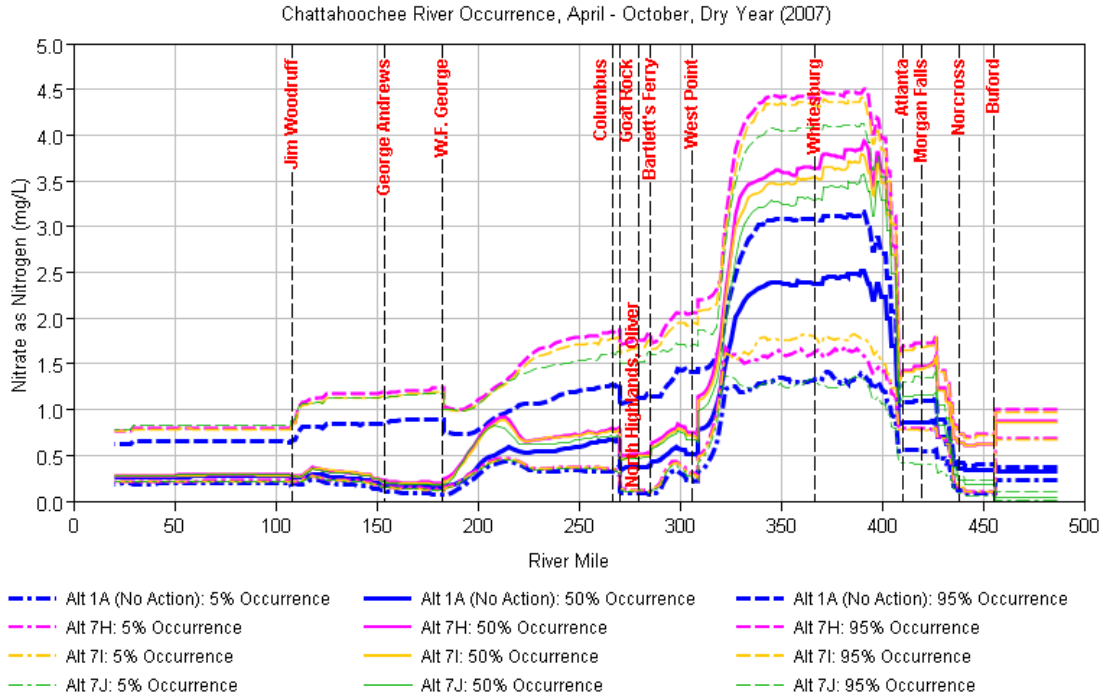


Figure 6.1-156. Longitudinal Profile Occurrence of Modeled Nitrate in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

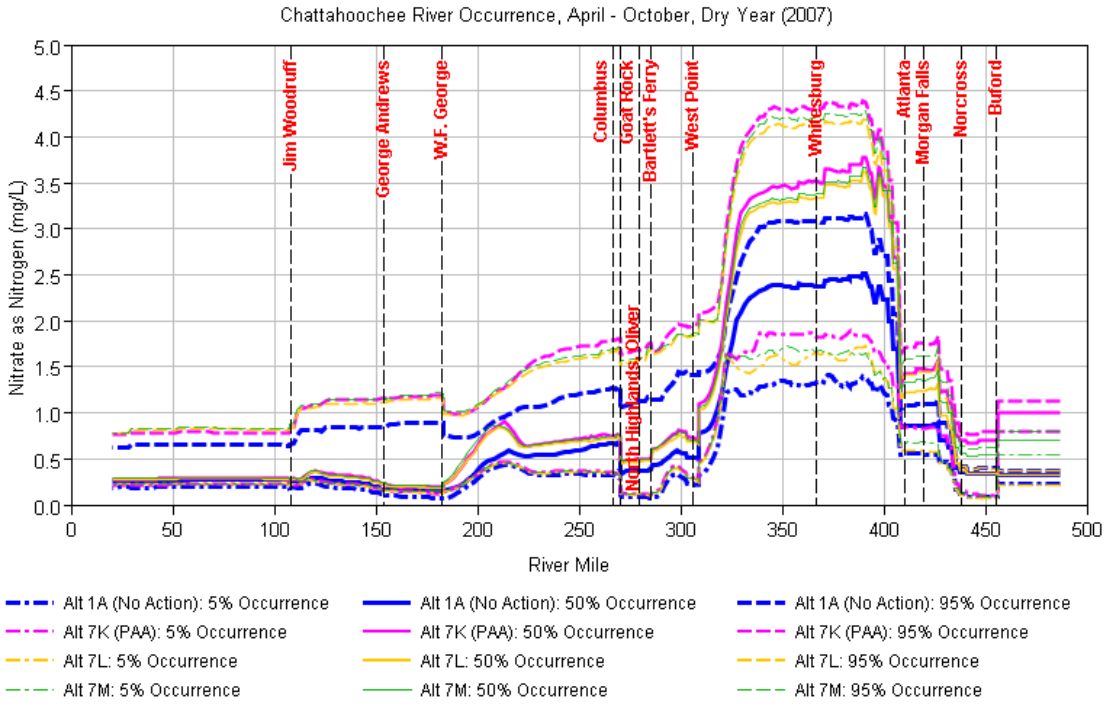


Figure 6.1-157. Longitudinal Profile Occurrence of Modeled Nitrate in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

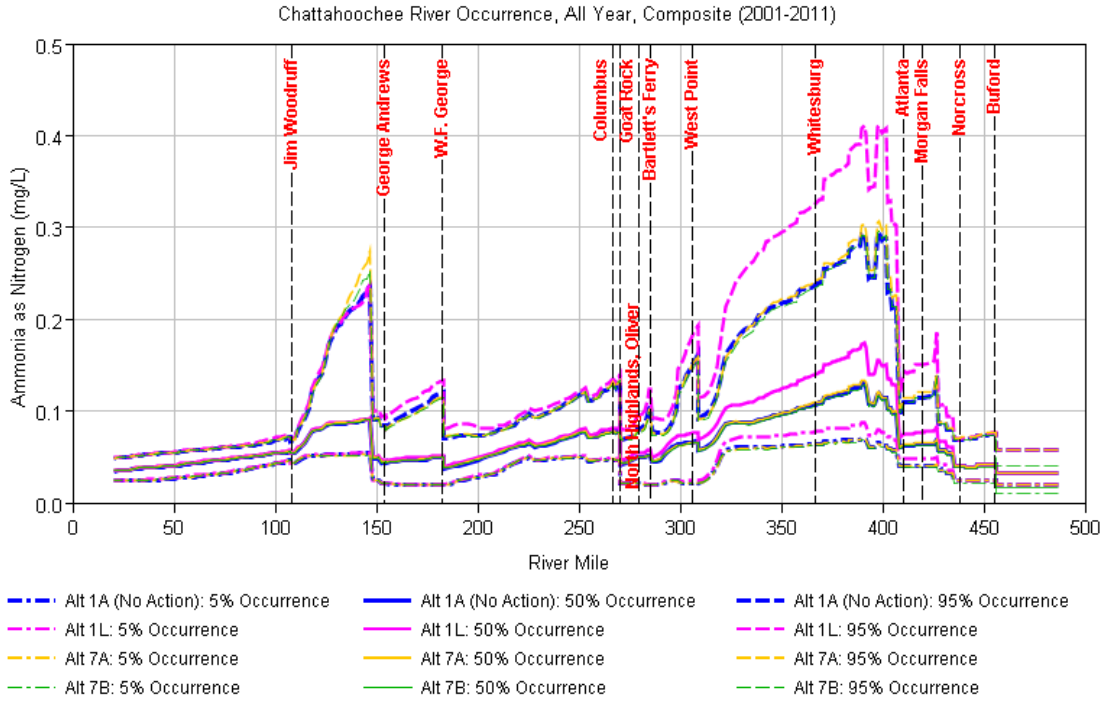


Figure 6.1-158. Longitudinal Profile Occurrence of Modeled Ammonia in the ACF Basin for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

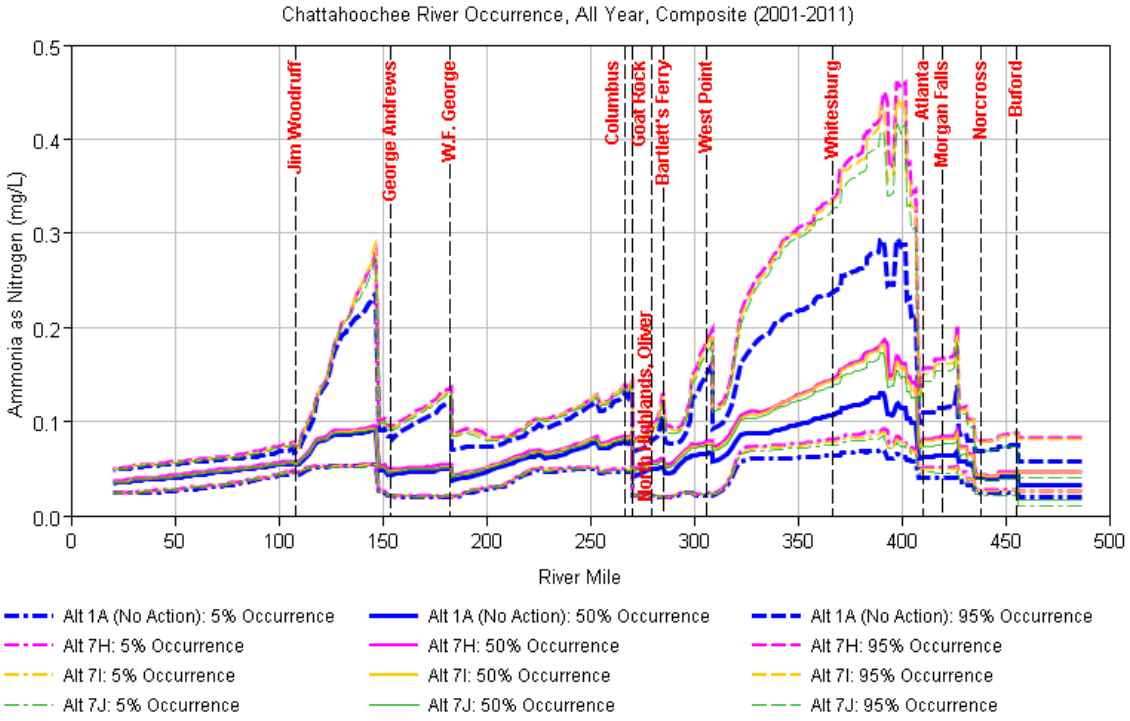


Figure 6.1-159. Longitudinal Profile Occurrence of Modeled Ammonia in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

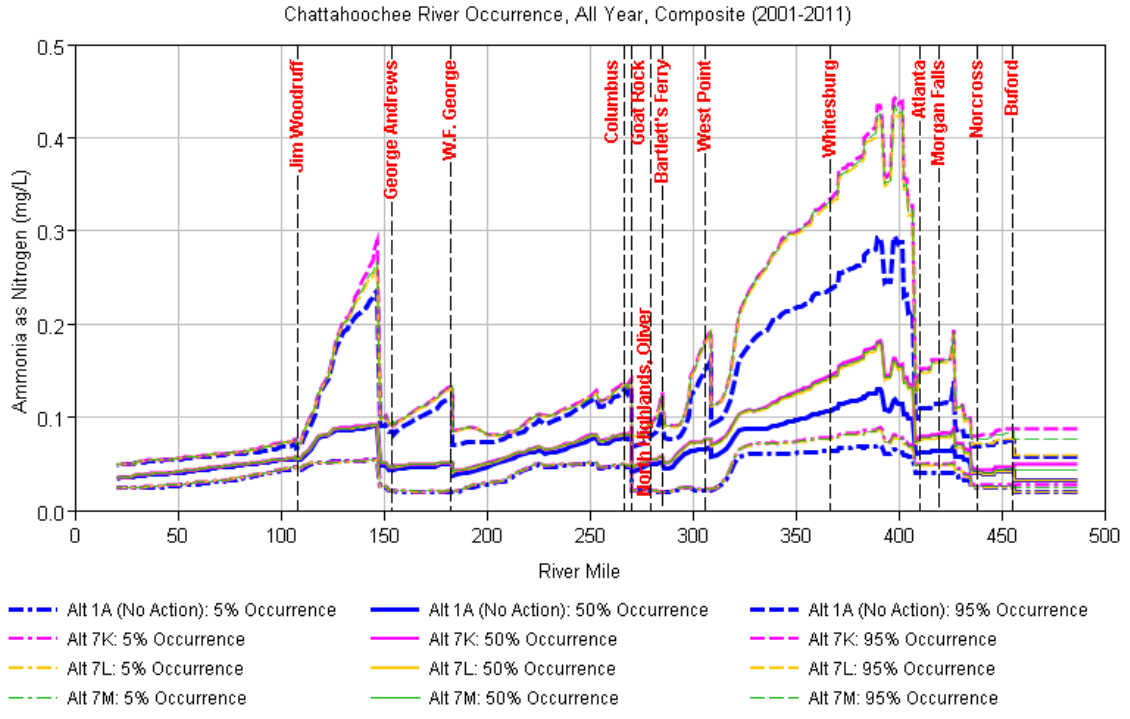


Figure 6.1-160. Longitudinal Profile Occurrence of Modeled Ammonia in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

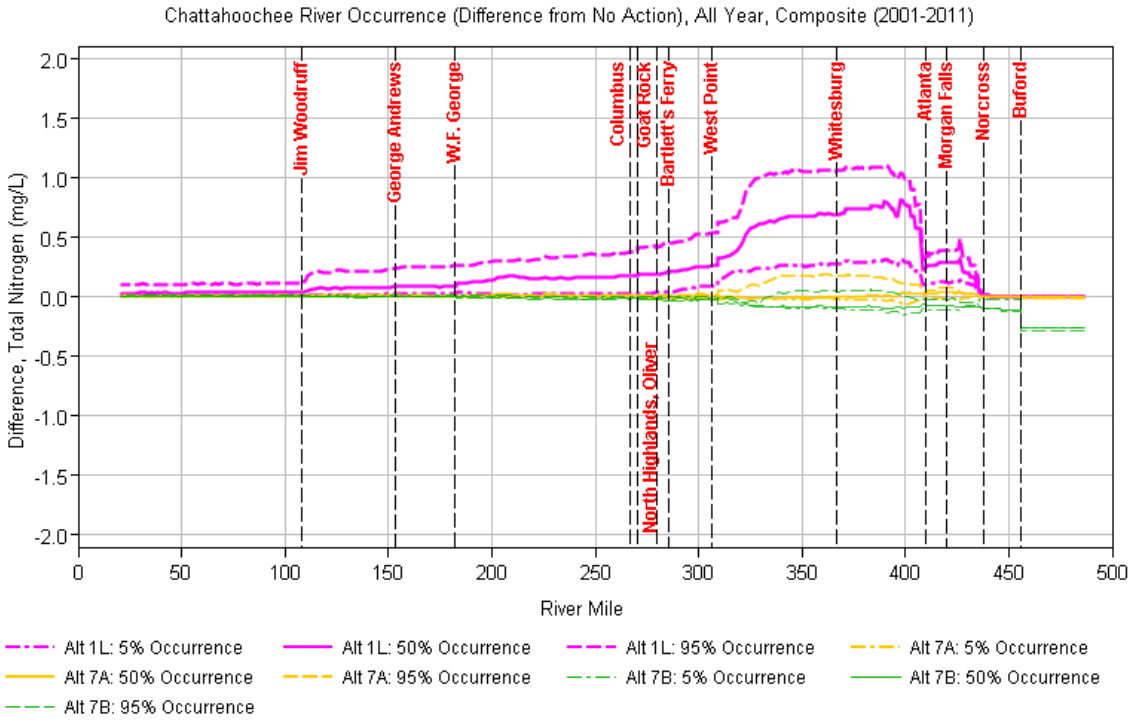


Figure 6.1-161. Longitudinal Profile of Difference in Modeled Total Nitrogen from the NAA in the ACF Basin for Alt1L, Alt7A, and Alt7B.

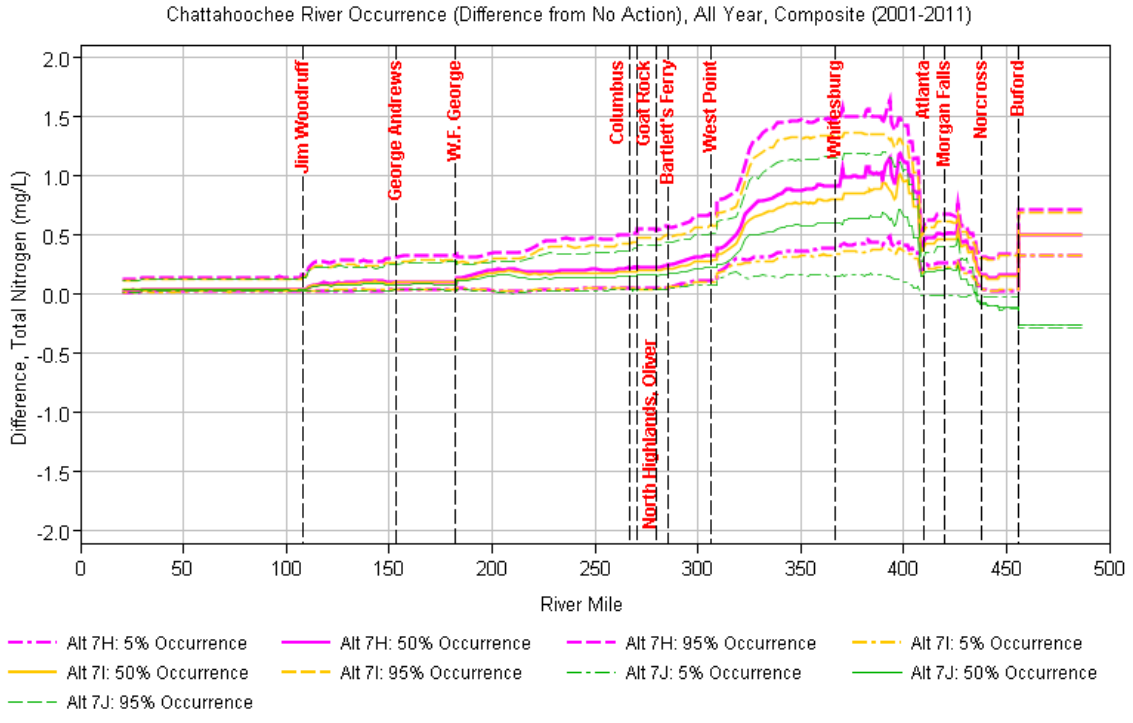


Figure 6.1-162. Longitudinal Profile of Difference in Modeled Total Nitrogen from the NAA in the ACF Basin for Alt7H, Alt7I, and Alt7J.

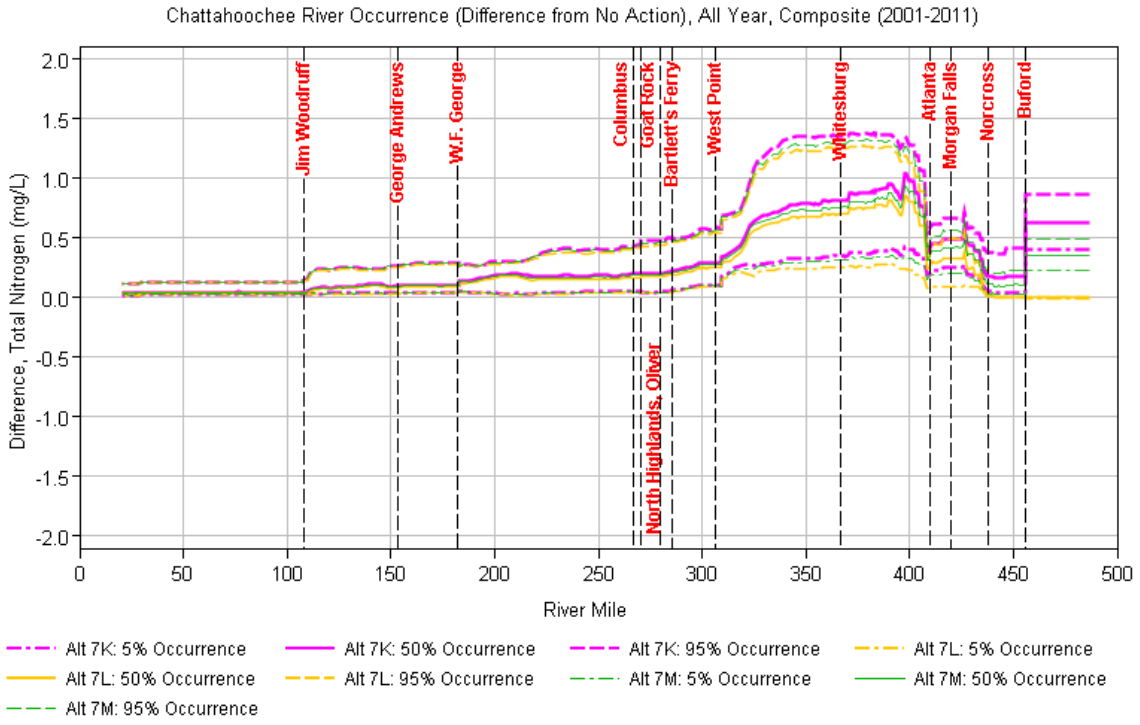


Figure 6.1-163. Longitudinal Profile of Difference in Modeled Total Nitrogen from the NAA in the ACF Basin for Alt7K (the PAA), Alt7L, and Alt7M.

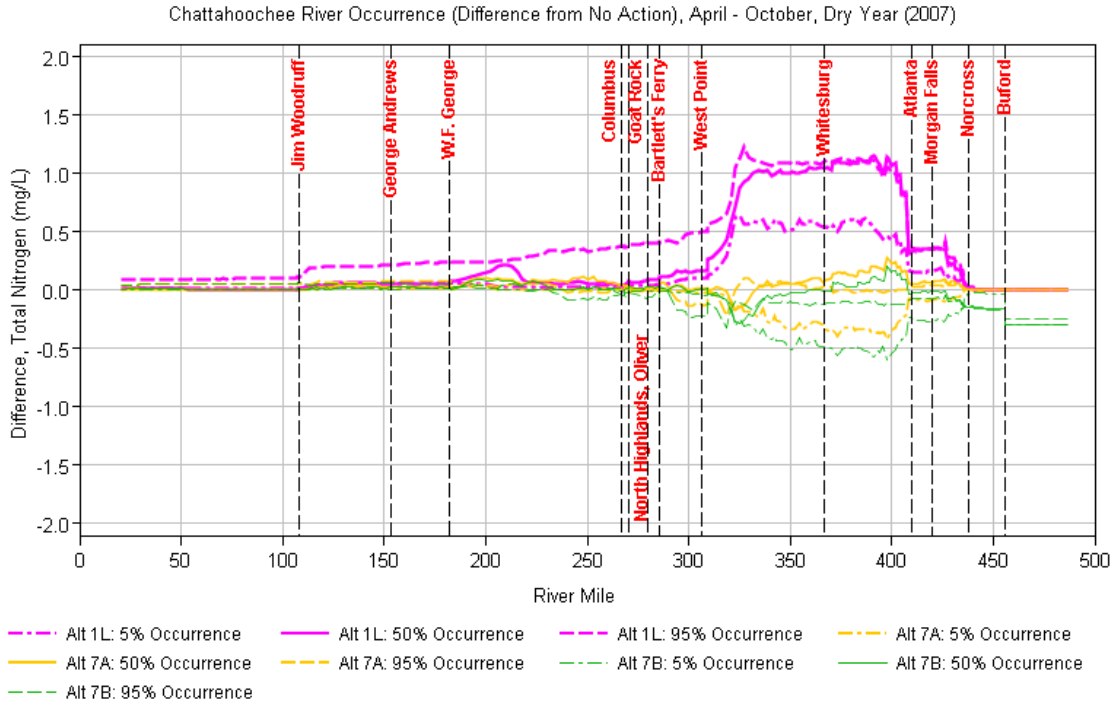


Figure 6.1-164. Longitudinal Profile of Difference in Modeled Total Nitrogen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

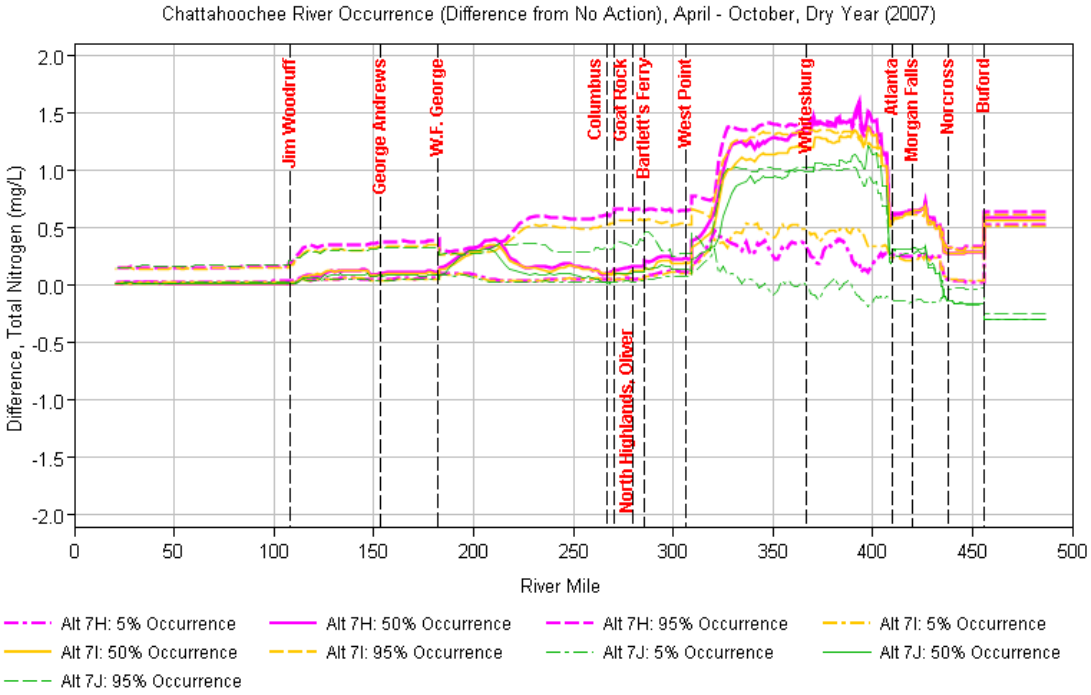


Figure 6.1-165. Longitudinal Profile of Difference in Modeled Total Nitrogen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

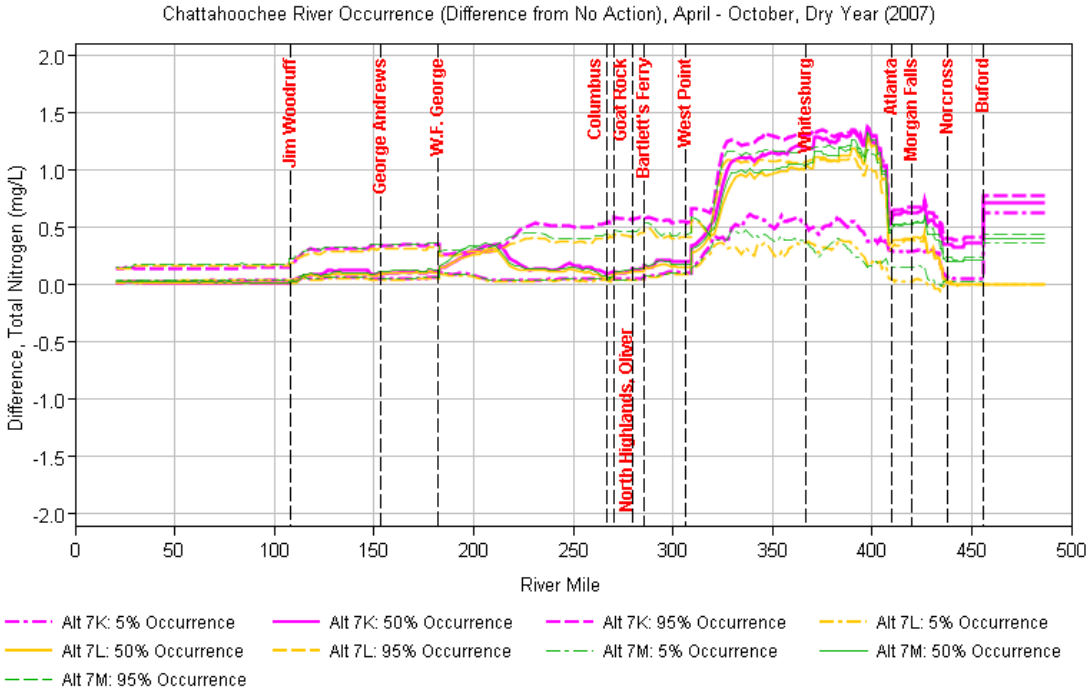


Figure 6.1-166. Longitudinal Profile of Difference in Modeled Total Nitrogen from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

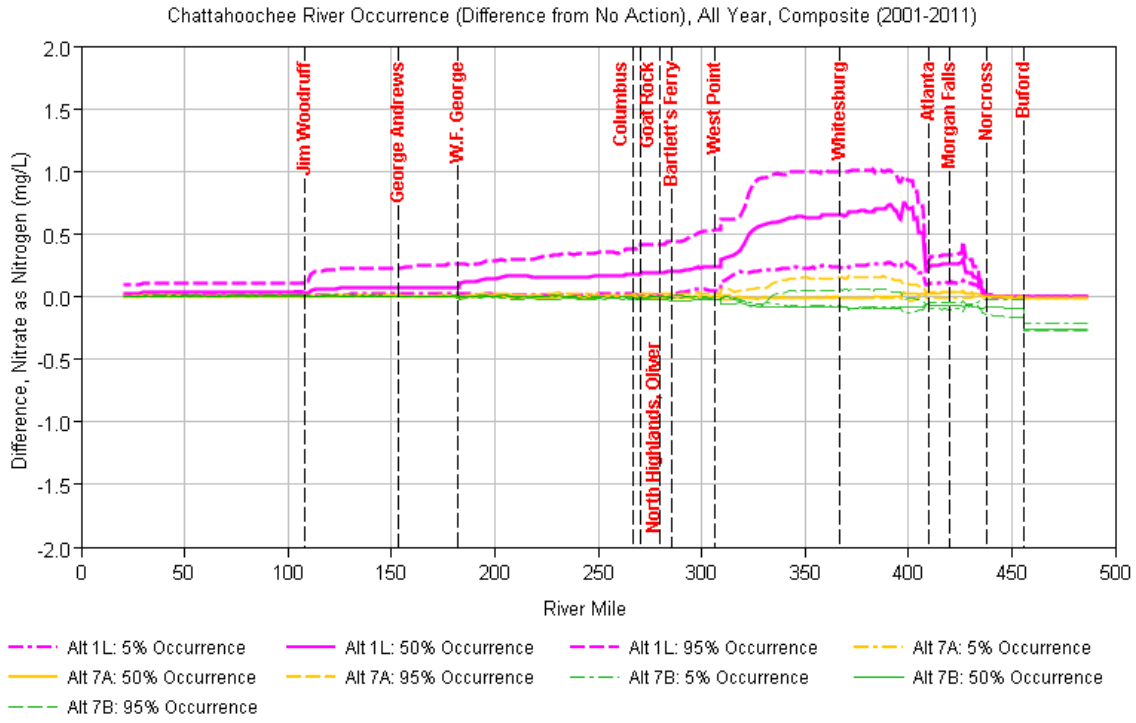


Figure 6.1-167. Longitudinal Profile of Difference in Modeled Nitrate from the NAA in the ACF Basin for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

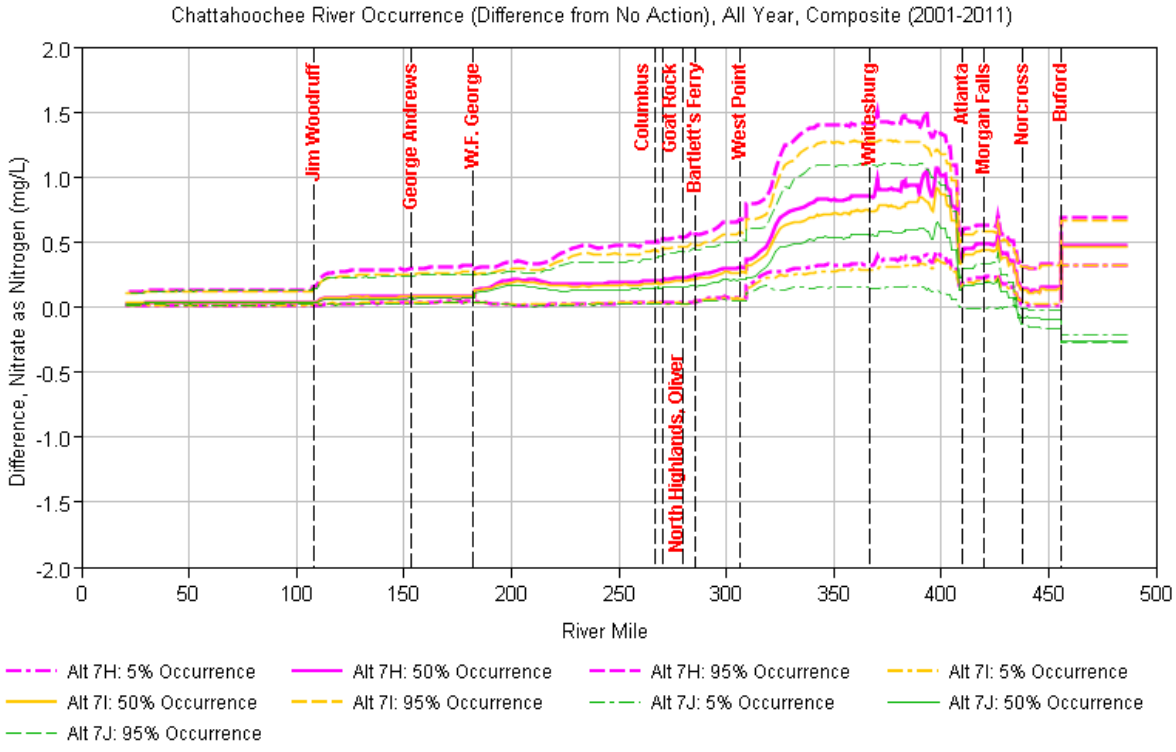


Figure 6.1-168. Longitudinal Profile of Difference in Modeled Nitrate from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

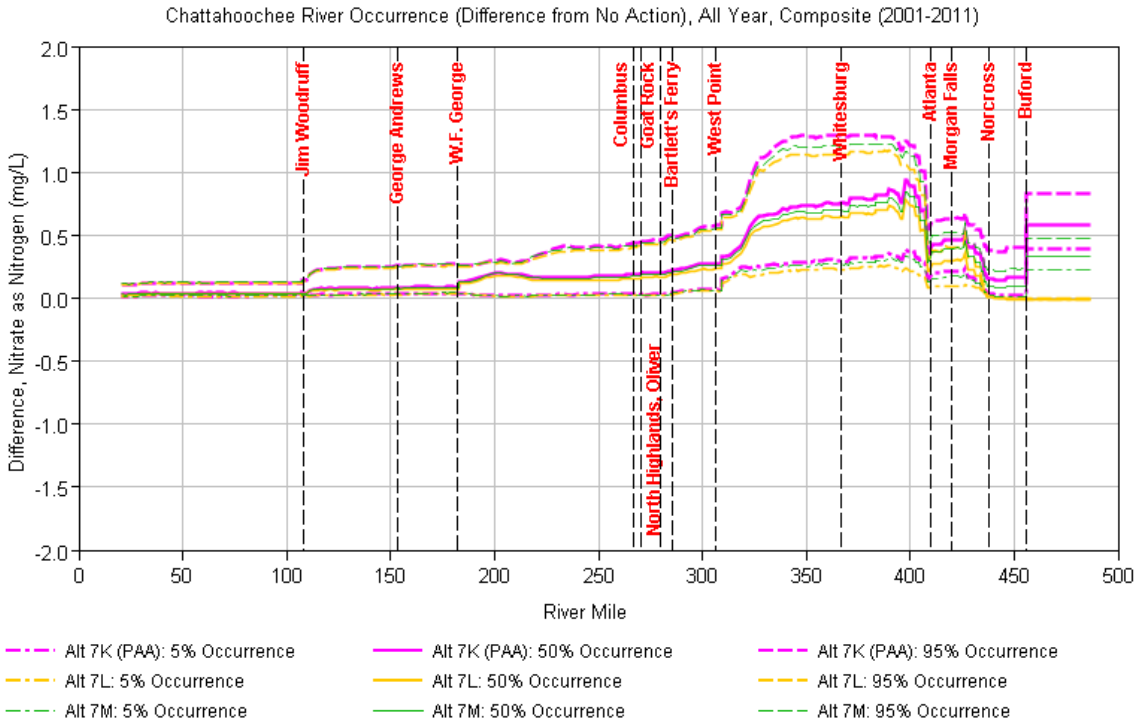


Figure 6.1-169. Longitudinal Profile of Difference in Modeled Nitrate from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

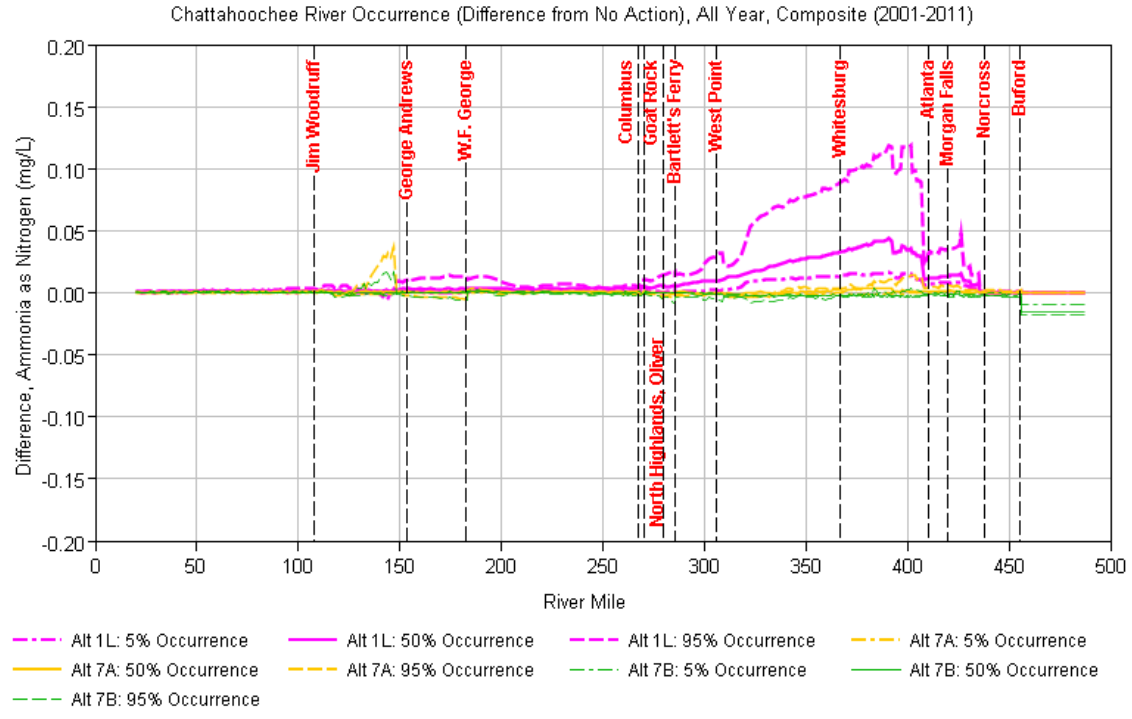


Figure 6.1-170. Longitudinal Profile of Difference in Modeled Ammonia from the NAA in the ACF Basin for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

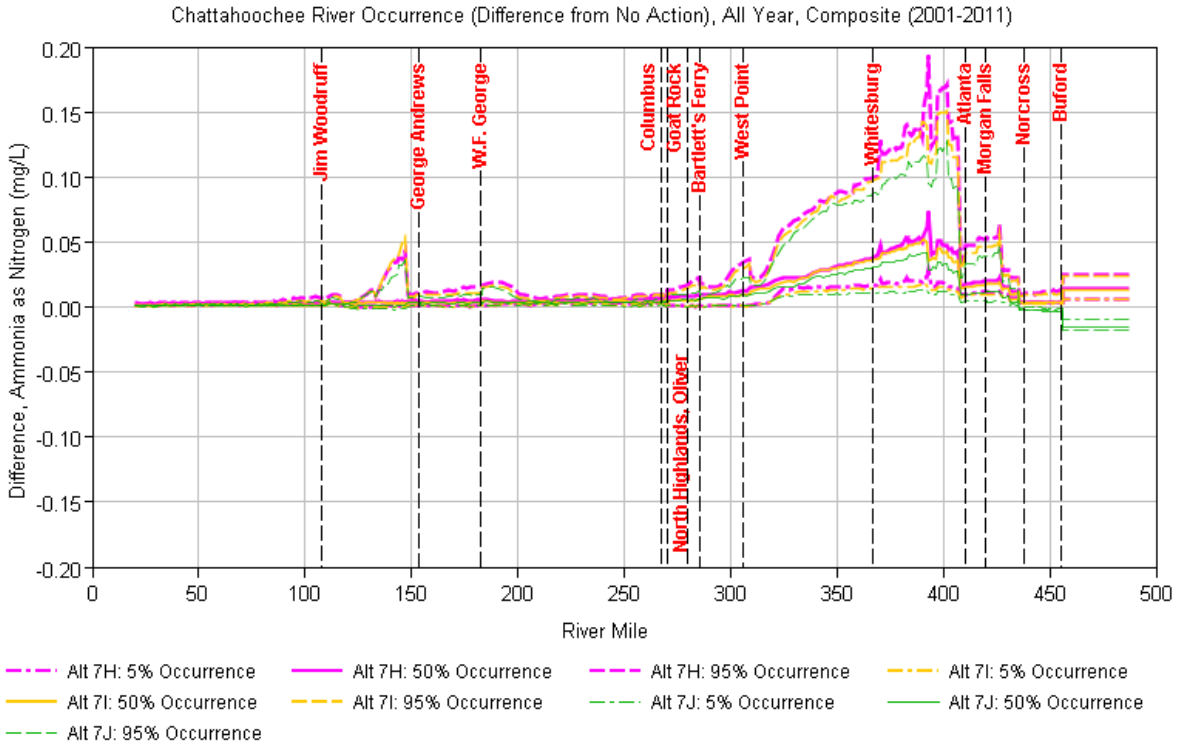


Figure 6.1-171. Longitudinal Profile of Difference in Modeled Ammonia from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

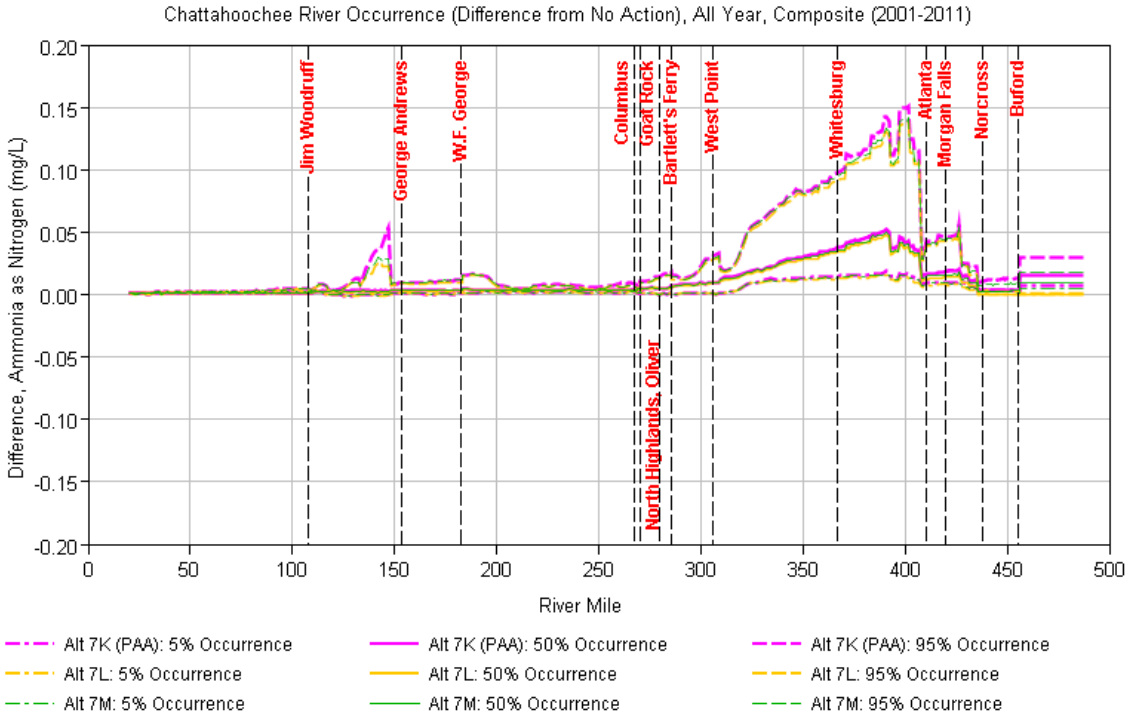


Figure 6.1-172. Longitudinal Profile of Difference in Modeled Ammonia from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

Lake Lanier, West Point Lake, and Walter F. George Lake also have site-specific water quality standards for TN. TN concentrations at Lake Lanier and West Point Lake are not to exceed 4 mg/L, and at Walter F. George Lake, they cannot exceed 3 mg/L (GAEPD 2015). Georgia has no in-stream standards for nitrogen. In November 2010, Florida finalized in-stream TN standards for freshwater streams. The standard in the freshwater reach of the Apalachicola River is 0.67 mg/L and, for clear lakes, it is 0.51 mg/L, with a range of 0.51–0.93 mg/L (FLDEP 2016). Any increase in nitrogen from the NAA may lead to exceedences of these standards, which should be verified by the States' site-specific models.

Table 6.1-22 shows the summary of effects of alternatives from the NAA based on the specified criteria. These criteria were defined starting from the assumption that a 0.5 mg/L change in TN was a trigger between a slight effect and a beneficial or adverse effect. Consistent with other parameters, negligible change was assumed if the difference from the NAA was less than 0.1 mg/L. The results obtained in the alternatives are discussed in detail in the following sections.

Table 6.1-22.
Summary of the Effects on Median Total Nitrogen of the Alternatives from the NAA during the Modeled Period (2001–2011)

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Negligible/ No change	Slightly adverse
Buford Dam to Atlanta	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse
Atlanta to West Point Lake	Baseline	Adverse	Negligible/ No change	Negligible/ No change	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
West Point Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Adverse	Slightly adverse	Slightly adverse	Adverse	Slightly adverse	Slightly adverse
West Point Dam to Walter F. George Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Walter F. George Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Negligible/ No change	Slightly adverse	Negligible/ No change	Slightly adverse
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Negligible/No change if the change in TN was < 0.1 mg/L.

Slightly adverse—Slightly adverse if TN increased by 0.1–0.5 mg/L.

Slightly beneficial—Slightly beneficial if TN decreased by 0.1–0.5 mg/L.
Adverse—Adverse impact if TN increased by more than 0.5 mg/L.

6.1.2.4.1 No Action Alternative

Modeled results indicate that, over the modeled period and during a representative critical period of dry weather in the growing season (April–October), the median TN concentrations and the 5th and 95th percent occurrences would be expected to meet the water quality standard of 4 mg/L (Figure 6.1-149 and Figure 6.1-154).

From the tailrace of Buford Dam to Atlanta, the daily median TN concentrations over the modeled period increase from 0.4 mg/L to 0.9 mg/L. The rare 95th percent occurrence of TN concentrations would be in the range of 0.5–1.2 mg/L (Figure 6.1-149). A similar trend and magnitude would be expected for median TN concentrations during the growing season of a representative dry weather year (Figure 6.1-154).

From Atlanta to West Point Lake, there is an increase of more than 1.0 mg/L in median TN over the modeled period, which could be attributed to wastewater returns (Figure 6.1-149). The most critical changes in TN would be expected in the growing season (April–October) of a representative dry weather year. The modeled median TN concentrations would be expected to increase to nearly 4 mg/L downstream of Atlanta (Figure 6.1-152). Algal growth would be expected as well, with nitrate being the significant contributor to such high TN concentrations (Figure 6.1-155).

In West Point Lake, TN concentrations (5th, median, and 95th percent occurrences) over the modeled period would not be expected to exceed the water quality standard of 4 mg/L (Figure 6.1-149).

TN steadily declines from West Point Dam to the Apalachicola River. Water quality standards would be expected to be met in Walter F. George Lake. Median TN concentrations, over the modeled period, in Lake Seminole would be within range of the defined standard but would be at or greater than 0.51 mg/L. Median TN would be expected to meet water quality standards in the Apalachicola River, but the highest concentrations (95th percent occurrences) would be expected to be higher than the standard of 0.67 mg/L (Figure 6.1-149). In the Apalachicola River during the growing season of a representative dry weather year, median concentrations of TN would be expected to meet water quality standards (Figure 6.1-152).

A closer look at ammonia in the basin illustrates the influence of point and nonpoint sources (Figure 6.1-158). The sharp increases in the ammonia concentrations are mostly caused by wastewater treatment discharges, and some of the minor increases are caused by increased watershed ammonia loadings. Reservoir operations resulting in changes in flow along the Chattahoochee River would be expected to affect the impact that wastewater returns have in the system, especially under low flow conditions.

6.1.2.4.2 Alternative 1L

Under Alt1L, slightly adverse conditions would be expected from Buford Dam downstream to Walter F. George Lake and in the reach from Atlanta to West Point Lake. Conditions would be adverse from increased water withdrawals and returns downstream of Buford Dam (Figure 6.1-149). Median TN concentrations over the modeled period from Norcross to Atlanta and downstream of West Point Dam would be expected to increase by at least 0.1 mg/L from the NAA (Figure 6.1-161). Wastewater returns would be expected to have less of an effect on median TN concentrations downstream of West Point Lake during the growing season of a representative dry weather year (Figure 6.1-164). Delta median TN concentrations would be expected to decrease to levels near the NAA in the Apalachicola River over the modeled period and in the growing season of a representative dry weather year (Figure 6.1-161 and Figure 6.1-164).

6.1.2.4.3 Alternative 7A

Negligible change in median TN over the modeled period would be expected under Alt7A when compared to the NAA (Figure 6.1-149 and Figure 6.1-164). Therefore, little change in TN concentrations would be expected from proposed water management operations. Even during the growing season of a representative dry weather year, changes from the NAA would be expected to be minor, with the lowest concentrations of TN decreasing from Altanta into West Point Lake by as much as 0.4 mg/L (Figure 6.1-152 and Figure 6.1-164).

6.1.2.4.4 Alternative 7B

Alt7B would be expected to result in negligible change in median TN from Buford Dam downstream over the modeled period when compared with the NAA (Figure 6.1-149 and Figure 6.1-164). This alternative assumes proposed water management operations (Water Management Alternative 7) and water withrdawals and returns downstream of Buford Dam equal to the NAA. Slightly beneficial effects would be expected in Lake Lanier from reducing water withdrawals and returns from current conditions in the NAA to relocation contracted amounts (Figure 6.1-149 and Figure 6.1-164). Differences between Alt7B and Alt7A illustrate the benefits of reducing water withdrawals and returns in Lake Lanier. Those benefits also would be expected to slightly reduce the lowest and highest TN concentrations (5th and 95th percent occurrences) from Atlanta to West Point Lake during the growing season of a representative dry weather year (Figure 6.1-164).

6.1.2.4.5 Alternative 7H

Under Alt7H, slightly adverse effects to TN from Lake Lanier to Lake Seminole would be expected from increased withdrawals and returns in Lake Lanier and downstream of Buford Dam consistent with Georgia's 2013 water supply request with the exception of the reach from Atlanta to West Point Lake, where adverse effects would be expected (Figure 6.1-150 and Figure 6.1-162). In Lake Seminole and the Apalachicola River, negligible effects would be expected. Median TN over the modeled period in Lake Lanier would be expected to increase by 0.5 mg/L from the NAA.

Alt7H was the PAA in the draft EIS, but is no longer a viable alternative. The HEC-5Q model was updated following comments received on the draft EIS, and Alt7H has been retained in this final EIS only to enable comparison of its results with the NAA as well as with Alt7M to illustrate differences in withdrawals and returns downstream of Buford Dam between Georgia's 2013 and 2015 water supply requests.

6.1.2.4.6 Alternative 7I

Comparing Alt7I with the NAA illustrates the effects of Lake Lanier withdrawals and returns consistent with Georgia's 2013 water supply request with the addition of 40 mgd requested from Glades Reservoir and Georgia's 2015 water supply request downstream of Buford Dam. Increased returns in Lake Lanier and downstream of Buford Dam would be expected to be slightly adverse on TN levels in the reach from Lake Lanier to Lake Seminole with adverse effects in the reach from Atlanta to West Point Lake (Figure 6.1-150 and Figure 6.1-162). In Lake Seminole and the Apalachicola River, negligible effects would be expected.

Median TN in Lake Lanier over the modeled period would be expected to increase by 0.5 mg/L from the NAA. This change is consistent with Alt7H because both Alt7I and Alt7H assume the same water withdrawals and returns from Lake Lanier. The median TN concentration over the modeled period for Alt7I is slightly less than concentrations from Alt7H, peaking at a 1.0 mg/L change because of reduced water withdrawals and increased returns downstream of Alanta (Figure 6.1-162). Downstream of West

Point Dam deltas of Alt7I and Alt7H from the NAA would be expected to be similar and to decrease to concentrations near the NAA in the Apalachicola River. The delta of Alt7I in the Apalachicola River from the NAA would be 0.04 mg/L.

6.1.2.4.7 Alternative 7J

Increased water withdrawals and returns downstream of Buford Dam in Alt7J would be expected to adversely affect TN from Atlanta to West Point Lake and to be slightly adverse from West Point Dam to Walter F. George Lake. Assuming relocation contract water withdrawals and returns to Lake Lanier, slightly beneficial effects would be expected and negligible effects downstream of Walter F. George Lake over the modeled period (Figure 6.1-150 and Figure 6.1-162). As with other parameters, changes from the NAA are generally less in Alt7J than in Alt7I, illustrating the effects of comparing current relocation contracts in Lake Lanier with Georgia's 2013 water supply request plus Glades Reservoir (Figure 6.1-162); both Alt7J and Alt7I include the same water withdrawals and returns downstream of Buford Dam.

6.1.2.4.8 Alternative 7K (PAA)

Slightly adverse effects to median TN would be expected over the modeled period when comparing the PAA with the NAA in Lake Lanier downstream to Atlanta and from West Point Dam to Lake Seminole. Adverse effects would be expected from Atlanta into West Point Lake and negligible effects would be expected in Lake Seminole and the Apalachicola River (Figure 6.1-163 and Figure 6.1-145). Those effects would be the response of median TN levels to water returns assumed in the PAA to be consistent with Georgia's 2015 water supply request.

Increasing water withdrawals and returns in Lake Lanier would be expected to increase median TN over the modeled period by 0.4 mg/L over the NAA. The increased concentrations would be passed downstream into the Chattahoochee River. The addition of increased returns downstream of Atlanta would be expected to increase the delta from the NAA by 0.82 mg/L in the reach from Atlanta to West Point Lake. A closer look at nitrate and ammonia illustrates the influence of wastewater returns. The sharp increase in ammonia concentrations is mostly due to wastewater treatment discharges (Figure 6.1-157 and Figure 6.1-160). Concentrations in West Point Lake and downstream would gradually decrease to the Apalachicola River, where deltas would be expected to be negligible at 0.04 mg/L (Figure 6.1-145).

The greatest effects would be expected in the growing season of a representative dry weather year when median TN would be expected to increase to around 4 mg/L in the reach from Atlanta to West Point Lake, with a maximum delta of 1.37 mg/L from the NAA (Figure 6.1-157 and Figure 6.1-166). Downstream of West Point Dam, median TN during this period would be expected to remain below 1.0 mg/L and less than 0.5 mg/L downstream of Walter F. George Lock and Dam (Figure 6.1-157).

6.1.2.4.9 Alternative 7L

Comparing Alt7L with the NAA illustrates the effects of proposed increased river withdrawals downstream of Buford Dam and updated water management operations; the water withdrawals and returns from Lake Lanier are consistent with the NAA. Increased returns downstream of Buford Dam would be expected to have a slightly adverse effect on TN in the reaches from Buford Dam to Atlanta and in West Point Lake downstream to Walter F. George Lake. Lake Lanier and downstream of Walter F. George Lock and Dam would be expected to have negligible effects from the NAA over the modeled period (Figure 6.1-163 and Figure 6.1-145). In the Apalachicola River, the median TN over the modeled period would be expected to increase by 0.04 mg/L from the NAA.

6.1.2.4.10 Alternative 7M

Comparing Alt7M with the NAA illustrates the effects of proposed increased river withdrawals downstream of Buford Dam, updated water management operations, and water withdrawals and returns from Lake Lanier proposed in Alt7H; therefore, the effects to median TN over the modeled period are similar to those for Alt7H. Slightly adverse effects to TN from Lake Lanier to Lake Seminole would be expected from increased withdrawals and returns in Lake Lanier and downstream of Buford Dam consistent with Georgia's 2013 water supply request with the exception of the reach from Atlanta to West Point Lake, where adverse effects would be expected (Figure 6.1-163 and Figure 6.1-145). In Lake Seminole and the Apalachicola River, negligible effects would be expected.

6.1.2.5 Chlorophyll *a*

Chlorophyll *a* is an indicator of lake and reservoir health. Too much chlorophyll *a* caused by excess nutrients can cause the lake or reservoir to become unhealthy for humans and fish. According to GAEPD, however, there may be positive benefits to a reservoir fishery from increased chlorophyll *a* (USFWS 2016 response to comments are provided in appendix J). If chlorophyll *a* is not at critical levels, an increase in nutrient loading could lead to increased biomass and improved fishing at Lake Lanier, West Point Lake, and Walter F. George Lake. Those potential benefits are considered in section 6.4.3.2.

Management of reservoirs does not generally contribute to nutrient loads in water bodies. However, the regulation of inflows to and outflows from reservoirs, along with the change in water withdrawals and returns, or wastewater discharges, do influence phytoplankton growth.

Figure 6.1-173 through Figure 6.1-196 present the processed HEC-5Q modeled output for chlorophyll *a* over the modeled period for the NAA. Like the other water quality parameter profiles, they also illustrate variations between proposed revisions to the Master Manual as defined in Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M from the NAA.

The median change in chlorophyll *a* for each alternative was compared to the NAA over the modeled period and determined to have the following impacts:

- Negligible impact if the change in chlorophyll *a* was less than 0.5 micrograms per liter (µg/L)
- A slightly adverse impact if chlorophyll *a* increased by 0.5–2.0 µg/L
- An adverse impact if chlorophyll *a* increased by more than 2.0 µg/L
- A substantial adverse impact if the change in chlorophyll *a* contributes to a state water quality standard exceedance set for lakes
- A slightly beneficial impact if chlorophyll *a* decreased by 0.5–2.0 µg/L
- A beneficial impact if chlorophyll *a* decreased by more than 2.0 µg/L
- A substantial beneficial impact if the change in chlorophyll *a* avoided any state water quality standard exceedance set for lakes

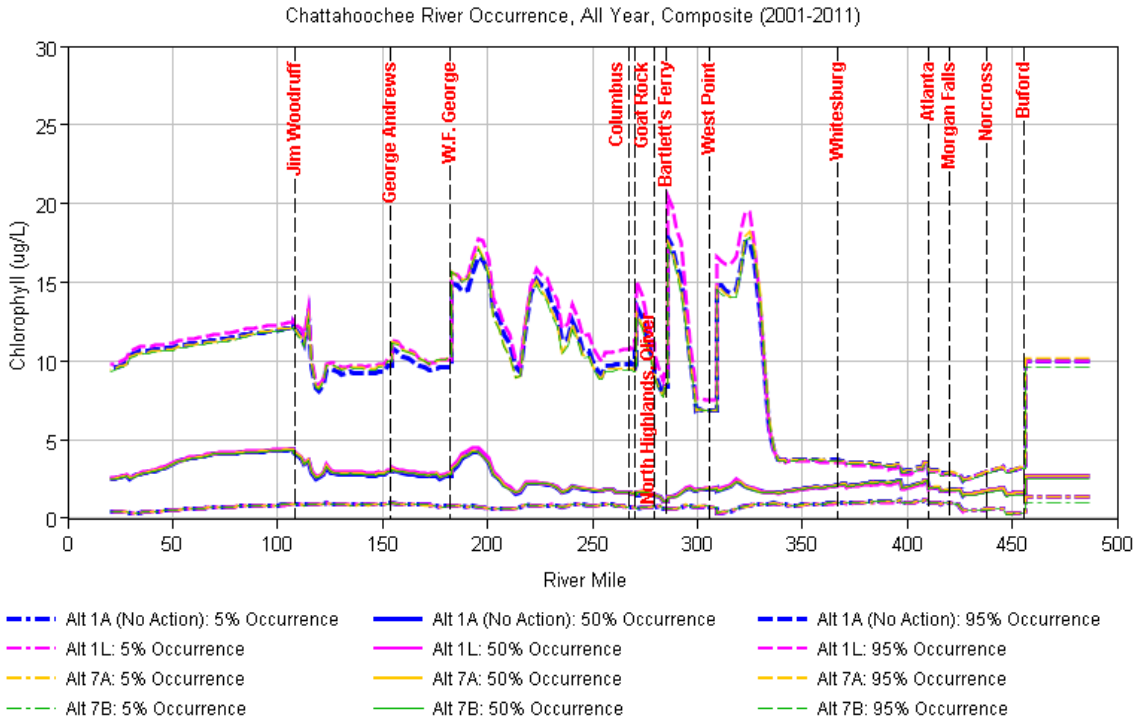


Figure 6.1-173. Longitudinal Profile Occurrence of Daily Chlorophyll *a* in the ACF Basin for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

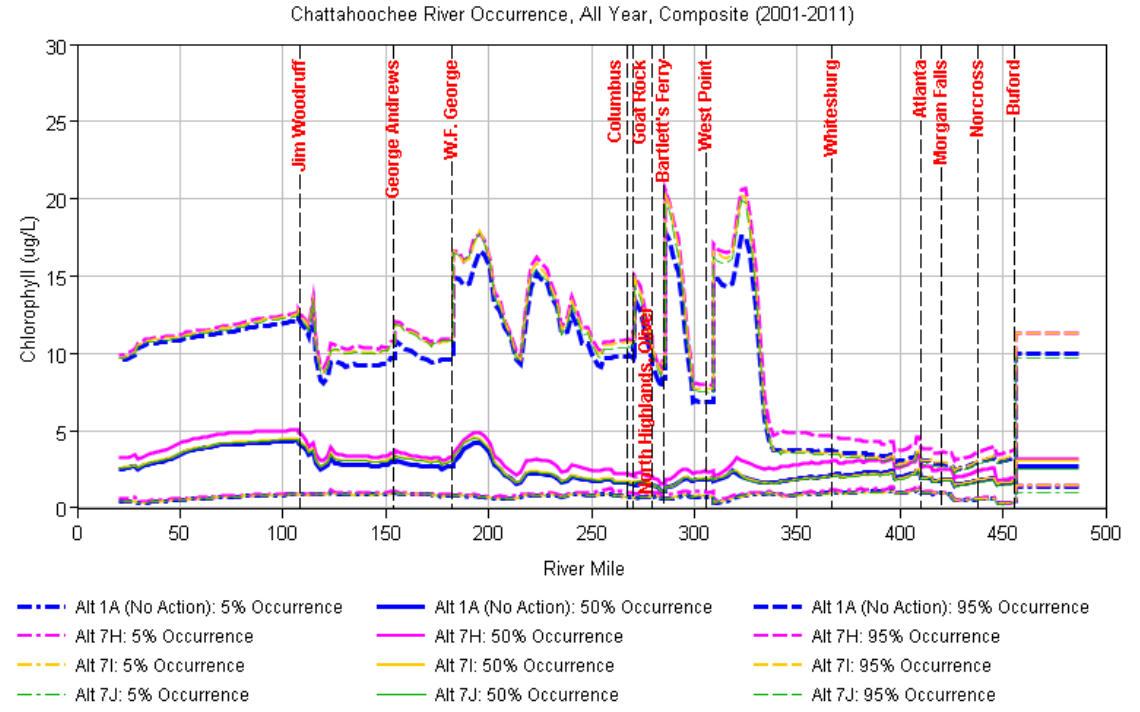


Figure 6.1-174. Longitudinal Profile Occurrence of Daily Chlorophyll *a* in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

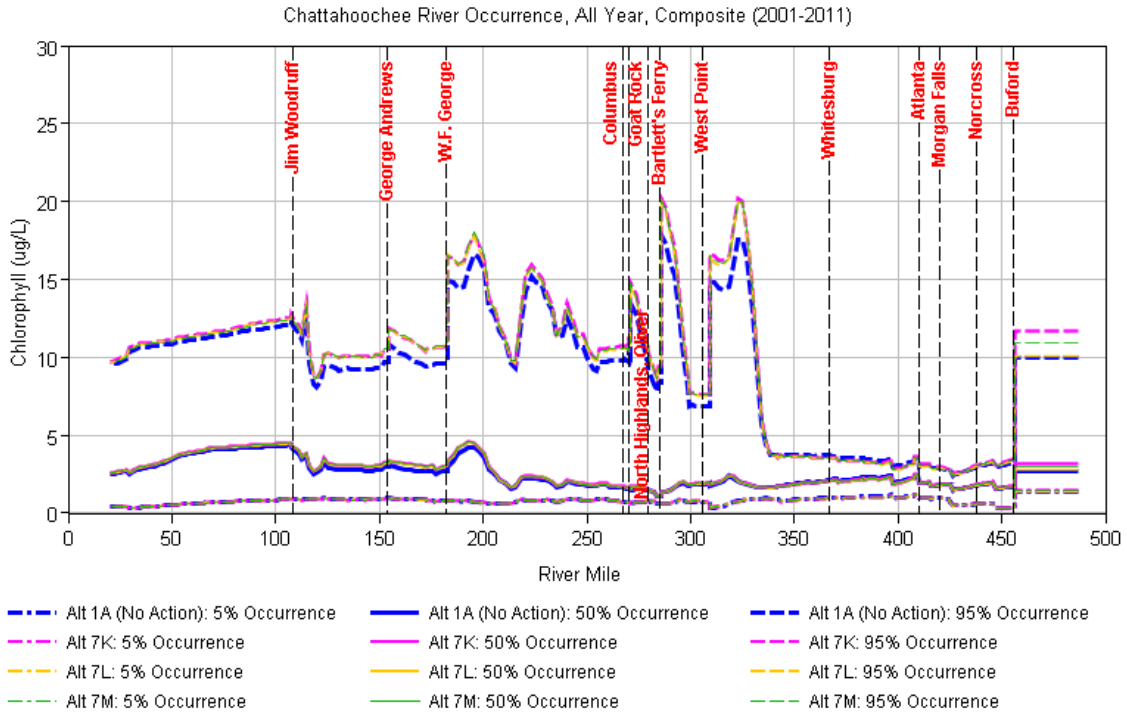


Figure 6.1-175. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

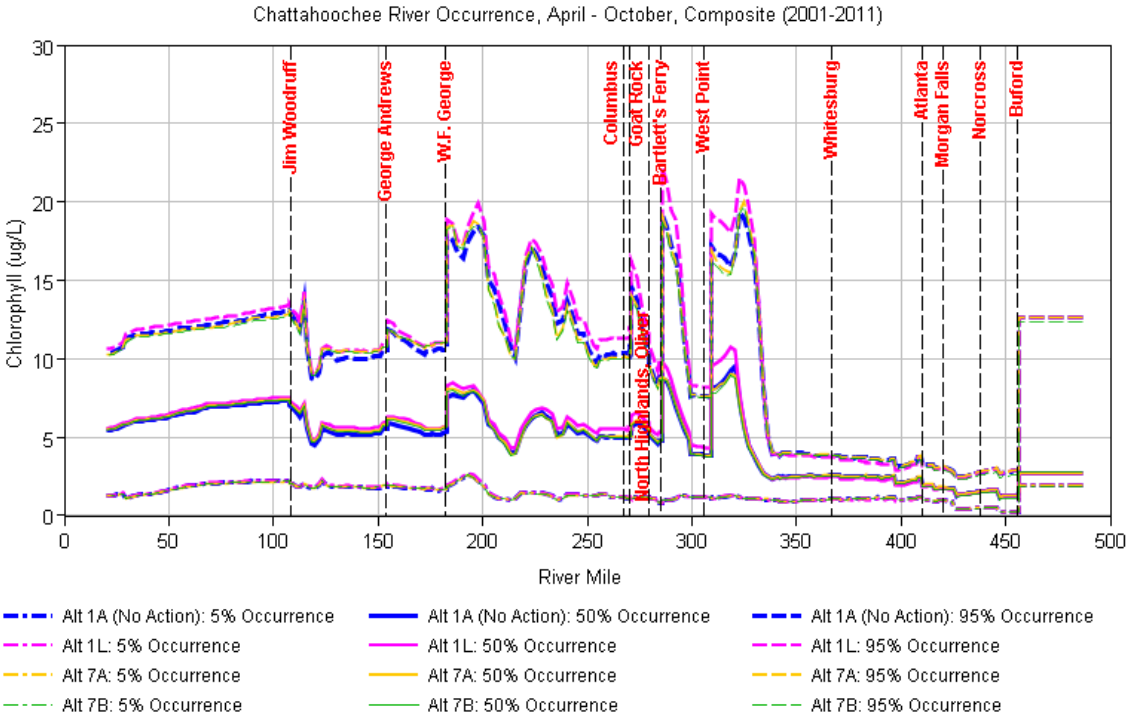


Figure 6.1-176. Longitudinal Profile Occurrence of Daily Chlorophyll *a* in the ACF Basin during the Growing Season (Apr-Oct) for the Period of 2001–2011 for the NAA and Alt1L, Alt7A, and Alt7B.

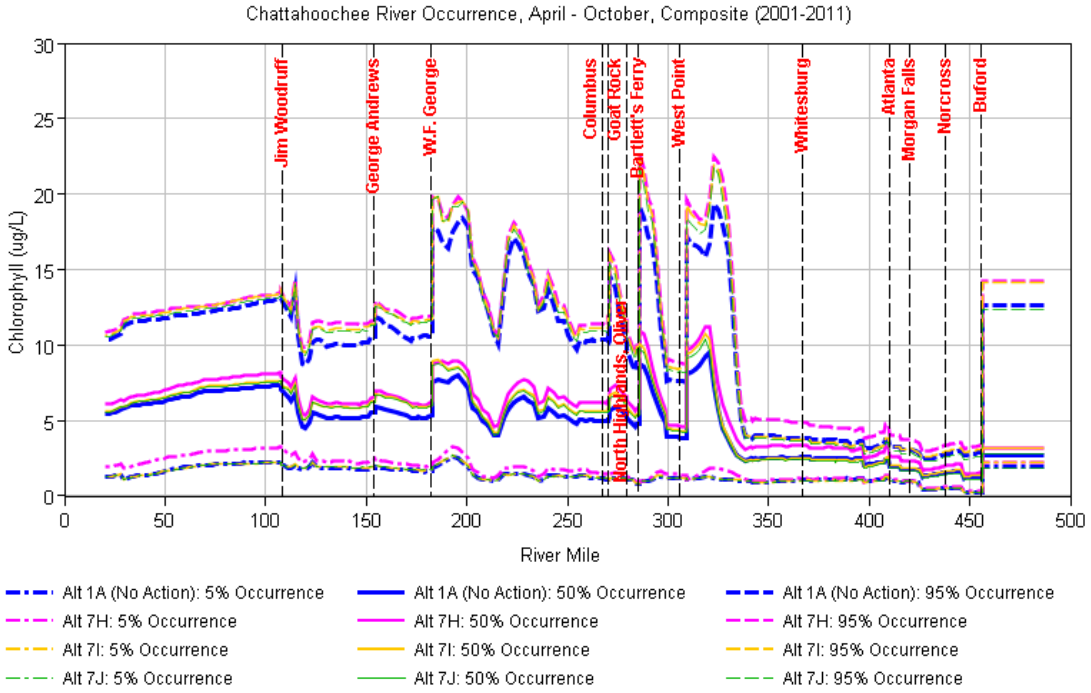


Figure 6.1-177. Longitudinal Profile Occurrence of Daily Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) for the Period of 2001–2011 for the NAA and Alt7H, Alt7I, and Alt7J.

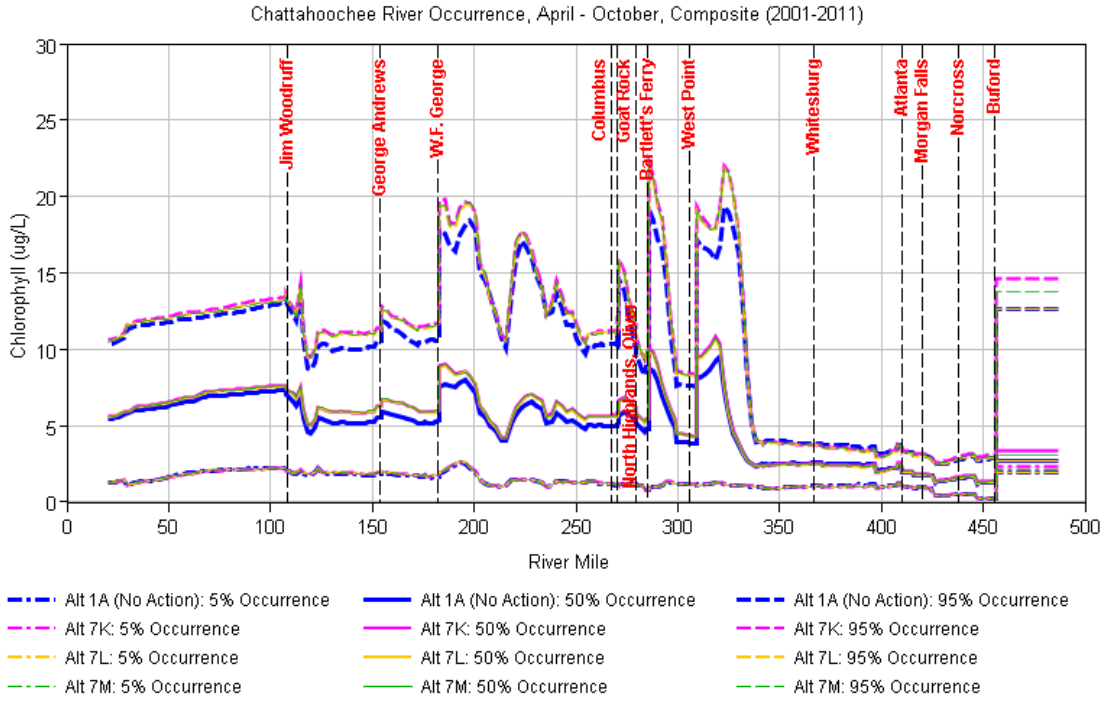


Figure 6.1-178. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) for the Period of 2001–2011 for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

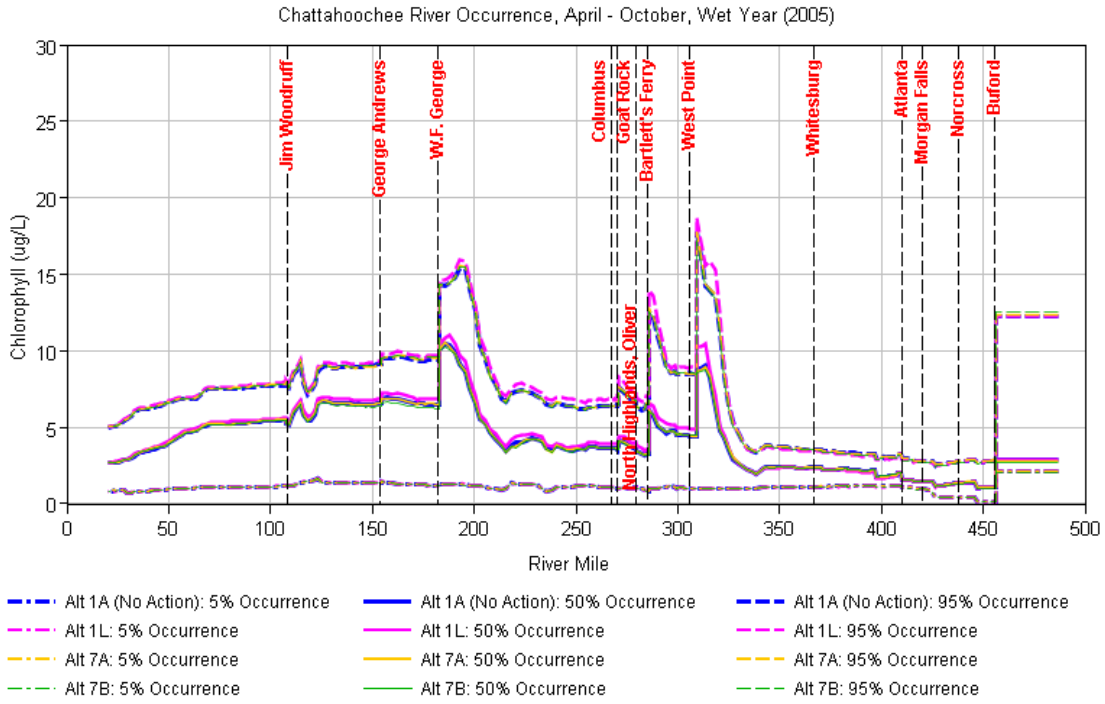


Figure 6.1-179. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) of a Wet Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

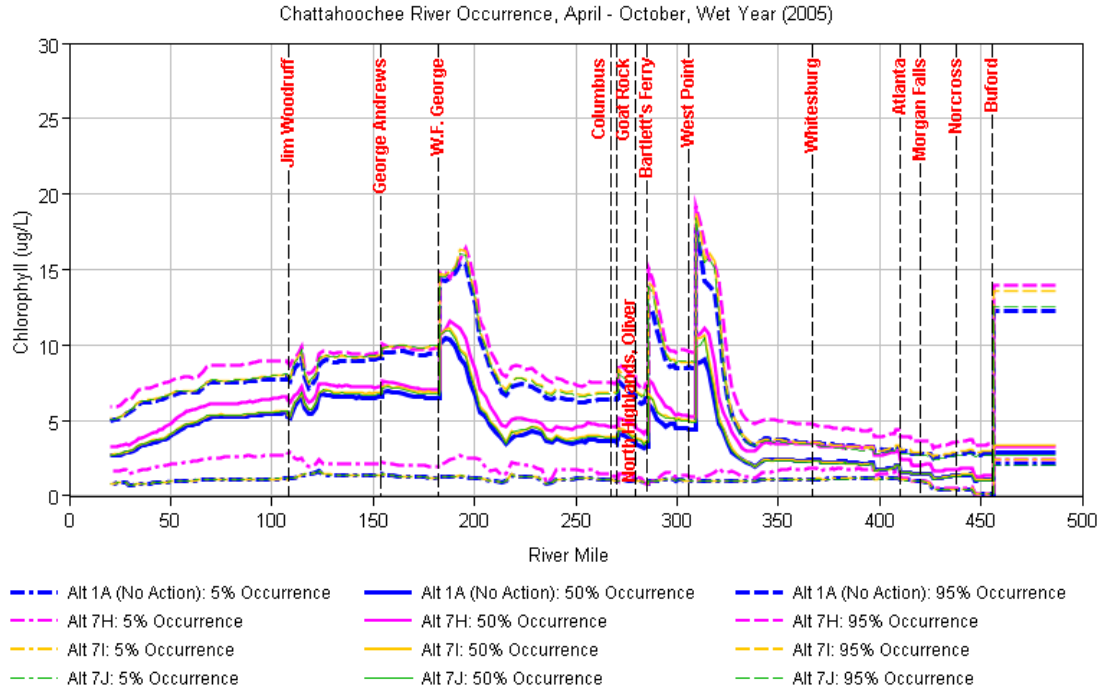


Figure 6.1-180. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) of a Wet Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

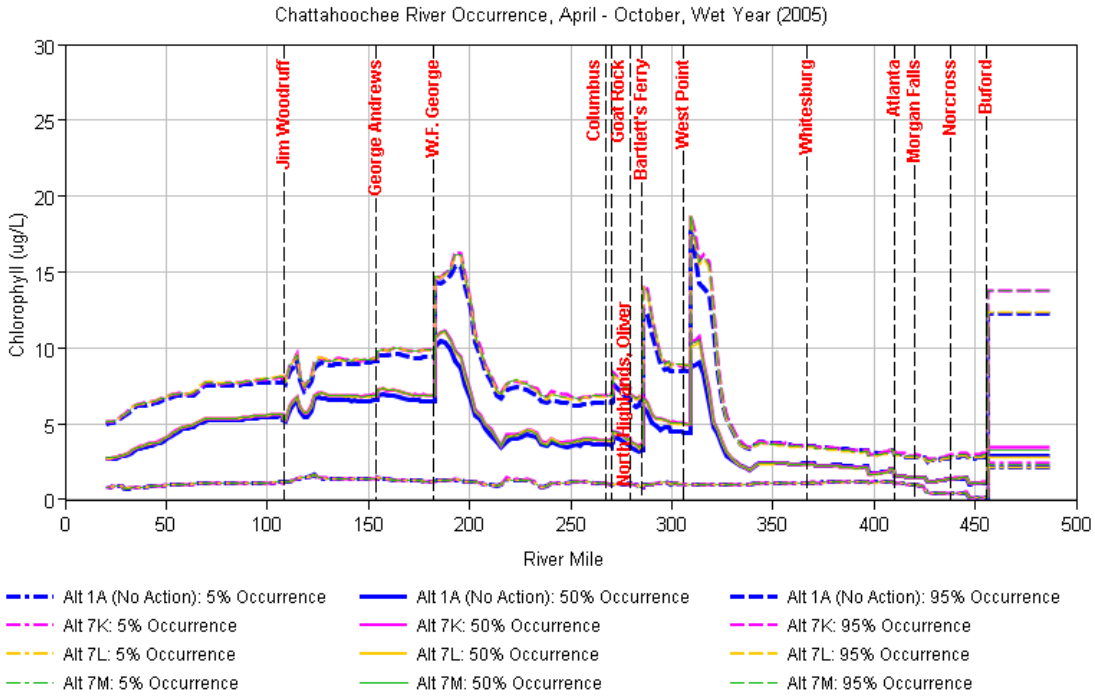


Figure 6.1-181. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) of a Wet Weather Year for the NAA and Alt7K (the PAA), Alt7L, and Alt7M.

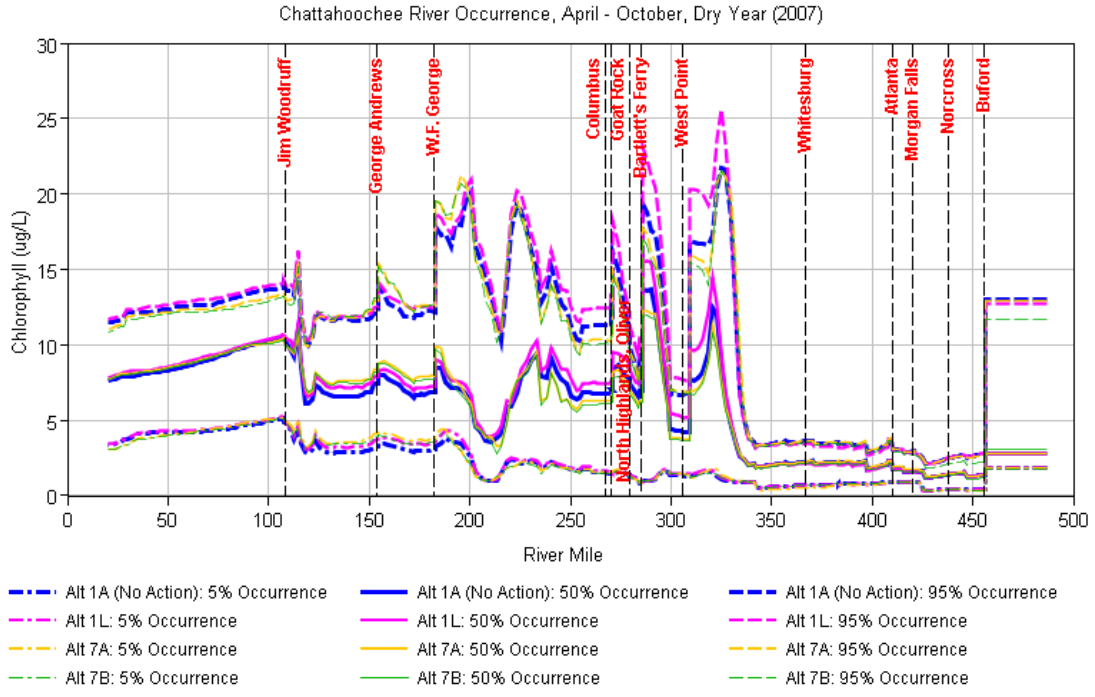


Figure 6.1-182. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt1L, Alt7A, and Alt7B.

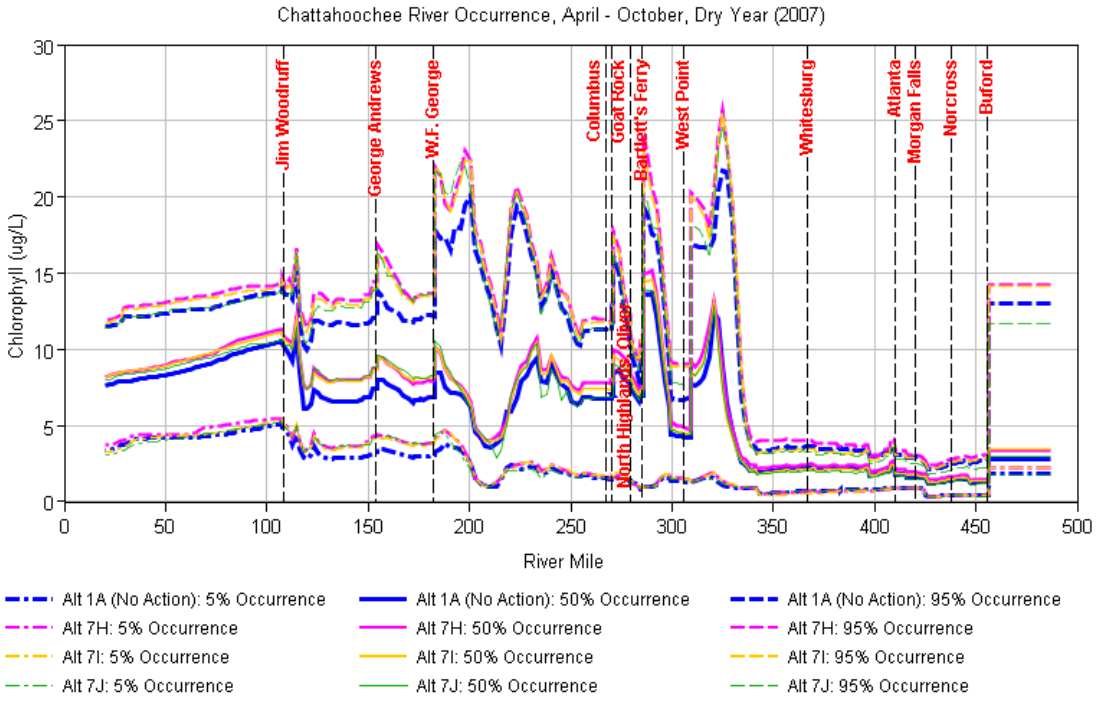


Figure 6.1-183. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for the NAA and Alt7H, Alt7I, and Alt7J.

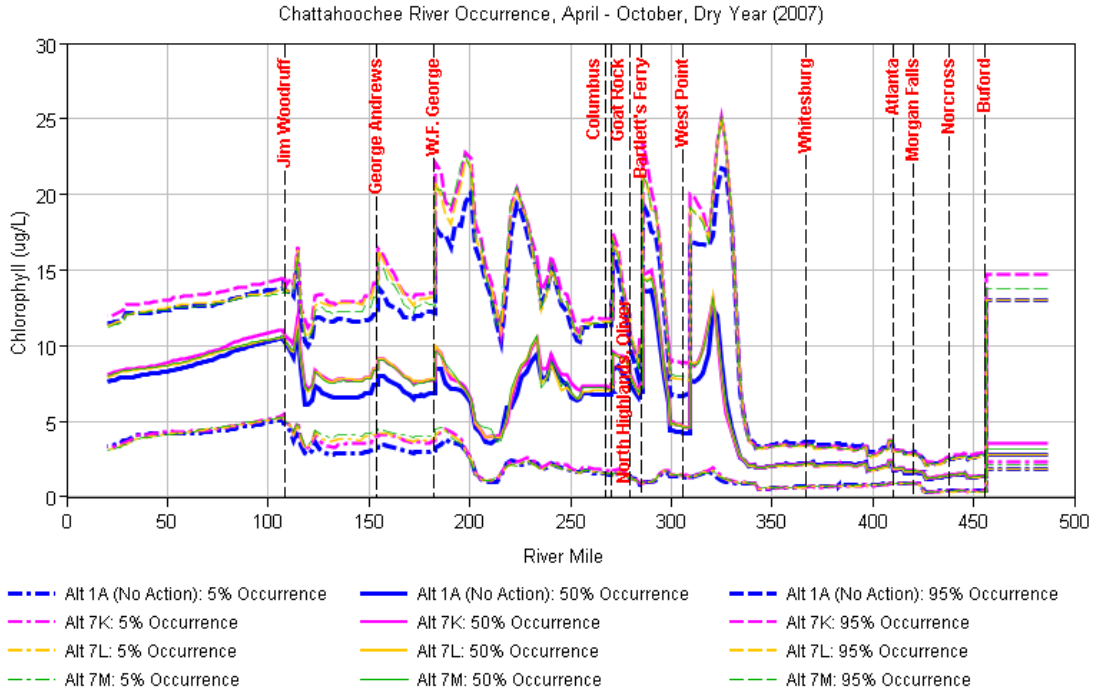


Figure 6.1-184. Longitudinal Profile Occurrence of Modeled Chlorophyll *a* in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for NAA and Alt7K (the PAA), Alt7L, and Alt7M.

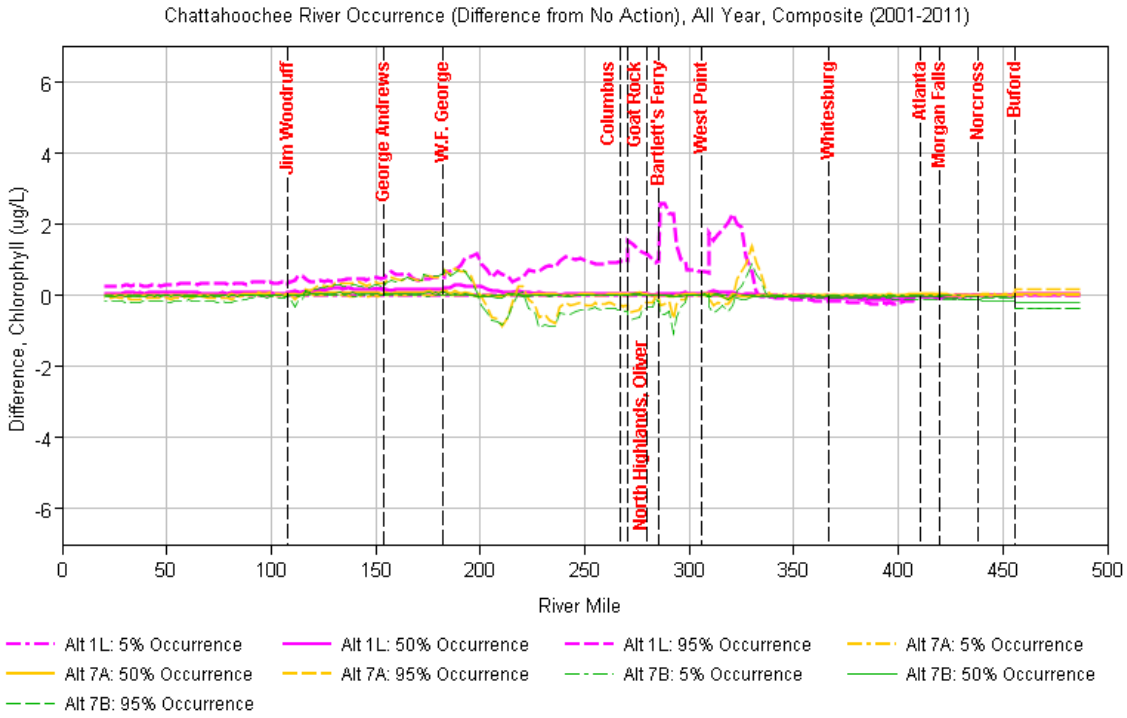


Figure 6.1-185. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

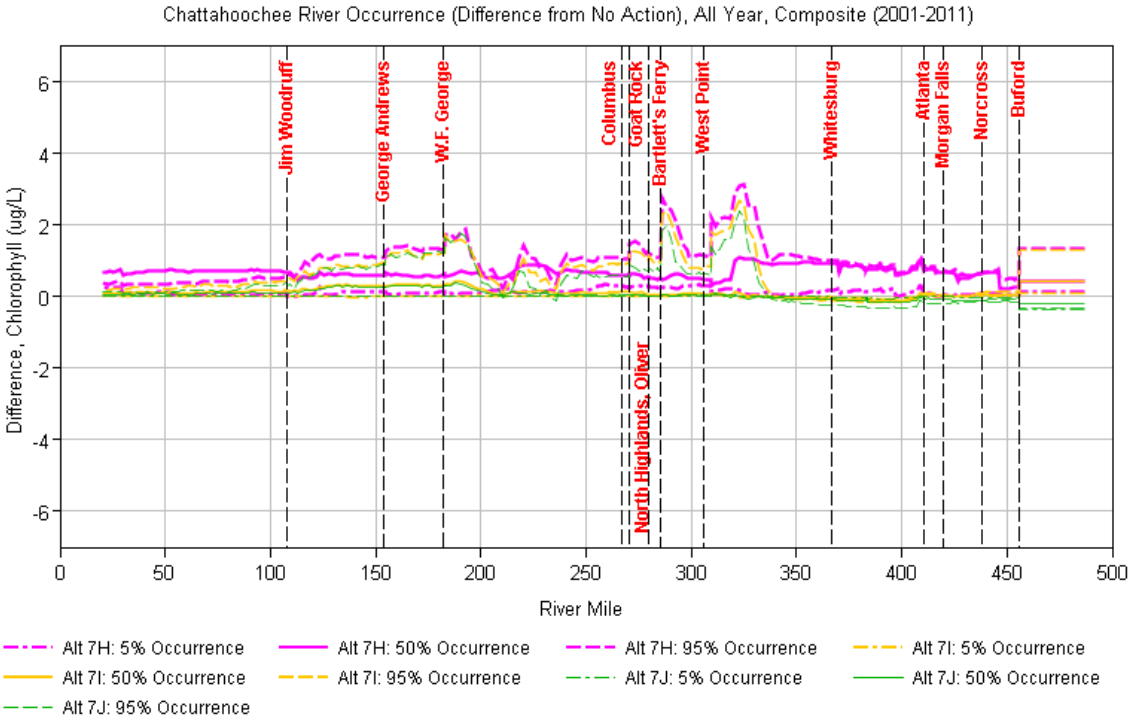


Figure 6.1-186. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

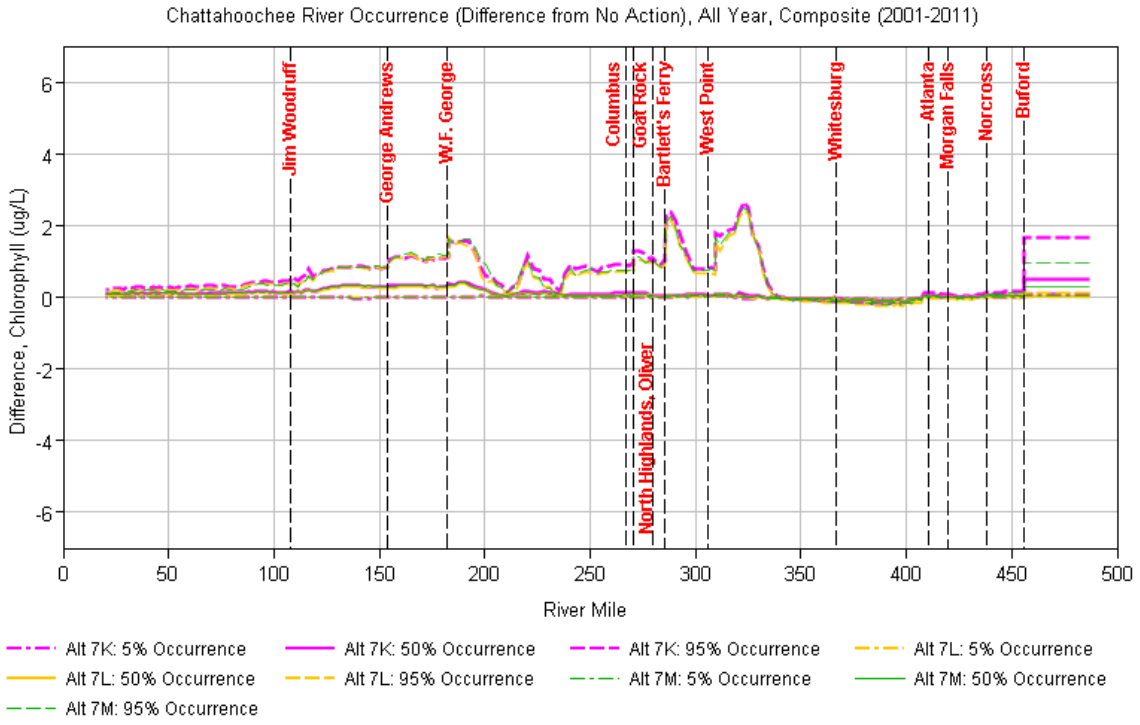


Figure 6.1-187. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

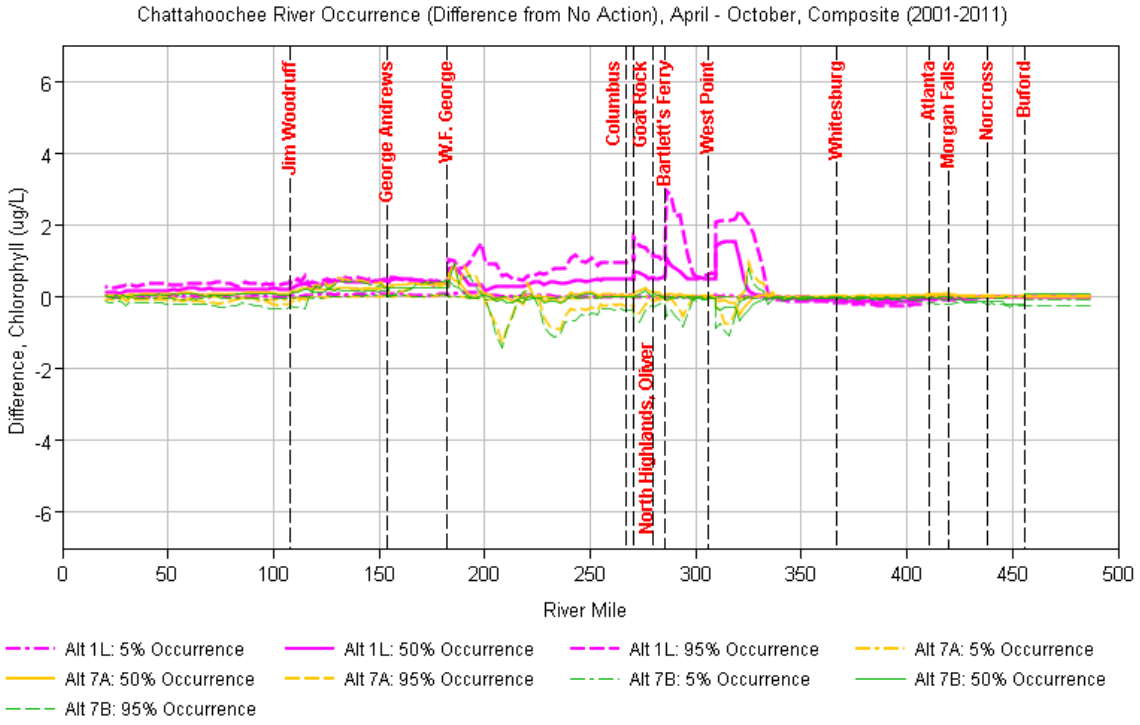


Figure 6.1-188. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) for the Period of 2001–2011 for Alt1L, Alt7A, and Alt7B.

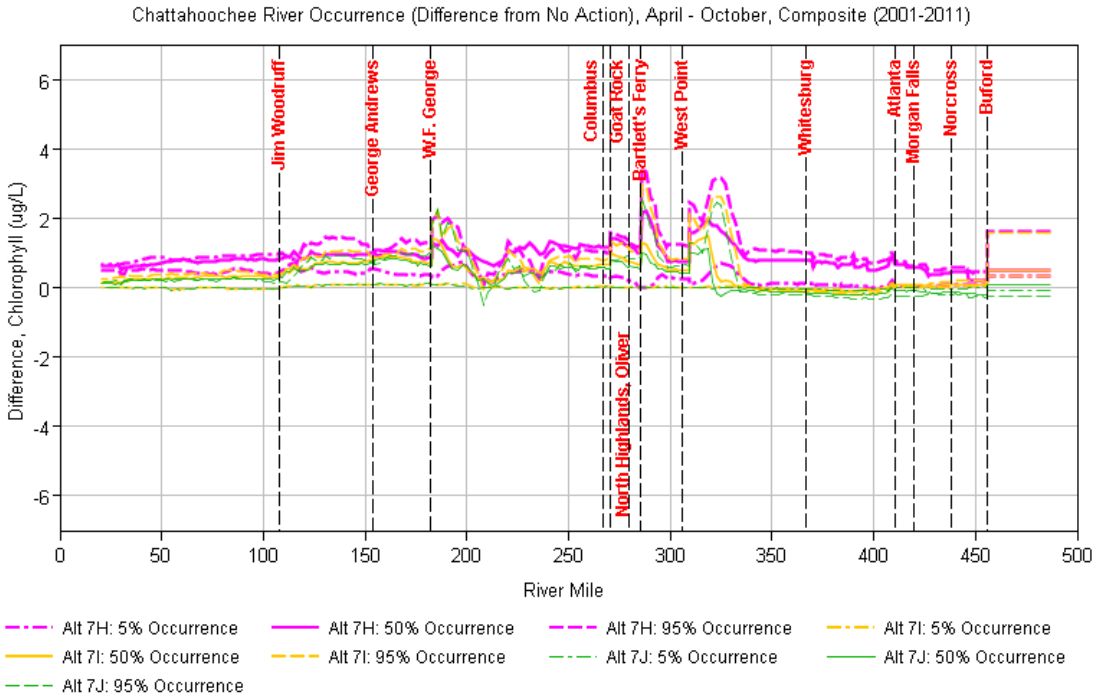


Figure 6.1-189. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) for the Period of 2001–2011 for Alt7H, Alt7I, and Alt7J.

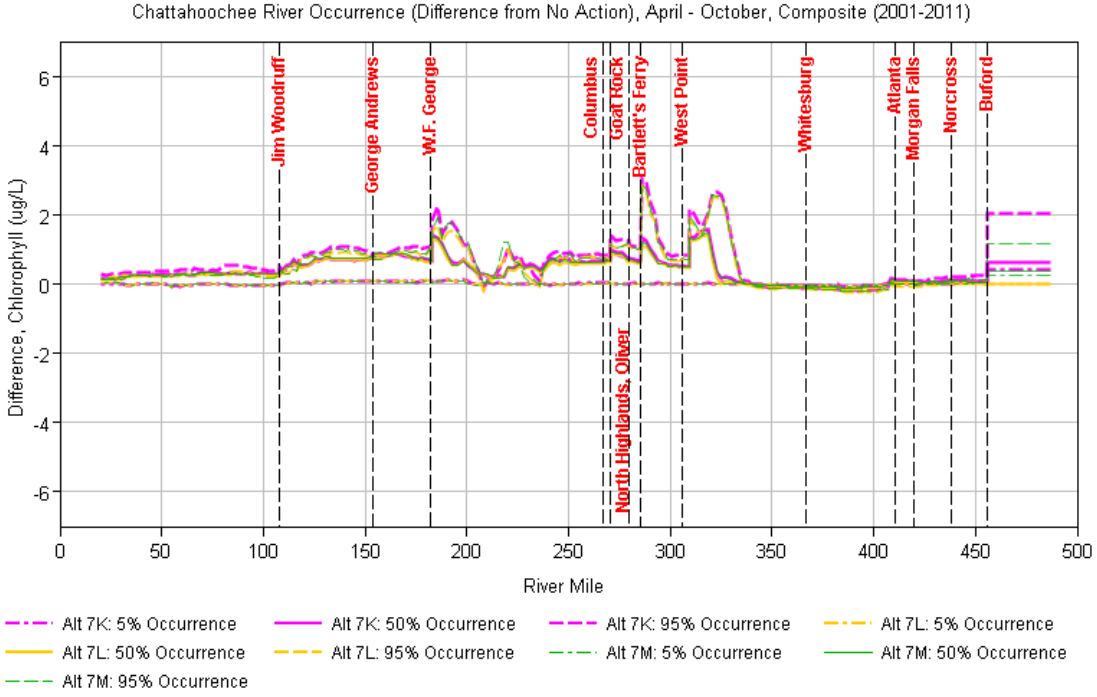


Figure 6.1-190. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) for the Period of 2001–2011 for Alt7K (the PAA), Alt7L, and Alt7M.

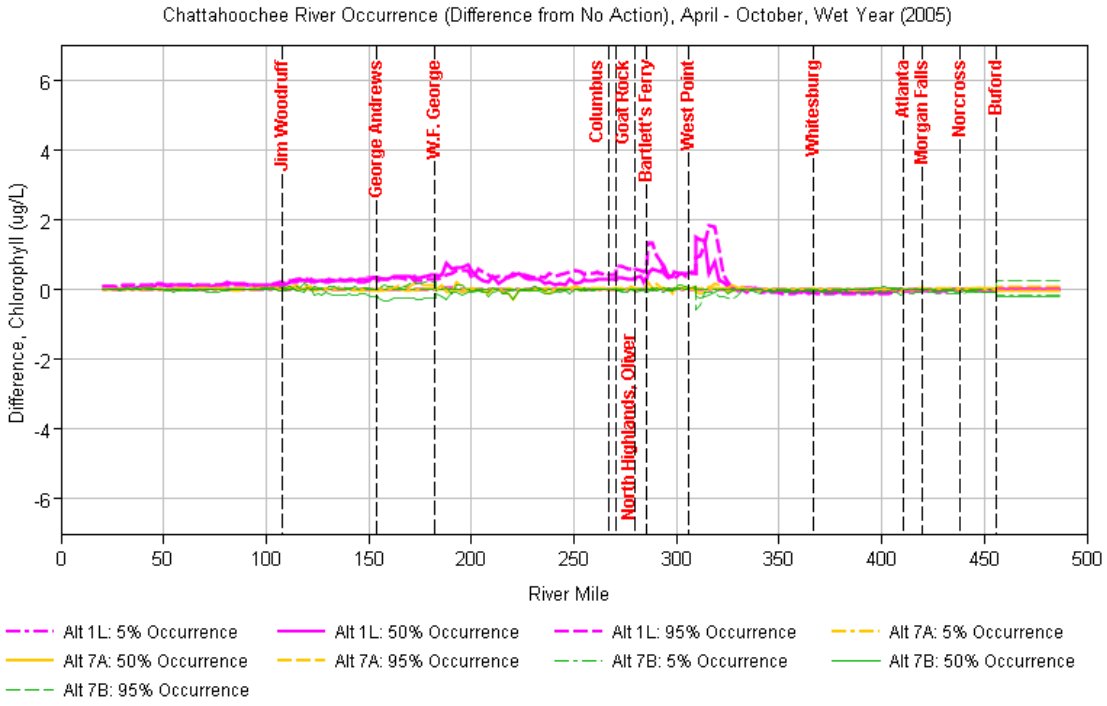


Figure 6.1-191. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Wet Weather Year for Alt1L, Alt7A, and Alt7B.

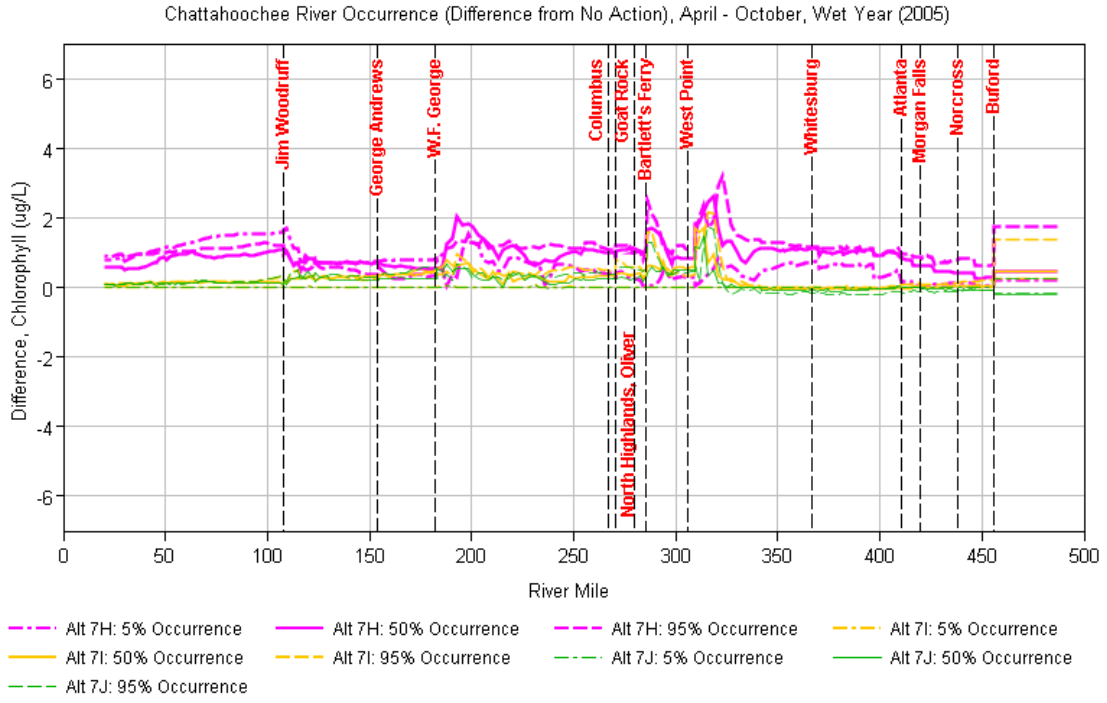


Figure 6.1-192. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Wet Weather Year for Alt7H, Alt7I, and Alt7J.

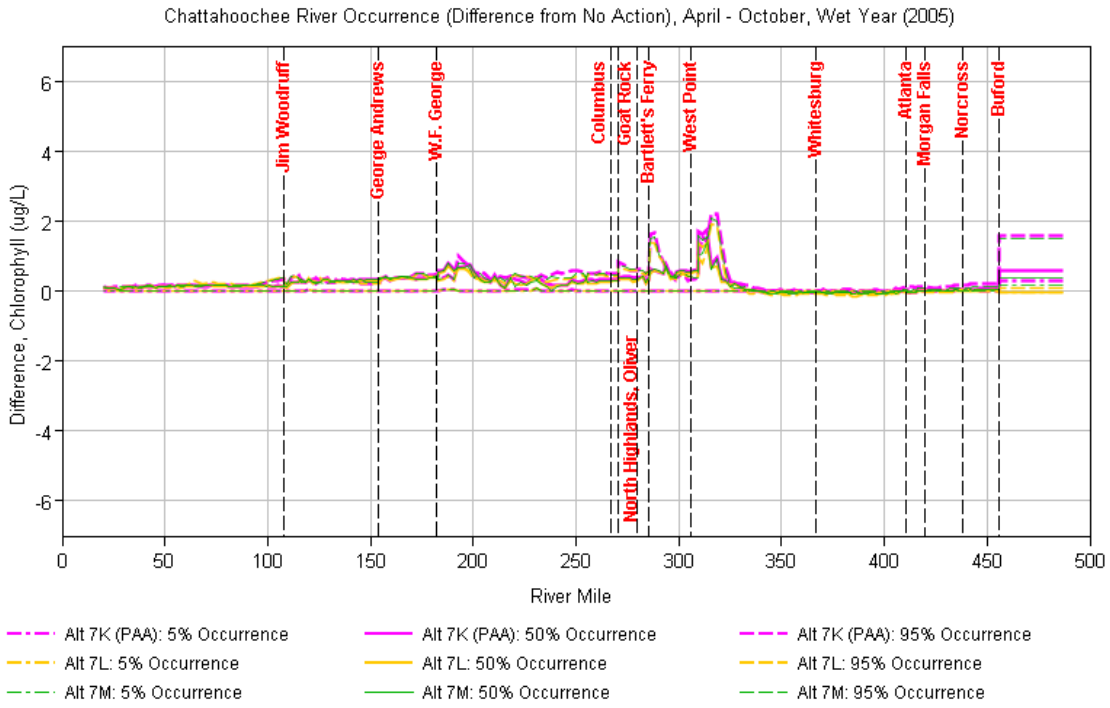


Figure 6.1-193. Longitudinal Profile of Differences in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Wet Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

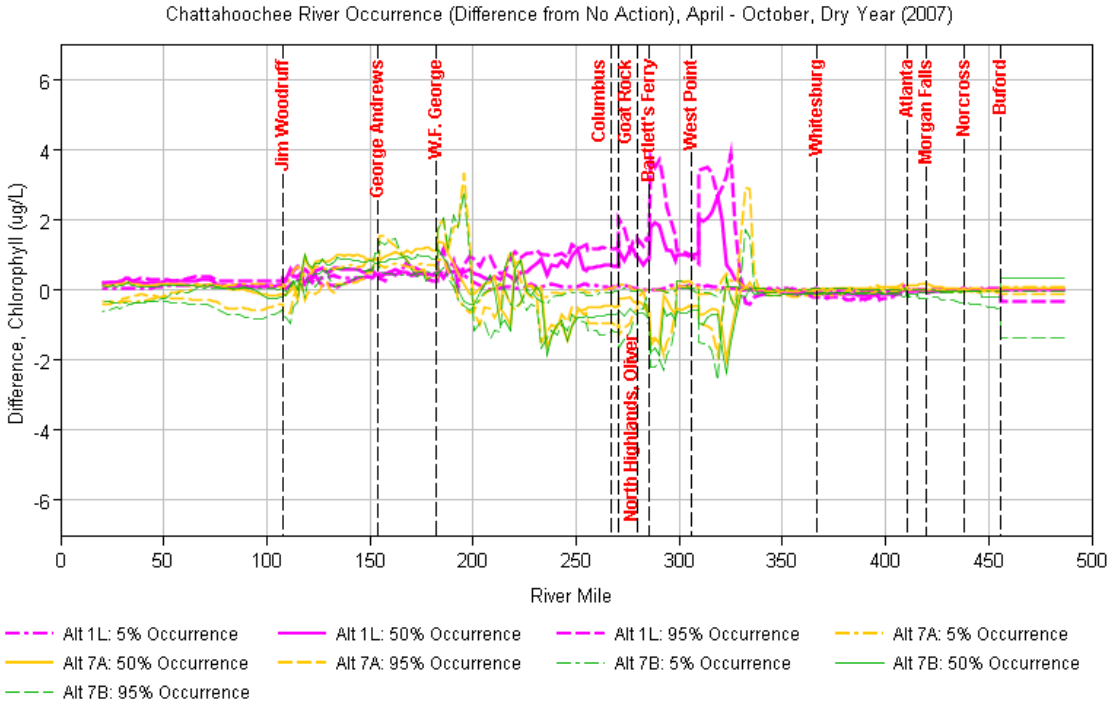


Figure 6.1-194. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt1L, Alt7A, and Alt7B.

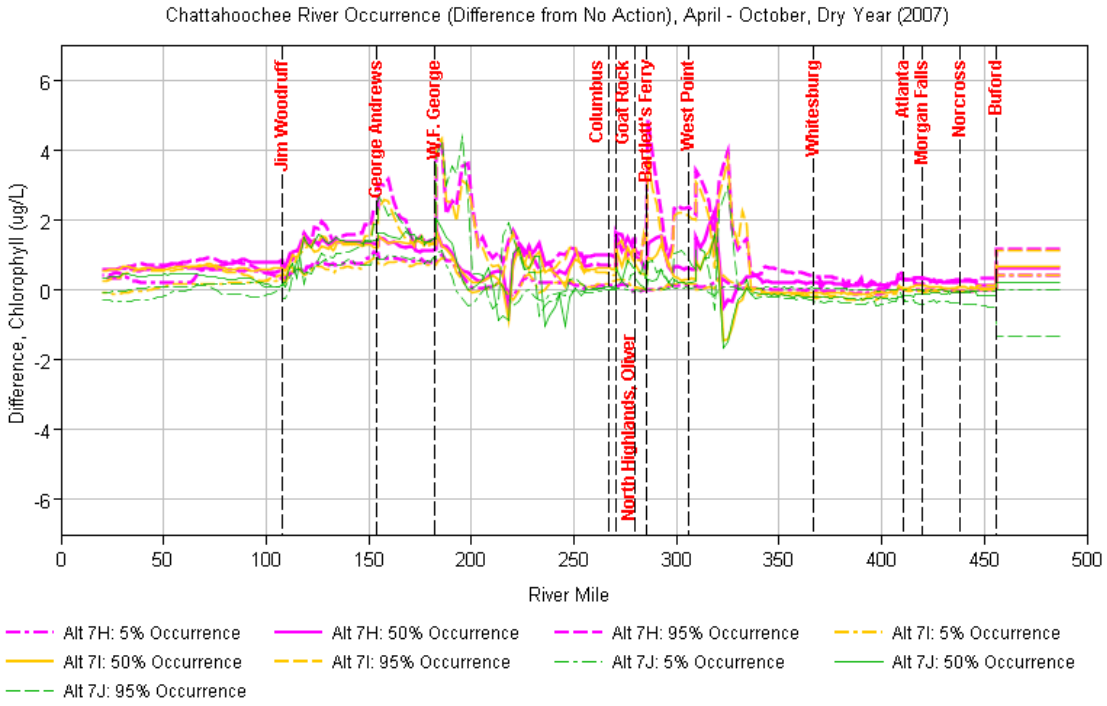


Figure 6.1-195. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7H, Alt7I, and Alt7J.

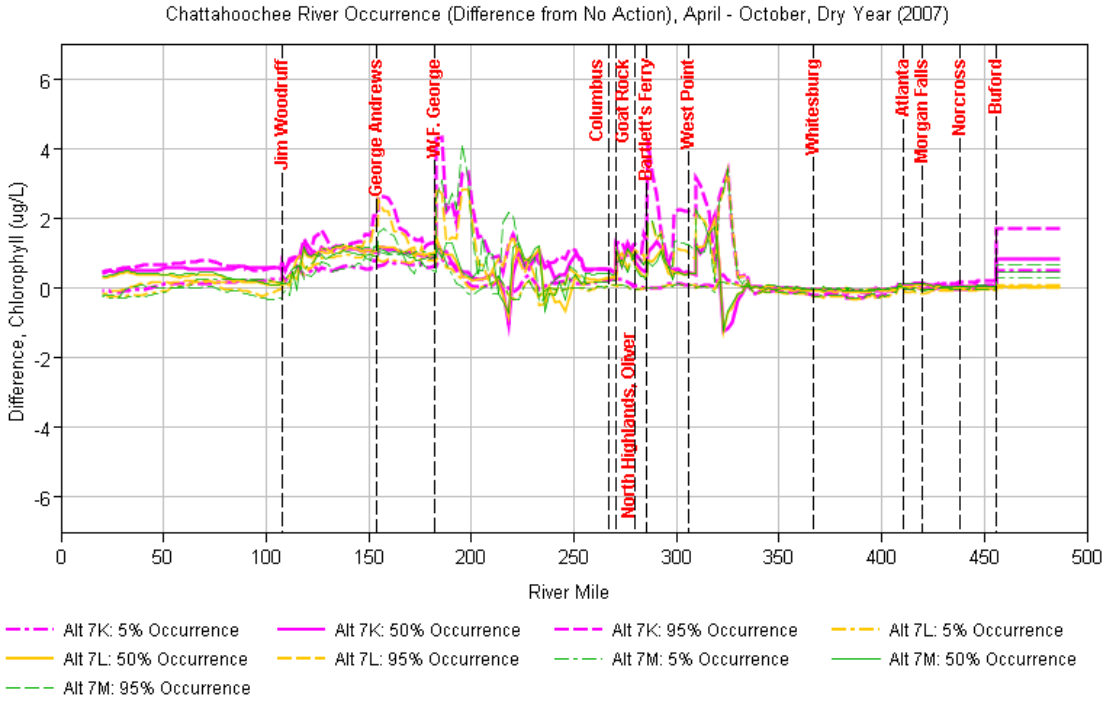


Figure 6.1-196. Longitudinal Profile of Difference in Modeled Chlorophyll *a* from the NAA in the ACF Basin during the Growing Season (Apr–Oct) of a Dry Weather Year for Alt7K (the PAA), Alt7L, and Alt7M.

Table 6.1-23 shows the summary of effects of alternatives from the NAA based on the specified criteria for which breakpoints were defined from best professional judgement and known site-specific standards. The results from the HEC-5Q model were used to illustrate changes in chlorophyll *a* for each alternative and identify areas where the potential for violations of chlorophyll *a* standards would be expected. These results are discussed in detail in the following sections.

Table 6.1-23.
Summary of the Effects on Median Chlorophyll *a* of the Alternatives from the NAA during the Modeled Period of 2001–2011

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Buford Dam to Atlanta	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Atlanta to West Point Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
West Point Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
West Point Dam to Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lock and Dam to Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Negligible/No change if the change in chlorophyll *a* was less than 0.5 µg/L.
Slightly adverse—Slightly adverse if chlorophyll *a* increased by 0.5–2.0 µg/L.

6.1.2.5.1 No Action Alternative

Water quality standards for chlorophyll *a* apply during the growing season (April–October) and are site-specific for Lake Lanier, West Point Lake, and Walter F. George Lake. The growing season average of chlorophyll *a* at Lake Lanier upstream from the Flowery Branch confluence should not exceed 6 µg/L, and at Browns Bridge Road, it should not exceed 7 µg/L (Table 2.1-29). At Boiling Bridge on the Chestatee River and at the Chattahoochee River, the growing season average of chlorophyll *a* should not exceed 10 µg/L (Table 2.1-29). According to Georgia water quality standards, the growing season average of chlorophyll *a* for West Point Lake should not exceed 24 µg/L at the LaGrange water intake (Table 2.1-29). For Walter F. George Lake, at mid-river at U.S. Highway 82, the growing season average should not exceed 18 µg/L, and at mid-river below the dam forebay, it should not exceed 15 µg/L (Table 2.1-29). For clear lakes in Florida, EPA has set the numeric criteria of 0.006 mg/L (6 µg/L). No standard has been set for freshwater streams in the State of Florida (Table 2.1-30). The finalized 303(d) lists of impaired waters identified Lake Lanier and Apalachicola Bay as being impaired for chlorophyll *a* (Table 2.1-31). Other water bodies in the ACF Basin meet water quality standards for chlorophyll *a*.

Figure 6.1-176 through Figure 6.1-178 present the longitudinal profile occurrence of phytoplankton as chlorophyll *a* in micrograms per cubic meter or µg/L of water for April–October for the modeled period of 2001–2011. That period is considered the growing season by water quality regulators in Alabama and Georgia. The figures illustrate the modeled water quality for the modeled period (Figure 6.1-176 through Figure 6.1-178) as well as representative wet and dry weather years (Figure 6.1-179 through Figure 6.1-181 and Figure 6.1-182 through Figure 6.1-184, respectively).

The greatest changes in chlorophyll *a* growth would be expected to occur in a representative dry weather year because retention times are longer during periods of decreased inflows. During years of more rainfall, pollutants are often flushed through the system by higher streamflows. That flushing process also is referred to as *dilution*. Reservoir retention times for the NAA and various alternatives are presented in Table 6.1-24.

In the reach from West Point Dam to Walter F. George Lake, median growing season concentrations upstream would be expected to peak in the forebays of Bartletts Ferry Dam and Walter F. George Lock and Dam, and at Jim Woodruff Lock and Dam (Figure 6.1-176). In other areas of the system from West Point Dam to Lake Seminole, median chlorophyll *a* would be around 5 µg/L over the modeled period (Figure 6.1-176). A greater range of chlorophyll *a* would be expected in representative wet and dry weather years (Figure 6.1-182), but median concentrations would be expected to remain below 10 µg/L (Figure 6.1-179).

Stakeholders in the basin are concerned about chlorophyll *a* in Walter F. George Lake, where concentrations would exceed 18 µg/L. Daily chlorophyll *a* in the 95th percent occurrence could be expected to reach 20 µg/L in representative dry weather years (Figure 6.1-182). The increased level of chlorophyll *a* would be expected to occur when reservoir retention times increase during periods of low inflows. Table 6.1-25 illustrates that, despite elevated daily concentrations, growing season averages would be expected to remain below water quality standards.

At Lake Seminole, the geometric mean could exceed 6 µg/L, rising to 6.1 µg/L during a representative dry weather year (Table 6.1-25). The growing season median chlorophyll *a* concentration would be in the range of 5–10 µg/L for the modeled period (Figure 6.1-176) and seasonally in representative wet and dry weather years (Figure 6.1-179 and Figure 6.1-182 respectively).

At the Apalachicola River, the median growing season concentrations would consistently decrease from downstream of Lake Seminole to less than 6 µg/L at RM 50 over the modeled period (Figure 6.1-176) and in a representative wet weather year (Figure 6.1-179). In a representative dry weather year, higher chlorophyll *a* concentrations released from Jim Woodruff Lock and Dam would result in concentrations closer to 8 µg/L at RM 50 (Figure 6.1-182).

Table 6.1-24.
Reservoir Retention Times in the ACF Basin

Month-Year	BARTLETTS FERRY-POOL NAA days	BARTLETTS FERRY-POOL Alt1A days	BARTLETTS FERRY-POOL Alt7A days	BARTLETTS FERRY-POOL Alt7B days	BARTLETTS FERRY-POOL Alt7H days	BARTLETTS FERRY-POOL Alt7I days	BARTLETTS FERRY-POOL Alt7J days	BARTLETTS FERRY-POOL Alt7K days	BARTLETTS FERRY-POOL Alt7L days	BARTLETTS FERRY-POOL Alt7M days
Dec-00	40.261	40.261	40.261	40.261	40.261	40.261	40.261	40.261	40.261	40.261
Jan-01	25.094	23.402	25.168	24.354	24.184	24.307	24.071	24.307	23.675	24.156
Feb-01	20.020	19.527	20.128	20.112	19.687	19.746	19.745	19.746	19.732	19.746
Mar-01	6.640	6.607	6.640	6.575	6.582	6.574	6.548	6.574	6.555	6.555
Apr-01	14.393	14.100	14.009	13.760	13.716	13.724	13.735	13.724	13.726	13.725
May-01	38.958	36.576	34.219	29.962	34.217	34.312	34.354	34.312	34.328	34.321
Jun-01	23.622	23.969	24.342	22.431	21.930	22.128	22.047	22.128	22.142	22.135
Jul-01	29.750	29.307	27.823	26.777	26.618	26.642	26.662	26.642	26.648	26.646
Aug-01	31.948	31.948	32.080	32.078	31.984	32.046	31.886	32.053	31.979	32.003
Sep-01	38.278	38.334	38.464	38.462	38.573	38.555	38.557	38.546	38.574	38.576
Oct-01	35.676	35.202	51.318	47.687	54.031	54.050	43.608	55.528	42.718	44.586
Nov-01	30.508	29.060	37.035	33.843	37.121	37.110	32.684	37.095	36.444	37.112
Dec-01	35.403	33.622	40.970	35.149	41.765	40.012	34.253	41.183	35.760	38.972
Jan-02	28.677	28.342	20.477	18.232	20.406	20.668	18.087	20.457	20.279	20.515
Feb-02	23.348	22.920	30.821	31.360	29.351	29.613	24.542	29.668	29.947	29.396
Mar-02	24.797	24.250	22.885	22.557	22.317	22.318	24.600	22.318	22.318	22.318
Apr-02	30.789	30.114	29.344	29.219	29.623	29.574	28.959	29.680	29.086	29.218
May-02	36.782	35.011	31.789	30.299	30.829	31.286	30.230	31.337	31.243	31.240
Jun-02	53.965	54.068	53.962	53.998	54.015	54.030	54.028	54.019	54.032	54.032
Jul-02	45.185	45.369	45.208	45.299	45.357	45.345	45.366	45.333	45.348	45.349
Aug-02	52.050	52.536	52.090	52.295	52.565	52.495	52.542	52.475	52.501	52.502
Sep-02	44.514	40.548	44.549	44.764	45.148	45.048	45.100	45.030	45.054	45.054
Oct-02	23.460	22.587	26.826	25.649	24.613	25.170	24.327	25.212	25.164	25.156
Nov-02	14.538	14.393	14.909	14.284	14.325	14.415	13.776	14.442	14.142	14.247
Dec-02	10.344	10.337	10.206	9.997	10.622	10.583	10.020	10.600	10.168	10.214
Jan-03	19.544	19.594	17.661	16.209	18.199	18.173	16.208	18.178	17.742	18.089
Feb-03	11.691	11.618	11.010	10.250	11.559	11.495	10.115	11.536	11.221	11.430
Mar-03	7.694	7.891	7.238	7.171	7.341	7.324	7.132	7.332	7.203	7.281
Apr-03	10.375	10.320	10.364	10.277	10.407	10.406	10.187	10.413	10.319	10.359
May-03	5.088	5.076	5.091	5.035	5.092	5.098	5.032	5.100	5.077	5.086

	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL
	NAA	Alt1A	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K	Alt7L	Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Jun-03	6.033	6.019	6.033	5.970	6.049	6.052	5.956	6.056	6.018	6.034
Jul-03	8.586	8.558	8.586	8.463	8.620	8.625	8.436	8.631	8.558	8.588
Aug-03	15.851	15.763	15.838	15.527	15.903	15.927	15.435	15.943	15.750	15.829
Sep-03	26.517	26.205	26.586	26.225	26.040	26.230	25.919	26.230	26.230	26.230
Oct-03	30.802	30.157	30.693	29.640	29.992	30.120	29.228	30.119	30.130	30.125
Nov-03	12.067	12.018	12.079	11.721	12.396	12.360	11.648	12.391	12.026	12.174
Dec-03	14.830	14.699	14.829	14.632	14.792	14.800	14.505	14.809	14.698	14.744
Jan-04	17.023	16.819	13.114	12.858	12.871	12.884	12.750	12.889	12.826	12.847
Feb-04	9.737	9.662	10.969	10.950	10.889	10.887	10.871	10.887	10.888	10.888
Mar-04	18.630	18.445	17.565	17.261	17.770	17.817	17.130	17.814	17.548	17.674
Apr-04	21.688	21.612	16.943	16.401	17.217	17.220	15.932	17.196	16.893	17.249
May-04	23.416	22.990	33.746	33.852	33.461	33.659	33.300	33.916	33.294	33.285
Jun-04	27.798	27.490	27.953	27.953	27.728	27.921	27.879	27.800	27.783	27.842
Jul-04	21.758	21.773	23.567	23.566	23.493	23.526	23.520	23.514	23.520	23.516
Aug-04	23.186	22.585	23.184	23.376	22.470	22.613	22.648	22.606	22.601	22.615
Sep-04	11.829	11.788	11.821	11.398	11.755	11.753	11.500	11.752	11.713	11.733
Oct-04	21.940	21.727	23.205	21.623	23.746	23.808	21.413	23.804	23.074	23.652
Nov-04	8.831	8.787	9.089	8.684	9.337	9.326	8.643	9.325	9.059	9.116
Dec-04	9.380	9.325	9.379	9.284	9.450	9.434	9.231	9.507	9.324	9.347
Jan-05	16.319	16.120	16.102	15.892	15.951	15.994	15.778	15.998	15.946	15.968
Feb-05	9.385	9.321	9.467	9.336	9.476	9.483	9.244	9.492	9.388	9.430
Mar-05	6.380	6.349	6.380	6.331	6.371	6.375	6.300	6.378	6.349	6.361
Apr-05	8.333	8.298	8.333	8.268	8.324	8.333	8.233	8.336	8.298	8.314
May-05	16.281	16.211	16.885	16.621	17.007	17.037	16.531	17.053	16.800	16.874
Jun-05	14.854	14.736	14.394	13.908	14.466	14.491	13.818	14.513	14.291	14.404
Jul-05	5.718	5.704	5.715	5.647	5.733	5.735	5.633	5.738	5.700	5.716
Aug-05	10.981	10.932	10.981	10.802	11.027	11.035	10.755	11.045	10.932	10.978
Sep-05	26.151	26.078	26.488	26.104	26.508	26.547	26.040	26.563	26.391	26.465
Oct-05	32.595	32.111	32.534	32.046	31.848	32.029	31.600	32.066	31.917	31.973
Nov-05	19.590	19.155	19.621	19.633	19.137	19.218	19.239	19.217	19.226	19.222
Dec-05	16.551	16.453	16.343	15.373	16.432	16.432	15.259	16.443	16.219	16.302
Jan-06	12.565	12.443	12.610	12.414	12.880	12.858	12.291	12.890	12.512	12.670
Feb-06	11.436	11.349	11.436	11.288	11.420	11.429	11.204	11.436	11.349	11.385

	BARTLETTS FERRY-POOL NAA	BARTLETTS FERRY-POOL Alt1A	BARTLETTS FERRY-POOL Alt7A	BARTLETTS FERRY-POOL Alt7B	BARTLETTS FERRY-POOL Alt7H	BARTLETTS FERRY-POOL Alt7I	BARTLETTS FERRY-POOL Alt7J	BARTLETTS FERRY-POOL Alt7K	BARTLETTS FERRY-POOL Alt7L	BARTLETTS FERRY-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Mar-06	13.293	13.162	13.219	13.020	13.210	13.239	12.902	13.249	13.090	13.137
Apr-06	21.877	21.079	19.105	18.765	19.201	19.235	18.659	19.219	18.961	19.102
May-06	24.364	24.859	19.408	18.999	19.349	19.383	18.930	19.418	19.298	19.377
Jun-06	36.408	35.873	38.121	38.339	37.292	37.503	37.772	37.515	37.426	37.513
Jul-06	37.125	36.703	54.798	54.576	53.503	53.893	53.374	54.015	53.600	53.585
Aug-06	49.794	49.883	49.562	49.696	49.829	49.752	49.896	49.743	49.799	49.782
Sep-06	36.545	35.562	50.199	50.355	49.480	50.450	48.402	50.441	50.291	50.478
Oct-06	32.192	30.750	44.148	43.347	40.734	42.277	39.659	42.444	40.684	41.311
Nov-06	23.937	23.986	23.746	23.060	22.124	22.224	22.130	22.223	22.181	22.206
Dec-06	24.930	23.776	24.363	24.067	25.604	25.674	23.843	25.674	23.851	25.674
Jan-07	13.559	13.419	13.574	13.049	13.990	13.993	12.931	13.993	13.433	13.994
Feb-07	19.135	18.984	19.539	18.443	20.474	20.533	18.826	20.532	19.271	19.529
Mar-07	19.790	19.442	17.516	16.562	19.743	19.543	16.498	19.834	17.881	17.247
Apr-07	34.869	34.224	22.235	21.200	21.586	21.614	20.868	21.483	22.586	21.930
May-07	33.581	33.284	36.844	34.867	30.923	30.692	34.802	30.760	36.794	34.866
Jun-07	50.395	49.082	50.432	50.291	49.279	50.774	49.055	49.434	49.161	49.352
Jul-07	53.709	53.777	56.797	56.228	53.258	54.311	53.678	53.859	53.669	53.900
Aug-07	53.374	52.867	53.147	53.589	50.977	52.701	51.204	51.680	51.585	51.714
Sep-07	52.680	51.986	45.519	45.067	50.022	48.197	49.999	50.026	50.166	49.866
Oct-07	41.722	44.014	60.076	44.591	46.225	56.534	42.125	54.779	46.249	46.138
Nov-07	52.126	50.180	57.773	43.371	53.237	53.869	52.023	53.851	54.517	54.731
Dec-07	47.545	45.505	49.264	49.264	46.619	47.080	47.081	47.080	47.080	47.080
Jan-08	26.353	25.215	28.232	28.232	28.317	28.309	28.308	28.309	28.309	28.309
Feb-08	21.833	21.673	22.500	22.500	21.108	21.285	21.285	21.285	21.285	21.285
Mar-08	21.520	21.110	20.918	20.918	20.519	20.563	20.563	20.563	20.563	20.563
Apr-08	27.087	26.613	27.177	27.179	26.927	26.994	26.995	26.994	26.994	26.994
May-08	39.871	37.042	36.372	36.370	33.433	34.172	34.171	34.172	34.172	34.172
Jun-08	49.055	49.138	48.920	48.920	49.018	48.994	48.994	48.994	48.994	48.994
Jul-08	46.295	46.477	46.141	46.141	46.390	46.333	46.333	46.333	46.333	46.333
Aug-08	34.472	34.635	34.380	34.380	34.602	34.552	34.552	34.552	34.552	34.552
Sep-08	44.809	38.100	44.637	44.637	45.158	45.046	45.046	45.046	45.046	45.046
Oct-08	39.163	34.991	44.531	44.531	42.491	45.240	45.238	45.240	45.240	45.240
Nov-08	48.759	46.232	48.856	48.856	50.296	50.179	50.179	50.179	50.179	50.179

	BARTLETTS FERRY-POOL NAA	BARTLETTS FERRY-POOL Alt1A	BARTLETTS FERRY-POOL Alt7A	BARTLETTS FERRY-POOL Alt7B	BARTLETTS FERRY-POOL Alt7H	BARTLETTS FERRY-POOL Alt7I	BARTLETTS FERRY-POOL Alt7J	BARTLETTS FERRY-POOL Alt7K	BARTLETTS FERRY-POOL Alt7L	BARTLETTS FERRY-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Dec-08	25.530	25.138	30.191	30.191	22.494	23.066	23.066	23.066	23.066	23.066
Jan-09	20.761	20.916	23.250	22.208	22.341	22.649	21.791	22.649	22.649	22.649
Feb-09	28.206	27.663	29.383	28.573	27.944	27.970	27.786	27.970	27.970	27.970
Mar-09	9.184	9.090	9.006	8.887	8.933	8.932	8.863	8.932	8.932	8.932
Apr-09	12.785	12.937	12.625	11.909	12.843	12.858	11.948	12.858	12.816	12.857
May-09	22.663	22.854	23.784	21.131	25.239	25.491	20.825	25.491	24.296	25.045
Jun-09	30.075	30.095	29.975	29.824	29.979	30.050	29.588	30.420	30.061	30.059
Jul-09	45.312	42.770	40.305	35.579	52.110	48.626	35.801	52.230	43.239	43.228
Aug-09	42.789	41.762	47.392	46.357	49.562	49.556	45.185	50.735	45.890	49.637
Sep-09	9.294	9.272	9.124	9.100	9.635	9.646	9.049	9.626	9.101	9.508
Oct-09	9.966	9.908	9.640	8.646	10.058	9.982	8.755	9.985	9.916	9.916
Nov-09	5.944	6.089	5.760	5.719	6.347	6.095	5.703	6.127	5.870	6.001
Dec-09	4.627	4.613	4.627	4.603	4.624	4.626	4.589	4.627	4.613	4.619
Jan-10	7.329	7.287	7.329	7.272	7.310	7.318	7.230	7.321	7.287	7.301
Feb-10	6.788	6.757	6.788	6.735	6.779	6.785	6.705	6.787	6.757	6.769
Mar-10	7.128	7.089	7.128	7.067	7.115	7.122	7.029	7.125	7.089	7.104
Apr-10	16.660	16.526	16.661	16.412	16.696	16.723	16.302	16.737	16.618	16.602
May-10	12.192	12.156	12.392	12.130	12.488	12.501	12.096	12.513	12.338	12.443
Jun-10	27.249	26.959	27.509	27.414	27.050	27.167	26.990	27.173	27.091	27.130
Jul-10	33.752	33.317	34.706	34.570	34.183	34.466	34.259	34.465	34.477	34.472
Aug-10	36.434	36.514	36.519	36.572	36.637	36.614	36.620	36.614	36.612	36.613
Sep-10	35.322	35.462	36.074	35.565	35.557	35.525	35.600	35.518	35.550	35.541
Oct-10	34.916	35.170	40.217	35.447	41.033	41.882	35.512	41.869	38.720	40.246
Nov-10	29.304	29.571	29.756	29.963	29.803	29.817	30.103	29.800	29.824	29.836
Dec-10	24.914	22.913	23.512	22.044	24.138	24.040	20.754	24.230	22.515	22.998
Jan-11	25.748	25.522	16.447	15.818	17.032	17.019	15.706	17.033	16.446	17.002
Feb-11	16.403	16.111	24.577	24.464	24.104	24.085	24.075	24.105	24.176	24.058
Mar-11	12.402	12.299	12.710	12.077	12.593	12.599	11.894	12.638	12.529	12.442
Apr-11	13.581	13.427	12.128	12.110	12.158	12.150	11.972	12.154	11.923	12.150
May-11	24.183	23.292	17.066	16.874	16.871	16.869	16.019	16.866	16.773	16.948
Jun-11	46.569	45.948	45.794	43.703	45.993	46.368	45.130	46.365	46.304	45.496
Jul-11	48.624	46.905	51.622	52.326	51.044	51.110	52.187	51.100	51.200	51.817
Aug-11	47.970	47.316	60.091	54.293	52.560	52.445	52.509	52.441	52.459	52.509

	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL	BARTLETTS FERRY-POOL
	NAA	Alt1A	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K	Alt7L	Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Sep-11	34.998	34.682	44.228	43.430	41.147	43.217	42.632	43.261	43.050	42.806
Oct-11	48.838	47.913	40.736	45.863	49.765	46.707	46.063	46.670	46.712	47.085
Nov-11	36.094	35.353	36.162	33.789	33.650	35.789	34.575	35.967	35.993	35.212
Dec-11	27.865	27.996	35.030	33.224	33.167	34.186	33.208	34.304	34.151	33.618
Overall Median	24.364	23.776	23.784	23.376	23.746	23.808	23.066	23.804	23.074	23.516
May-October Median	34.112	33.976	34.543	34.475	33.822	34.242	34.306	34.242	34.403	34.396
May-October Average	32.277	31.707	33.745	32.897	33.389	33.672	32.597	33.740	33.127	33.262
April-October Median	31.948	30.750	31.789	29.962	30.829	30.692	30.230	30.760	31.243	31.240
April-October Average	30.425	29.895	31.378	30.607	31.070	31.314	30.327	31.372	30.839	30.958
	BUFORD-POOL	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**	**BUFORD-POOL**
	NAA	**Alt1A**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**Alt7K**	**Alt7L**	**Alt7M**
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Dec-00	898.7	828.1	1078.4	1127.4	991.3	1021.2	1024.2	1021.2	1031.9	1027.2
Jan-01	1001.3	954.6	1295.5	1144.4	1238.1	1253.9	1195.4	1253.7	1092.0	1217.8
Feb-01	1182.2	1133.1	1307.7	1367.8	1289.1	1308.1	1324.3	1307.6	1321.1	1317.0
Mar-01	1366.5	1363.0	1437.4	1176.2	1289.7	1267.9	1194.8	1267.2	1209.8	1204.9
Apr-01	1219.3	1139.2	1018.2	946.7	955.2	962.2	976.0	961.4	975.6	970.2
May-01	1107.2	1016.7	1021.0	652.5	902.3	912.2	935.0	911.3	927.5	921.1
Jun-01	1270.3	1172.4	959.8	745.4	709.3	715.3	747.1	714.4	729.9	723.7
Jul-01	884.2	942.6	710.0	732.4	701.9	700.3	737.0	699.3	715.8	709.1
Aug-01	663.9	651.2	677.5	701.7	657.7	662.8	702.0	661.7	678.4	671.5
Sep-01	668.9	652.4	683.0	708.9	800.8	756.4	704.3	805.1	679.9	672.6
Oct-01	608.1	594.3	758.9	647.7	820.7	844.4	644.4	844.5	620.1	689.9
Nov-01	586.8	573.0	973.6	642.3	857.9	884.4	638.5	884.3	814.3	888.8
Dec-01	614.6	600.0	682.9	676.5	915.1	829.0	672.9	833.2	680.1	756.8
Jan-02	890.3	884.4	1248.3	757.0	1207.2	1226.7	676.3	1226.4	1200.2	1197.1
Feb-02	1232.8	1149.7	1395.6	1229.5	1307.9	1333.8	1060.4	1333.2	1343.4	1338.8
Mar-02	1371.4	1326.1	1453.4	1323.4	1435.6	1437.2	1324.1	1436.4	1450.3	1444.2

	BUFORD-POOL NAA	BUFORD-POOL Alt1A	BUFORD-POOL Alt7A	BUFORD-POOL Alt7B	BUFORD-POOL Alt7H	BUFORD-POOL Alt7I	BUFORD-POOL Alt7J	BUFORD-POOL Alt7K	BUFORD-POOL Alt7L	BUFORD-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Apr-02	1122.9	1015.3	944.3	828.2	996.8	971.1	849.6	988.7	922.6	931.8
May-02	1108.2	1003.8	931.3	932.1	890.7	899.7	934.5	899.2	911.4	905.6
Jun-02	942.2	842.1	898.3	870.4	836.0	844.8	874.4	858.4	852.9	846.5
Jul-02	873.2	776.7	910.5	860.9	782.1	806.6	823.4	806.2	821.7	814.3
Aug-02	711.6	641.0	743.1	764.5	648.4	664.8	707.1	664.3	679.7	672.6
Sep-02	845.2	875.1	996.3	884.5	886.4	904.9	868.8	904.1	927.4	916.7
Oct-02	632.6	685.1	898.5	916.5	1002.1	1022.1	902.1	1020.9	929.0	968.0
Nov-02	691.5	677.9	980.0	875.4	956.0	960.3	882.0	959.1	966.5	956.2
Dec-02	693.9	714.4	659.0	563.6	923.9	902.8	599.3	914.0	664.1	676.6
Jan-03	663.3	697.5	513.2	423.9	626.1	611.6	423.5	616.7	545.9	603.7
Feb-03	744.4	742.5	475.8	373.5	644.8	615.2	373.8	625.4	528.8	591.6
Mar-03	325.6	371.5	275.8	267.5	280.3	280.5	267.5	280.9	275.8	277.9
Apr-03	459.7	459.6	457.6	445.2	476.4	474.3	438.4	475.5	459.5	466.3
May-03	291.7	291.5	293.1	276.1	296.2	296.7	278.5	297.5	292.2	292.7
Jun-03	292.4	292.7	291.9	278.3	302.5	302.3	278.3	303.0	292.1	298.0
Jul-03	302.1	302.2	302.1	288.5	310.1	310.0	288.5	310.7	302.2	305.7
Aug-03	479.3	480.1	477.7	456.9	493.0	492.1	456.3	493.3	478.5	484.4
Sep-03	619.6	612.8	620.9	598.9	608.9	611.7	597.5	611.6	613.5	612.7
Oct-03	606.0	602.4	604.5	572.9	596.8	599.0	573.3	598.7	602.4	600.9
Nov-03	502.9	508.7	504.8	447.9	579.1	574.2	448.7	580.7	509.9	536.9
Dec-03	537.6	537.9	529.1	506.0	542.2	543.4	506.2	544.7	529.4	535.6
Jan-04	632.8	632.4	299.0	287.0	292.8	292.1	288.6	292.3	290.5	290.9
Feb-04	389.7	389.7	680.8	675.6	676.4	676.3	676.0	676.1	678.6	677.5
Mar-04	466.7	470.2	387.9	368.2	421.6	421.6	369.4	423.8	401.2	410.5
Apr-04	511.4	514.1	334.1	319.2	353.7	351.7	307.8	349.1	335.4	349.9
May-04	561.6	560.1	979.3	986.7	950.4	957.7	964.6	956.6	960.1	960.7
Jun-04	753.0	749.8	983.0	995.9	968.7	970.9	986.3	969.5	976.2	975.5
Jul-04	756.1	742.0	738.9	754.3	720.5	723.5	743.1	722.3	730.1	728.5
Aug-04	752.3	747.1	732.9	752.0	716.4	719.3	743.8	718.0	727.4	725.0
Sep-04	581.8	588.5	690.2	543.2	693.4	694.2	581.0	692.7	689.1	693.4
Oct-04	556.7	558.5	583.4	540.3	632.0	634.7	541.7	633.1	592.1	629.1
Nov-04	439.7	438.5	507.5	405.3	635.0	630.6	404.5	634.6	511.0	529.5
Dec-04	290.2	290.1	285.4	278.0	289.6	289.4	277.9	294.9	285.3	287.1
Jan-05	572.6	572.8	571.4	548.2	583.8	583.3	553.4	583.7	578.7	580.8

	BUFORD-POOL NAA	BUFORD-POOL Alt1A	BUFORD-POOL Alt7A	BUFORD-POOL Alt7B	BUFORD-POOL Alt7H	BUFORD-POOL Alt7I	BUFORD-POOL Alt7J	BUFORD-POOL Alt7K	BUFORD-POOL Alt7L	BUFORD-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Feb-05	341.4	341.4	348.4	331.0	359.7	359.2	329.2	360.4	345.8	351.6
Mar-05	302.7	302.7	302.7	292.4	308.5	308.4	292.4	308.9	302.7	305.2
Apr-05	394.2	394.2	394.2	383.3	400.0	400.4	383.3	400.9	394.2	397.0
May-05	389.7	391.6	421.5	406.3	442.0	440.9	407.4	442.0	423.3	428.4
Jun-05	420.6	418.8	393.4	357.7	407.1	407.3	357.1	409.1	392.3	401.0
Jul-05	297.2	297.0	295.9	281.3	303.9	303.9	281.2	304.7	295.7	299.3
Aug-05	295.4	295.4	295.4	283.9	302.0	302.0	283.9	302.6	295.4	298.3
Sep-05	505.8	507.1	513.9	495.6	519.4	519.0	497.5	520.4	513.2	516.1
Oct-05	635.0	626.5	637.2	637.2	622.9	625.9	632.7	625.7	628.4	627.3
Nov-05	608.1	602.6	614.6	621.2	604.2	606.0	617.0	605.7	609.9	608.2
Dec-05	599.1	610.8	565.6	471.2	600.3	601.3	475.1	602.6	573.2	584.1
Jan-06	392.6	392.1	400.4	379.3	438.9	436.4	378.9	439.9	401.9	417.1
Feb-06	460.9	460.9	460.9	439.9	473.0	472.6	439.9	473.7	460.9	466.1
Mar-06	497.2	497.2	462.7	442.3	499.9	500.7	445.8	501.9	464.2	469.5
Apr-06	435.8	436.2	378.3	364.2	380.9	379.0	364.9	380.3	376.9	383.2
May-06	465.0	466.1	318.5	305.2	322.5	322.0	306.7	322.2	319.6	322.1
Jun-06	695.9	686.4	922.1	884.4	889.9	909.4	846.6	916.4	873.6	885.1
Jul-06	665.5	649.8	805.9	814.4	717.0	737.0	750.7	736.7	741.1	739.2
Aug-06	646.4	634.1	884.7	852.2	787.1	811.1	816.9	810.6	817.9	814.8
Sep-06	653.5	639.1	841.6	857.7	807.3	832.6	815.6	831.8	820.8	837.6
Oct-06	658.2	647.0	864.6	884.5	839.4	844.2	848.0	843.3	827.4	828.4
Nov-06	679.0	671.2	933.6	958.8	897.7	904.5	941.3	903.4	915.7	910.8
Dec-06	698.7	685.6	726.2	711.2	917.6	926.9	734.0	925.7	711.9	934.7
Jan-07	719.3	710.7	743.2	605.0	977.3	984.3	604.0	982.7	731.5	993.1
Feb-07	741.3	731.4	767.3	623.2	1010.3	1017.9	697.4	1016.0	755.4	767.0
Mar-07	679.4	733.7	423.3	367.2	571.1	532.3	372.5	544.4	463.7	420.4
Apr-07	553.6	528.6	322.8	304.9	302.2	304.8	302.5	306.0	332.8	313.5
May-07	519.4	534.1	510.3	485.7	469.9	462.3	499.6	459.0	538.3	521.9
Jun-07	816.5	752.4	743.8	741.9	655.7	725.1	680.2	669.4	663.8	659.8
Jul-07	768.3	798.2	938.1	955.2	817.7	847.3	868.8	843.2	853.3	847.0
Aug-07	598.1	606.2	723.0	738.9	638.2	656.5	679.2	653.0	663.2	657.3
Sep-07	598.8	613.6	385.7	390.7	590.2	556.4	586.8	601.8	600.4	592.1
Oct-07	402.6	431.6	628.1	453.5	397.8	487.9	373.6	458.2	399.3	388.8
Nov-07	627.5	639.4	771.7	485.2	675.3	699.9	717.2	695.7	705.9	695.2

	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL	BUFORD-POOL
	NAA	Alt1A	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K	Alt7L	Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Dec-07	835.5	791.1	922.5	924.9	812.3	840.7	881.3	835.4	850.1	836.2
Jan-08	1007.7	933.8	1101.2	1108.8	964.7	1003.5	1058.1	997.0	1016.9	999.5
Feb-08	1192.9	1152.3	1218.9	1232.1	1133.9	1160.1	1228.5	1152.6	1177.6	1157.0
Mar-08	1306.1	1261.5	1311.4	1330.5	1240.2	1265.1	1343.8	1257.2	1286.1	1263.7
Apr-08	1094.0	1006.4	1186.9	1209.7	1015.0	1060.1	1133.4	1053.3	1080.4	1060.6
May-08	970.8	872.6	966.1	990.1	798.8	838.5	904.3	832.9	857.2	840.3
Jun-08	744.3	679.6	740.6	763.9	622.3	650.1	709.2	645.4	667.3	652.8
Jul-08	807.9	732.3	803.8	834.6	665.7	697.4	769.4	692.0	718.8	701.7
Aug-08	814.8	747.2	810.8	845.6	681.2	710.0	788.6	704.4	733.6	715.5
Sep-08	662.4	603.7	659.0	691.7	547.4	570.8	641.6	565.9	592.3	576.3
Oct-08	766.9	692.3	768.3	811.4	627.4	655.7	745.5	649.8	683.3	663.4
Nov-08	742.2	669.6	828.2	879.5	666.5	698.1	802.1	691.4	730.2	707.6
Dec-08	693.3	767.0	1118.8	1160.0	912.3	954.0	1097.5	945.0	998.7	967.8
Jan-09	674.5	699.9	1156.0	921.2	957.5	998.0	913.4	989.1	1043.9	1012.8
Feb-09	980.5	898.1	1131.5	1150.0	916.4	960.7	1098.5	952.0	1006.3	975.8
Mar-09	1333.2	1269.1	1429.2	1181.2	1237.8	1280.5	1239.6	1269.4	1340.1	1300.9
Apr-09	1015.9	1299.0	1042.6	665.8	1254.2	1299.4	692.5	1288.5	1237.8	1320.7
May-09	740.7	735.1	836.8	643.5	1035.9	1090.2	629.8	1081.2	955.4	1016.9
Jun-09	678.4	657.0	603.9	586.8	786.1	675.3	573.0	796.5	671.7	652.1
Jul-09	655.9	637.8	677.3	575.7	778.9	815.4	609.0	813.7	650.5	697.6
Aug-09	665.3	644.6	684.2	707.3	811.1	846.2	690.2	844.2	656.7	855.5
Sep-09	696.3	697.8	700.3	718.1	887.2	891.1	708.9	888.9	702.9	778.5
Oct-09	649.4	638.5	477.2	309.9	667.9	649.9	328.6	649.8	652.5	644.7
Nov-09	270.1	305.3	252.6	245.4	378.5	307.2	245.4	315.3	259.3	285.7
Dec-09	201.1	201.1	201.1	196.9	203.2	203.4	196.9	203.6	201.1	202.1
Jan-10	246.3	246.3	246.3	240.2	249.5	249.7	240.2	250.0	246.3	247.8
Feb-10	215.6	215.6	215.6	210.6	218.3	218.3	210.6	218.6	215.6	216.8
Mar-10	298.8	298.8	298.8	288.8	304.4	304.4	288.8	304.9	298.8	301.3
Apr-10	477.0	477.2	477.9	460.9	492.1	492.5	461.5	493.5	484.8	483.5
May-10	336.6	338.1	354.3	334.7	367.9	367.0	335.2	368.1	353.7	361.8
Jun-10	617.8	609.9	621.1	625.4	608.0	611.2	617.2	611.0	613.3	612.4
Jul-10	615.2	603.9	618.6	599.4	599.4	603.2	602.7	602.9	607.4	605.5
Aug-10	595.5	586.7	598.8	588.9	581.1	584.3	600.5	583.8	590.2	587.6
Sep-10	568.4	560.9	574.5	523.9	643.4	640.1	536.7	646.2	592.0	606.1

	BUFORD-POOL NAA	BUFORD-POOL Alt1A	BUFORD-POOL Alt7A	BUFORD-POOL Alt7B	BUFORD-POOL Alt7H	BUFORD-POOL Alt7I	BUFORD-POOL Alt7J	BUFORD-POOL Alt7K	BUFORD-POOL Alt7L	BUFORD-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Oct-10	609.5	630.0	654.0	562.8	691.9	688.8	564.6	688.3	659.0	677.1
Nov-10	677.3	676.5	719.3	686.6	700.9	704.3	665.6	703.6	711.0	707.9
Dec-10	558.9	551.9	573.1	575.8	700.6	688.6	571.7	703.5	567.9	611.6
Jan-11	706.0	703.7	447.9	402.3	503.9	503.3	407.1	501.2	463.3	504.4
Feb-11	740.9	733.7	992.3	1003.5	982.8	986.3	996.5	985.7	985.8	988.6
Mar-11	460.3	470.8	521.0	426.6	524.1	523.7	418.2	530.5	510.7	498.4
Apr-11	284.1	279.8	217.9	217.1	222.3	221.6	217.5	221.6	214.8	222.1
May-11	350.3	345.4	256.2	254.8	255.2	252.9	233.8	252.8	249.0	256.2
Jun-11	642.9	648.1	768.6	723.0	814.1	812.8	795.4	813.7	815.9	789.4
Jul-11	679.9	662.3	870.7	801.5	765.4	787.1	800.4	786.3	791.1	791.9
Aug-11	615.5	603.0	717.7	711.0	640.3	655.2	672.1	654.4	660.5	660.4
Sep-11	616.9	603.8	785.3	750.1	692.2	709.4	733.4	708.3	717.1	716.1
Oct-11	605.1	590.5	433.2	533.1	659.3	505.8	511.3	506.6	483.2	509.4
Nov-11	629.9	617.4	596.1	502.4	465.2	666.0	589.5	674.6	743.5	635.4
Dec-11	660.8	648.6	1095.1	825.4	1120.9	1104.7	951.9	1103.2	1059.8	1035.5
Overall Median	642.858	637.764	682.930	637.221	666.450	676.292	638.544	676.084	664.055	671.479
May-October Median	644.628	635.912	695.258	696.710	666.773	682.047	675.647	678.850	665.567	672.027
May-October Average	645.563	628.749	675.622	648.105	661.897	668.878	640.106	670.204	652.596	658.363
April-October Median	635.027	629.999	684.189	652.514	659.342	664.835	644.404	664.337	663.247	663.435
April-October Average	651.625	636.974	667.093	635.325	656.284	663.156	628.237	664.317	647.871	653.907
	GEORGE ANDREWS-POOL NAA	**GEORGE ANDREWS-POOL Alt1A**	**GEORGE ANDREWS-POOL Alt7A**	**GEORGE ANDREWS-POOL Alt7B**	**GEORGE ANDREWS-POOL Alt7H**	**GEORGE ANDREWS-POOL Alt7I**	**GEORGE ANDREWS-POOL Alt7J**	**GEORGE ANDREWS-POOL Alt7K**	**GEORGE ANDREWS-POOL Alt7L**	**GEORGE ANDREWS-POOL Alt7M**
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Dec-00	0.8934	0.8938	0.9121	0.9093	0.9078	0.9080	0.9080	0.9080	0.9080	0.9080
Jan-01	1.4157	1.3605	1.4184	1.3922	1.3866	1.3907	1.3830	1.3907	1.3699	1.3857
Feb-01	1.3840	1.3761	1.4051	1.3883	1.3839	1.3869	1.3868	1.3869	1.3862	1.3869
Mar-01	0.2930	0.2917	0.2929	0.2924	0.2919	0.2912	0.2912	0.2917	0.2908	0.2908
Apr-01	0.7146	0.7046	0.6991	0.6925	0.6926	0.6945	0.6927	0.6913	0.6945	0.6945

Month-Year	GEORGE ANDREWS-POOL NAA days	GEORGE ANDREWS-POOL Alt1A days	GEORGE ANDREWS-POOL Alt7A days	GEORGE ANDREWS-POOL Alt7B days	GEORGE ANDREWS-POOL Alt7H days	GEORGE ANDREWS-POOL Alt7I days	GEORGE ANDREWS-POOL Alt7J days	GEORGE ANDREWS-POOL Alt7K days	GEORGE ANDREWS-POOL Alt7L days	GEORGE ANDREWS-POOL Alt7M days
May-01	2.9143	2.8141	2.3554	2.2152	2.4224	2.4586	2.4122	2.4586	2.4558	2.4593
Jun-01	1.1873	1.1969	1.2867	1.2084	1.1959	1.1980	1.2040	1.1980	1.1994	1.1982
Jul-01	2.2972	2.2816	2.1601	2.0929	2.0790	2.0824	2.0788	2.0824	2.0830	2.0828
Aug-01	2.2947	2.2835	2.1106	2.0861	2.1211	2.1260	2.0751	2.1283	2.1185	2.1101
Sep-01	2.6608	2.6614	2.8441	2.8265	2.8444	2.8441	2.8160	2.8439	2.8511	2.8618
Oct-01	2.2462	2.2541	2.7198	2.7425	2.7427	2.7164	2.6830	2.7417	2.5534	2.5579
Nov-01	2.2823	2.1636	2.6606	2.5288	2.6972	2.7172	2.4150	2.7167	2.5078	2.6081
Dec-01	2.6014	2.5570	2.9656	2.6631	2.9980	2.9689	2.6421	2.9930	2.8336	2.9526
Jan-02	1.8300	1.7977	1.3491	1.2269	1.3879	1.3812	1.2020	1.3808	1.3113	1.3421
Feb-02	1.2436	1.2372	1.5832	1.5943	1.4931	1.5126	1.2222	1.5155	1.5570	1.5336
Mar-02	1.2830	1.2632	1.2597	1.2658	1.2374	1.2337	1.5341	1.2337	1.2368	1.2368
Apr-02	1.5053	1.4875	1.4468	1.4180	1.4579	1.4568	1.4095	1.4593	1.4440	1.4473
May-02	3.0115	2.9351	2.1859	2.1148	2.1390	2.1616	2.1129	2.1640	2.1614	2.1612
Jun-02	4.9711	4.8653	4.2916	4.2938	4.2953	4.2960	4.2958	4.2954	4.2962	4.2962
Jul-02	3.5567	3.5677	3.5535	3.5589	3.5623	3.5616	3.5629	3.5608	3.5618	3.5618
Aug-02	4.1814	4.1830	4.7204	4.7212	4.7328	4.7302	4.7320	4.7297	4.7309	4.7307
Sep-02	3.3284	3.2865	4.5805	4.6113	4.6121	4.6119	4.6119	4.6119	4.6120	4.6119
Oct-02	2.9058	2.7628	3.0424	3.0268	2.9950	3.0472	2.9668	3.0455	3.0475	3.0477
Nov-02	1.2656	1.2321	1.3700	1.2934	1.2766	1.2881	1.2323	1.2915	1.2662	1.2743
Dec-02	0.8160	0.8154	0.8084	0.7978	0.8340	0.8316	0.7968	0.8326	0.8060	0.8088
Jan-03	1.4982	1.5064	1.3438	1.2772	1.3528	1.3531	1.2814	1.3531	1.3417	1.3468
Feb-03	0.7424	0.7381	0.7335	0.6914	0.7584	0.7550	0.6859	0.7569	0.7431	0.7527
Mar-03	0.4859	0.4937	0.4651	0.4619	0.4716	0.4709	0.4603	0.4712	0.4644	0.4692
Apr-03	0.6580	0.6557	0.6544	0.6508	0.6562	0.6561	0.6472	0.6564	0.6557	0.6573
May-03	0.4382	0.4374	0.4397	0.4356	0.4400	0.4404	0.4355	0.4406	0.4373	0.4382
Jun-03	0.4440	0.4432	0.4441	0.4407	0.4447	0.4448	0.4399	0.4450	0.4433	0.4438
Jul-03	0.5298	0.5287	0.5298	0.5251	0.5311	0.5313	0.5241	0.5314	0.5287	0.5299
Aug-03	0.9382	0.9352	0.9382	0.9273	0.9400	0.9407	0.9240	0.9416	0.9351	0.9377
Sep-03	1.9482	1.9361	1.9536	1.9328	1.9317	1.9419	1.9192	1.9423	1.9384	1.9397
Oct-03	1.6676	1.6449	1.6618	1.6301	1.6379	1.6420	1.6152	1.6420	1.6424	1.6422
Nov-03	1.0137	1.0104	1.0145	0.9896	1.0366	1.0342	0.9847	1.0363	1.0110	1.0212
Dec-03	1.0964	1.0891	1.0963	1.0851	1.0945	1.0948	1.0779	1.0953	1.0890	1.0916
Jan-04	0.9303	0.9244	0.7996	0.7901	0.7908	0.7912	0.7862	0.7914	0.7891	0.7898

Month-Year	GEORGE ANDREWS-POOL NAA days	GEORGE ANDREWS-POOL Alt1A days	GEORGE ANDREWS-POOL Alt7A days	GEORGE ANDREWS-POOL Alt7B days	GEORGE ANDREWS-POOL Alt7H days	GEORGE ANDREWS-POOL Alt7I days	GEORGE ANDREWS-POOL Alt7J days	GEORGE ANDREWS-POOL Alt7K days	GEORGE ANDREWS-POOL Alt7L days	GEORGE ANDREWS-POOL Alt7M days
Feb-04	0.5548	0.5524	0.5933	0.5928	0.5910	0.5910	0.5905	0.5910	0.5910	0.5910
Mar-04	1.2981	1.2891	1.1736	1.1688	1.1740	1.1749	1.1658	1.1754	1.1716	1.1728
Apr-04	1.6520	1.6436	1.3437	1.3008	1.3708	1.3722	1.2660	1.3710	1.3412	1.3701
May-04	1.9422	1.9243	2.8246	2.7955	2.7883	2.8030	2.7704	2.8301	2.8210	2.7791
Jun-04	2.7288	2.7133	2.7573	2.7825	2.7584	2.7769	2.7667	2.7510	2.7196	2.7593
Jul-04	2.0901	2.0754	2.3895	2.3881	2.3860	2.3905	2.3840	2.3894	2.3867	2.3896
Aug-04	2.1504	2.1450	2.1468	2.1412	2.1091	2.1140	2.1189	2.1109	2.1505	2.1374
Sep-04	0.7838	0.7737	0.7816	0.7688	0.7750	0.7760	0.7681	0.7763	0.7692	0.7720
Oct-04	1.3815	1.3796	1.4384	1.3674	1.4598	1.4617	1.3595	1.4616	1.4338	1.4558
Nov-04	0.6542	0.6517	0.6682	0.6463	0.6783	0.6777	0.6440	0.6777	0.6665	0.6695
Dec-04	0.6787	0.6758	0.6786	0.6735	0.6852	0.6844	0.6707	0.6882	0.6757	0.6769
Jan-05	0.9894	0.9822	0.9815	0.9743	0.9762	0.9777	0.9696	0.9779	0.9759	0.9768
Feb-05	0.6132	0.6105	0.6166	0.6039	0.6172	0.6173	0.6003	0.6176	0.6133	0.6150
Mar-05	0.7785	0.7768	0.7785	0.7810	0.7775	0.7782	0.7793	0.7783	0.7768	0.7774
Apr-05	0.3481	0.3475	0.3481	0.3469	0.3480	0.3481	0.3462	0.3482	0.3475	0.3478
May-05	1.2618	1.2574	1.2533	1.2446	1.2569	1.2583	1.2400	1.2589	1.2488	1.2514
Jun-05	0.8746	0.8705	0.8797	0.8586	0.8838	0.8849	0.8548	0.8858	0.8757	0.8806
Jul-05	0.3890	0.3883	0.3888	0.3858	0.3897	0.3897	0.3852	0.3899	0.3882	0.3889
Aug-05	0.6451	0.6434	0.6451	0.6388	0.6466	0.6469	0.6372	0.6472	0.6434	0.6450
Sep-05	2.0267	2.0221	2.0467	2.0217	2.0492	2.0514	2.0174	2.0525	2.0407	2.0457
Oct-05	1.7171	1.7037	1.7155	1.7019	1.6963	1.7014	1.6893	1.7024	1.6982	1.6998
Nov-05	1.3480	1.3280	1.3495	1.3500	1.3268	1.3307	1.3317	1.3307	1.3311	1.3309
Dec-05	1.0399	1.0361	1.0337	0.9953	1.0346	1.0344	0.9910	1.0348	1.0291	1.0311
Jan-06	0.7808	0.7760	0.7814	0.7734	0.7931	0.7924	0.7684	0.7936	0.7775	0.7842
Feb-06	0.6933	0.6901	0.6933	0.6913	0.6927	0.6930	0.6883	0.6933	0.6901	0.6914
Mar-06	0.7520	0.7479	0.7494	0.7394	0.7498	0.7507	0.7357	0.7510	0.7452	0.7468
Apr-06	1.2132	1.1926	1.1246	1.1148	1.1237	1.1249	1.1109	1.1244	1.1192	1.1247
May-06	1.6409	1.6581	1.1784	1.1669	1.1796	1.1795	1.1656	1.1803	1.1724	1.1782
Jun-06	3.2967	3.2771	3.2010	3.2475	3.1775	3.1800	3.2424	3.1798	3.2188	3.1822
Jul-06	2.6934	2.6844	4.9048	4.8813	4.8681	4.8824	4.8443	4.8857	4.8646	4.8707
Aug-06	3.8264	3.7541	4.0595	3.9549	3.9676	4.0103	3.8575	4.0200	3.9595	3.9782
Sep-06	2.9449	2.9430	3.9955	4.0031	3.9693	4.0076	3.9044	4.0072	4.0099	4.0089
Oct-06	2.8612	2.8268	3.8835	3.8961	3.7426	3.8738	3.6688	3.8852	3.7566	3.8146

Month-Year	GEORGE ANDREWS-POOL NAA days	GEORGE ANDREWS-POOL Alt1A days	GEORGE ANDREWS-POOL Alt7A days	GEORGE ANDREWS-POOL Alt7B days	GEORGE ANDREWS-POOL Alt7H days	GEORGE ANDREWS-POOL Alt7I days	GEORGE ANDREWS-POOL Alt7J days	GEORGE ANDREWS-POOL Alt7K days	GEORGE ANDREWS-POOL Alt7L days	GEORGE ANDREWS-POOL Alt7M days
Nov-06	1.5861	1.5444	1.6634	1.6165	1.5572	1.5646	1.5530	1.5649	1.5577	1.5600
Dec-06	1.7327	1.6894	1.7408	1.7309	1.7872	1.7915	1.7151	1.7915	1.7155	1.7915
Jan-07	0.8958	0.8861	0.8870	0.8631	0.9082	0.9083	0.8593	0.9083	0.8807	0.9083
Feb-07	1.1630	1.1574	1.1777	1.1405	1.2109	1.2129	1.1506	1.2129	1.1679	1.1773
Mar-07	1.0412	1.0313	0.9523	0.9367	1.0595	1.0554	0.9375	1.0614	0.9538	0.9484
Apr-07	1.6216	1.6172	1.2839	1.2169	1.1962	1.1955	1.2042	1.1986	1.3113	1.2645
May-07	3.2380	3.1349	3.1344	3.0357	2.6930	2.6906	3.0294	2.6599	3.1373	2.9913
Jun-07	3.9217	3.9024	3.9033	3.9027	3.8955	3.9088	3.8921	3.8967	3.8936	3.8935
Jul-07	4.0495	4.0898	4.2953	4.2865	4.2546	4.2661	4.2455	4.2621	4.2588	4.2634
Aug-07	3.3924	3.3867	3.4411	3.4417	3.4121	3.4170	3.4221	3.4130	3.4159	3.4133
Sep-07	3.8952	3.8835	3.8326	3.8256	3.8905	3.8936	3.8874	3.9055	3.8991	3.9037
Oct-07	4.0842	4.1428	5.3602	4.1741	4.2077	5.2696	4.1229	5.1316	4.2170	4.2270
Nov-07	3.8030	3.7779	4.5328	3.6766	4.4477	4.5261	3.8098	4.6213	4.4443	4.3997
Dec-07	5.0940	4.9194	5.3042	5.1327	5.2471	5.1288	5.1043	4.9939	5.2311	5.4431
Jan-08	1.4232	1.3826	1.5033	1.4856	1.4599	1.4597	1.5097	1.4597	1.4791	1.4695
Feb-08	0.8928	0.8898	0.9076	0.9076	0.8842	0.8873	0.8873	0.8873	0.8873	0.8873
Mar-08	1.0882	1.0777	1.0709	1.0709	1.0609	1.0621	1.0621	1.0621	1.0621	1.0621
Apr-08	1.2827	1.2720	1.2868	1.2876	1.2810	1.2826	1.2825	1.2826	1.2826	1.2826
May-08	4.3784	4.1317	2.8991	2.8954	2.8506	2.8547	2.8549	2.8547	2.8547	2.8547
Jun-08	5.1779	5.0391	4.6147	4.6147	4.2462	4.3582	4.3575	4.3582	4.3582	4.3582
Jul-08	4.1087	4.1354	4.0934	4.0934	4.1106	4.1066	4.1066	4.1066	4.1066	4.1066
Aug-08	1.8911	1.8937	2.4017	2.4017	2.4143	2.4114	2.4114	2.4114	2.4114	2.4114
Sep-08	2.8354	2.8166	2.8356	2.8356	2.8351	2.8352	2.8352	2.8352	2.8352	2.8352
Oct-08	2.6802	2.2786	2.7126	2.7126	2.7120	2.7111	2.7111	2.7111	2.7111	2.7111
Nov-08	1.8290	1.7924	1.9226	1.9226	1.9132	1.9653	1.9652	1.9652	1.9652	1.9653
Dec-08	0.8715	0.8670	0.9160	0.9160	0.8302	0.8378	0.8378	0.8378	0.8378	0.8378
Jan-09	1.1304	1.1349	1.2052	1.1767	1.1805	1.1890	1.1650	1.1890	1.1890	1.1890
Feb-09	1.6094	1.5917	1.7420	1.7150	1.6506	1.6943	1.6875	1.6943	1.6943	1.6943
Mar-09	0.5828	0.5805	0.5703	0.5687	0.5719	0.5684	0.5684	0.5684	0.5684	0.5684
Apr-09	0.4451	0.4455	0.4425	0.4333	0.4453	0.4455	0.4336	0.4455	0.4452	0.4455
May-09	1.0785	1.0904	1.1005	1.0430	1.1173	1.1214	1.0373	1.1214	1.0981	1.1129
Jun-09	1.7378	1.7355	1.7487	1.7284	1.7794	1.7830	1.7170	1.7817	1.7798	1.7828
Jul-09	2.7636	2.7049	2.5437	2.5169	2.7929	2.6938	2.5181	2.7909	2.6402	2.6403

Month-Year	GEORGE ANDREWS-POOL NAA days	GEORGE ANDREWS-POOL Alt1A days	GEORGE ANDREWS-POOL Alt7A days	GEORGE ANDREWS-POOL Alt7B days	GEORGE ANDREWS-POOL Alt7H days	GEORGE ANDREWS-POOL Alt7I days	GEORGE ANDREWS-POOL Alt7J days	GEORGE ANDREWS-POOL Alt7K days	GEORGE ANDREWS-POOL Alt7L days	GEORGE ANDREWS-POOL Alt7M days
Aug-09	2.8429	2.7585	2.9660	2.7985	2.9549	2.9550	2.7680	2.9526	2.9654	2.9631
Sep-09	0.6715	0.6704	0.6685	0.6613	0.7105	0.7113	0.6586	0.7156	0.6649	0.6945
Oct-09	0.6169	0.6148	0.6069	0.5663	0.6206	0.6175	0.5709	0.6177	0.6150	0.6149
Nov-09	0.3712	0.3767	0.3629	0.3613	0.3864	0.3769	0.3606	0.3781	0.3683	0.3734
Dec-09	0.2216	0.2213	0.2216	0.2211	0.2216	0.2216	0.2208	0.2216	0.2213	0.2215
Jan-10	0.3717	0.3708	0.3717	0.3705	0.3714	0.3715	0.3696	0.3716	0.3708	0.3711
Feb-10	0.3706	0.3694	0.3706	0.3688	0.3701	0.3704	0.3678	0.3705	0.3694	0.3699
Mar-10	0.4375	0.4360	0.4375	0.4352	0.4370	0.4373	0.4335	0.4374	0.4360	0.4366
Apr-10	1.0638	1.0583	1.0597	1.0533	1.0610	1.0621	1.0488	1.0627	1.0576	1.0572
May-10	0.7248	0.7236	0.7214	0.7121	0.7231	0.7234	0.7102	0.7237	0.7188	0.7219
Jun-10	1.7149	1.7022	1.7989	1.7857	1.7896	1.7952	1.7716	1.7959	1.7867	1.7907
Jul-10	2.4733	2.4748	2.4732	2.4741	2.4753	2.4744	2.4749	2.4744	2.4744	2.4744
Aug-10	2.6387	2.6194	2.6357	2.6020	2.6623	2.6904	2.5970	2.6611	2.6263	2.6360
Sep-10	2.8137	2.8138	2.8091	2.8076	2.8126	2.7928	2.8082	2.8116	2.8093	2.8100
Oct-10	2.3429	2.3563	2.4640	2.4455	2.5072	2.5024	2.4453	2.5071	2.4736	2.4773
Nov-10	2.0177	2.0296	2.1826	2.0545	2.1193	2.1494	2.0570	2.1526	2.1143	2.1502
Dec-10	1.8521	1.7431	1.7433	1.6658	1.7610	1.7548	1.5961	1.7649	1.6939	1.6998
Jan-11	1.7310	1.7179	1.0451	1.0194	1.0726	1.0726	1.0143	1.0726	1.0447	1.0724
Feb-11	0.9131	0.9040	1.4178	1.4108	1.4051	1.4042	1.3950	1.4060	1.4007	1.4018
Mar-11	0.7263	0.7229	0.7361	0.7195	0.7371	0.7363	0.7141	0.7369	0.7343	0.7298
Apr-11	0.9203	0.9108	0.8513	0.8387	0.8431	0.8439	0.8369	0.8447	0.8301	0.8474
May-11	2.4029	2.2746	1.3822	1.3793	1.3771	1.3773	1.3153	1.3774	1.3780	1.3794
Jun-11	3.4202	3.4159	3.3062	3.3021	3.3349	3.3394	3.2993	3.3398	3.3424	3.3250
Jul-11	3.3327	3.2992	4.2732	4.2733	4.2600	4.2630	4.2709	4.2618	4.2618	4.2695
Aug-11	3.2405	3.2291	3.5960	3.5533	3.5502	3.5523	3.5486	3.5527	3.5511	3.5507
Sep-11	2.6654	2.6567	2.9050	2.8958	2.8731	2.8911	2.8851	2.8915	2.8896	2.8869
Oct-11	3.4729	3.4605	3.4800	3.5348	3.5758	3.5511	3.5312	3.5510	3.5492	3.5520
Nov-11	2.9949	2.9664	3.3751	3.3045	3.3111	3.3600	3.3348	3.3643	3.3687	3.3507
Dec-11	2.8984	2.8686	4.2339	3.9465	3.9318	4.0984	3.9143	4.0941	4.0925	3.9838
Overall Median	1.586	1.544	1.418	1.388	1.388	1.391	1.383	1.391	1.386	1.387
May-October Median	2.650	2.547	2.590	2.559	2.678	2.691	2.558	2.661	2.590	2.597

Month-Year	GEORGE ANDREWS-POOL NAA days	GEORGE ANDREWS-POOL Alt1A days	GEORGE ANDREWS-POOL Alt7A days	GEORGE ANDREWS-POOL Alt7B days	GEORGE ANDREWS-POOL Alt7H days	GEORGE ANDREWS-POOL Alt7I days	GEORGE ANDREWS-POOL Alt7J days	GEORGE ANDREWS-POOL Alt7K days	GEORGE ANDREWS-POOL Alt7L days	GEORGE ANDREWS-POOL Alt7M days
May-October Average	2.445	2.417	2.535	2.499	2.503	2.526	2.483	2.526	2.507	2.508
April-October Median	2.295	2.275	2.355	2.215	2.386	2.391	2.384	2.389	2.387	2.390
April-October Average	2.244	2.219	2.310	2.276	2.282	2.301	2.262	2.301	2.286	2.286
Month-Year	**GOAT ROCK-POOL NAA days**	**GOAT ROCK-POOL Alt1A days**	**GOAT ROCK-POOL Alt7A days**	**GOAT ROCK-POOL Alt7B days**	**GOAT ROCK-POOL Alt7H days**	**GOAT ROCK-POOL Alt7I days**	**GOAT ROCK-POOL Alt7J days**	**GOAT ROCK-POOL Alt7K days**	**GOAT ROCK-POOL Alt7L days**	**GOAT ROCK-POOL Alt7M days**
Dec-00	1.7241	1.7241	1.7241	1.7241	1.7241	1.7241	1.7241	1.7241	1.7241	1.7241
Jan-01	1.1199	1.0495	1.1229	1.0891	1.0821	1.0872	1.0774	1.0872	1.0608	1.0809
Feb-01	0.9112	0.8899	0.9158	0.9152	0.8968	0.8994	0.8993	0.8994	0.8988	0.8994
Mar-01	0.2992	0.2978	0.2992	0.2964	0.2967	0.2964	0.2953	0.2964	0.2956	0.2956
Apr-01	0.6485	0.6361	0.6322	0.6216	0.6198	0.6201	0.6206	0.6201	0.6202	0.6202
May-01	1.7411	1.6417	1.5425	1.3611	1.5424	1.5464	1.5482	1.5464	1.5471	1.5468
Jun-01	1.0526	1.0670	1.0823	1.0033	0.9824	0.9907	0.9873	0.9906	0.9912	0.9909
Jul-01	1.3395	1.3209	1.2579	1.2133	1.2065	1.2076	1.2084	1.2076	1.2078	1.2077
Aug-01	1.4345	1.4345	1.4400	1.4400	1.4360	1.4386	1.4319	1.4389	1.4358	1.4368
Sep-01	1.7643	1.7667	1.7725	1.7724	1.7773	1.7765	1.7766	1.7761	1.7774	1.7775
Oct-01	1.6570	1.6358	2.3489	2.1900	2.4668	2.4676	2.0104	2.5316	1.9710	2.0536
Nov-01	1.3782	1.3166	1.6519	1.5189	1.6554	1.6549	1.4702	1.6543	1.6273	1.6550
Dec-01	1.6156	1.5383	1.8550	1.6046	1.8888	1.8140	1.5657	1.8640	1.6311	1.7695
Jan-02	1.2858	1.2718	0.9361	0.8380	0.9330	0.9444	0.8316	0.9352	0.9275	0.9378
Feb-02	1.0559	1.0377	1.3680	1.3900	1.3075	1.3183	1.1065	1.3205	1.3320	1.3093
Mar-02	1.1167	1.0936	1.0356	1.0216	1.0113	1.0114	1.1083	1.0114	1.0114	1.0114
Apr-02	1.3793	1.3511	1.3188	1.3135	1.3305	1.3284	1.3026	1.3329	1.3079	1.3135
May-02	1.6517	1.5772	1.4403	1.3765	1.3993	1.4188	1.3736	1.4210	1.4170	1.4169
Jun-02	2.4122	2.4164	2.4120	2.4135	2.4142	2.4148	2.4148	2.4144	2.4149	2.4149
Jul-02	2.0316	2.0394	2.0326	2.0364	2.0388	2.0383	2.0392	2.0378	2.0385	2.0385
Aug-02	2.3319	2.3522	2.3336	2.3421	2.3534	2.3505	2.3524	2.3496	2.3507	2.3508
Sep-02	2.0008	1.8331	2.0023	2.0113	2.0274	2.0232	2.0254	2.0225	2.0235	2.0235
Oct-02	1.0711	1.0331	1.2160	1.1655	1.1209	1.1449	1.1086	1.1468	1.1447	1.1444
Nov-02	0.6532	0.6471	0.6688	0.6425	0.6442	0.6480	0.6211	0.6492	0.6365	0.6409

	GOAT ROCK-POOL NAA	GOAT ROCK-POOL Alt1A	GOAT ROCK-POOL Alt7A	GOAT ROCK-POOL Alt7B	GOAT ROCK-POOL Alt7H	GOAT ROCK-POOL Alt7I	GOAT ROCK-POOL Alt7J	GOAT ROCK-POOL Alt7K	GOAT ROCK-POOL Alt7L	GOAT ROCK-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Dec-02	0.4668	0.4665	0.4610	0.4521	0.4786	0.4769	0.4531	0.4776	0.4594	0.4613
Jan-03	0.8816	0.8838	0.8014	0.7389	0.8245	0.8233	0.7389	0.8236	0.8049	0.8197
Feb-03	0.5262	0.5231	0.4974	0.4650	0.5207	0.5179	0.4592	0.5197	0.5063	0.5152
Mar-03	0.3453	0.3536	0.3262	0.3233	0.3305	0.3298	0.3217	0.3301	0.3247	0.3280
Apr-03	0.4702	0.4678	0.4697	0.4660	0.4715	0.4715	0.4621	0.4718	0.4678	0.4695
May-03	0.2277	0.2272	0.2278	0.2255	0.2279	0.2281	0.2254	0.2282	0.2272	0.2276
Jun-03	0.2718	0.2712	0.2717	0.2691	0.2724	0.2726	0.2685	0.2727	0.2711	0.2718
Jul-03	0.3860	0.3848	0.3860	0.3808	0.3874	0.3876	0.3796	0.3878	0.3848	0.3860
Aug-03	0.7104	0.7067	0.7098	0.6968	0.7125	0.7135	0.6930	0.7142	0.7062	0.7094
Sep-03	1.1887	1.1756	1.1916	1.1765	1.1687	1.1767	1.1637	1.1767	1.1767	1.1767
Oct-03	1.3760	1.3492	1.3715	1.3276	1.3423	1.3476	1.3104	1.3476	1.3481	1.3479
Nov-03	0.5492	0.5471	0.5497	0.5342	0.5633	0.5618	0.5311	0.5631	0.5474	0.5537
Dec-03	0.6600	0.6546	0.6599	0.6518	0.6584	0.6587	0.6466	0.6591	0.6545	0.6564
Jan-04	0.7687	0.7600	0.6005	0.5893	0.5899	0.5905	0.5846	0.5907	0.5879	0.5888
Feb-04	0.4408	0.4376	0.4929	0.4921	0.4896	0.4895	0.4888	0.4895	0.4895	0.4895
Mar-04	0.8497	0.8417	0.8035	0.7902	0.8124	0.8145	0.7845	0.8143	0.8027	0.8082
Apr-04	0.9850	0.9818	0.7789	0.7551	0.7910	0.7911	0.7344	0.7900	0.7767	0.7924
May-04	1.0839	1.0649	1.5370	1.5416	1.5247	1.5333	1.5177	1.5444	1.5175	1.5171
Jun-04	1.2618	1.2486	1.2685	1.2685	1.2588	1.2671	1.2653	1.2619	1.2612	1.2637
Jul-04	0.9755	0.9761	1.0507	1.0506	1.0476	1.0490	1.0487	1.0485	1.0487	1.0486
Aug-04	1.0346	1.0097	1.0345	1.0425	1.0049	1.0108	1.0123	1.0105	1.0103	1.0109
Sep-04	0.5220	0.5204	0.5217	0.5045	0.5190	0.5189	0.5087	0.5189	0.5173	0.5181
Oct-04	0.9808	0.9719	1.0331	0.9676	1.0554	1.0580	0.9588	1.0578	1.0278	1.0516
Nov-04	0.4016	0.3997	0.4127	0.3953	0.4233	0.4228	0.3935	0.4228	0.4114	0.4139
Dec-04	0.4213	0.4190	0.4212	0.4173	0.4242	0.4236	0.4150	0.4266	0.4189	0.4199
Jan-05	0.7291	0.7208	0.7201	0.7113	0.7138	0.7155	0.7066	0.7157	0.7136	0.7145
Feb-05	0.4266	0.4238	0.4301	0.4245	0.4305	0.4308	0.4205	0.4311	0.4267	0.4285
Mar-05	0.2884	0.2871	0.2884	0.2863	0.2880	0.2882	0.2850	0.2883	0.2871	0.2876
Apr-05	0.3730	0.3716	0.3730	0.3703	0.3726	0.3730	0.3688	0.3731	0.3716	0.3722
May-05	0.7377	0.7346	0.7634	0.7522	0.7685	0.7698	0.7483	0.7705	0.7598	0.7629
Jun-05	0.6636	0.6588	0.6445	0.6242	0.6475	0.6485	0.6204	0.6495	0.6402	0.6449
Jul-05	0.2574	0.2568	0.2572	0.2544	0.2580	0.2581	0.2538	0.2582	0.2566	0.2573
Aug-05	0.4946	0.4926	0.4946	0.4871	0.4966	0.4969	0.4851	0.4974	0.4926	0.4945
Sep-05	1.1669	1.1639	1.1808	1.1649	1.1817	1.1833	1.1623	1.1839	1.1768	1.1799

	GOAT ROCK-POOL NAA	GOAT ROCK-POOL Alt1A	GOAT ROCK-POOL Alt7A	GOAT ROCK-POOL Alt7B	GOAT ROCK-POOL Alt7H	GOAT ROCK-POOL Alt7I	GOAT ROCK-POOL Alt7J	GOAT ROCK-POOL Alt7K	GOAT ROCK-POOL Alt7L	GOAT ROCK-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Oct-05	1.4848	1.4639	1.4822	1.4611	1.4525	1.4604	1.4418	1.4620	1.4555	1.4579
Nov-05	0.8881	0.8695	0.8895	0.8900	0.8688	0.8722	0.8731	0.8722	0.8726	0.8724
Dec-05	0.7428	0.7387	0.7341	0.6932	0.7378	0.7378	0.6884	0.7383	0.7289	0.7324
Jan-06	0.5647	0.5595	0.5665	0.5583	0.5779	0.5769	0.5531	0.5783	0.5624	0.5690
Feb-06	0.5188	0.5151	0.5188	0.5125	0.5181	0.5185	0.5089	0.5188	0.5151	0.5166
Mar-06	0.5992	0.5936	0.5960	0.5876	0.5956	0.5969	0.5826	0.5973	0.5905	0.5926
Apr-06	0.9802	0.9469	0.8635	0.8490	0.8675	0.8689	0.8445	0.8683	0.8573	0.8633
May-06	1.0895	1.1101	0.8804	0.8628	0.8778	0.8792	0.8599	0.8808	0.8756	0.8790
Jun-06	1.6269	1.6047	1.6979	1.7068	1.6636	1.6723	1.6835	1.6728	1.6691	1.6727
Jul-06	1.6869	1.6687	2.4268	2.4177	2.3738	2.3898	2.3685	2.3948	2.3778	2.3772
Aug-06	2.2502	2.2540	2.2404	2.2461	2.2517	2.2484	2.2546	2.2481	2.2504	2.2497
Sep-06	1.6652	1.6227	2.2437	2.2502	2.2138	2.2541	2.1689	2.2538	2.2476	2.2553
Oct-06	1.4630	1.4009	1.9665	1.9334	1.8248	1.8890	1.7798	1.8960	1.8227	1.8489
Nov-06	1.0731	1.0752	1.0651	1.0364	0.9969	1.0011	0.9972	1.0011	0.9993	1.0004
Dec-06	1.1271	1.0778	1.1029	1.0903	1.1556	1.1586	1.0807	1.1586	1.0811	1.1586
Jan-07	0.6138	0.6079	0.6145	0.5920	0.6322	0.6323	0.5870	0.6323	0.6085	0.6323
Feb-07	0.8656	0.8591	0.8827	0.8360	0.9223	0.9248	0.8524	0.9248	0.8713	0.8823
Mar-07	0.8958	0.8809	0.7982	0.7568	0.8938	0.8852	0.7540	0.8976	0.8139	0.7866
Apr-07	1.5823	1.5546	1.0296	0.9834	1.0005	1.0018	0.9686	0.9958	1.0453	1.0162
May-07	1.5242	1.5114	1.6633	1.5792	1.4097	1.3998	1.5764	1.4027	1.6612	1.5791
Jun-07	2.2341	2.1803	2.2356	2.2298	2.1883	2.2496	2.1792	2.1947	2.1835	2.1913
Jul-07	2.4132	2.4161	2.5425	2.5187	2.3943	2.4385	2.4119	2.4195	2.4116	2.4213
Aug-07	2.3743	2.3534	2.3649	2.3832	2.2753	2.3465	2.2847	2.3044	2.3005	2.3058
Sep-07	2.3232	2.2951	2.0302	2.0114	2.2152	2.1405	2.2142	2.2154	2.2211	2.2089
Oct-07	1.8862	1.9833	2.6468	2.0077	2.0765	2.5030	1.9033	2.4313	2.0775	2.0728
Nov-07	2.2910	2.2125	2.5158	1.9340	2.3355	2.3608	2.2868	2.3601	2.3867	2.3952
Dec-07	2.1527	2.0655	2.2259	2.2259	2.1132	2.1329	2.1329	2.1329	2.1329	2.1329
Jan-08	1.2124	1.1622	1.2949	1.2949	1.2987	1.2983	1.2983	1.2983	1.2983	1.2983
Feb-08	0.9725	0.9659	1.0000	1.0000	0.9425	0.9498	0.9499	0.9498	0.9498	0.9498
Mar-08	0.9673	0.9501	0.9420	0.9420	0.9252	0.9270	0.9270	0.9270	0.9270	0.9270
Apr-08	1.2220	1.2019	1.2258	1.2259	1.2152	1.2181	1.2181	1.2181	1.2181	1.2181
May-08	1.7746	1.6574	1.6294	1.6293	1.5060	1.5372	1.5371	1.5372	1.5372	1.5372
Jun-08	2.2365	2.2401	2.2307	2.2307	2.2349	2.2338	2.2338	2.2338	2.2338	2.2338
Jul-08	2.1263	2.1343	2.1196	2.1196	2.1305	2.1280	2.1280	2.1280	2.1280	2.1280

	GOAT ROCK-POOL NAA	GOAT ROCK-POOL Alt1A	GOAT ROCK-POOL Alt7A	GOAT ROCK-POOL Alt7B	GOAT ROCK-POOL Alt7H	GOAT ROCK-POOL Alt7I	GOAT ROCK-POOL Alt7J	GOAT ROCK-POOL Alt7K	GOAT ROCK-POOL Alt7L	GOAT ROCK-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Aug-08	1.5420	1.5488	1.5382	1.5382	1.5475	1.5454	1.5454	1.5454	1.5454	1.5454
Sep-08	2.0581	1.7617	2.0505	2.0505	2.0734	2.0685	2.0685	2.0685	2.0685	2.0685
Oct-08	1.8015	1.6170	2.0365	2.0365	1.9475	2.0673	2.0672	2.0673	2.0673	2.0673
Nov-08	2.1349	2.0337	2.1388	2.1388	2.1960	2.1914	2.1914	2.1914	2.1914	2.1914
Dec-08	1.1327	1.1166	1.3209	1.3209	1.0072	1.0310	1.0310	1.0310	1.0310	1.0310
Jan-09	0.9418	0.9484	1.0476	1.0035	1.0091	1.0222	0.9857	1.0222	1.0222	1.0222
Feb-09	1.2894	1.2658	1.3404	1.3053	1.2780	1.2791	1.2711	1.2791	1.2791	1.2791
Mar-09	0.4141	0.4101	0.4066	0.4015	0.4035	0.4034	0.4005	0.4034	0.4034	0.4034
Apr-09	0.5692	0.5755	0.5626	0.5329	0.5716	0.5722	0.5345	0.5722	0.5705	0.5722
May-09	1.0228	1.0309	1.0702	0.9576	1.1312	1.1418	0.9446	1.1418	1.0917	1.1231
Jun-09	1.3857	1.3865	1.3813	1.3746	1.3814	1.3846	1.3641	1.4008	1.3851	1.3850
Jul-09	2.0778	1.9663	1.8577	1.6478	2.3732	2.2224	1.6577	2.3784	1.9870	1.9865
Aug-09	1.9529	1.9083	2.1513	2.1068	2.2441	2.2438	2.0564	2.2940	2.0868	2.2473
Sep-09	0.4163	0.4154	0.4092	0.4082	0.4306	0.4310	0.4061	0.4302	0.4083	0.4253
Oct-09	0.4469	0.4445	0.4333	0.3912	0.4507	0.4476	0.3958	0.4477	0.4448	0.4448
Nov-09	0.2690	0.2752	0.2612	0.2594	0.2861	0.2754	0.2587	0.2768	0.2659	0.2715
Dec-09	0.2087	0.2081	0.2087	0.2077	0.2086	0.2086	0.2071	0.2087	0.2081	0.2083
Jan-10	0.3297	0.3279	0.3297	0.3272	0.3288	0.3292	0.3255	0.3293	0.3279	0.3285
Feb-10	0.3045	0.3032	0.3045	0.3023	0.3041	0.3044	0.3011	0.3045	0.3032	0.3038
Mar-10	0.3202	0.3186	0.3202	0.3176	0.3196	0.3199	0.3160	0.3201	0.3186	0.3192
Apr-10	0.7578	0.7520	0.7578	0.7471	0.7593	0.7605	0.7424	0.7611	0.7560	0.7553
May-10	0.5479	0.5464	0.5562	0.5453	0.5603	0.5608	0.5439	0.5614	0.5540	0.5584
Jun-10	1.2238	1.2117	1.2348	1.2308	1.2155	1.2204	1.2130	1.2206	1.2172	1.2189
Jul-10	1.5272	1.5087	1.5678	1.5620	1.5455	1.5576	1.5488	1.5575	1.5581	1.5578
Aug-10	1.6454	1.6488	1.6490	1.6512	1.6540	1.6530	1.6533	1.6530	1.6529	1.6530
Sep-10	1.6419	1.6482	1.6757	1.6528	1.6524	1.6510	1.6544	1.6507	1.6521	1.6517
Oct-10	1.5951	1.6061	1.8235	1.6181	1.8584	1.8946	1.6209	1.8940	1.7594	1.8248
Nov-10	1.3260	1.3374	1.3453	1.3540	1.3472	1.3478	1.3600	1.3471	1.3482	1.3486
Dec-10	1.1168	1.0327	1.0580	0.9959	1.0843	1.0802	0.9409	1.0882	1.0159	1.0363
Jan-11	1.1618	1.1523	0.7589	0.7310	0.7848	0.7842	0.7260	0.7848	0.7589	0.7835
Feb-11	0.7413	0.7289	1.0786	1.0740	1.0596	1.0588	1.0584	1.0596	1.0625	1.0577
Mar-11	0.5526	0.5484	0.5654	0.5392	0.5605	0.5607	0.5315	0.5623	0.5579	0.5543
Apr-11	0.6088	0.6023	0.5476	0.5468	0.5489	0.5485	0.5410	0.5487	0.5389	0.5485
May-11	1.0882	1.0506	0.7822	0.7739	0.7736	0.7735	0.7363	0.7734	0.7694	0.7770

	GOAT ROCK-POOL NAA	GOAT ROCK-POOL Alt1A	GOAT ROCK-POOL Alt7A	GOAT ROCK-POOL Alt7B	GOAT ROCK-POOL Alt7H	GOAT ROCK-POOL Alt7I	GOAT ROCK-POOL Alt7J	GOAT ROCK-POOL Alt7K	GOAT ROCK-POOL Alt7L	GOAT ROCK-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Jun-11	2.0604	2.0350	2.0288	1.9432	2.0369	2.0522	2.0017	2.0521	2.0496	2.0167
Jul-11	2.1798	2.1078	2.3046	2.3338	2.2807	2.2834	2.3281	2.2830	2.2871	2.3127
Aug-11	2.1377	2.1106	2.6293	2.3965	2.3260	2.3213	2.3239	2.3211	2.3219	2.3239
Sep-11	1.5620	1.5489	1.9374	1.9054	1.8136	1.8969	1.8734	1.8987	1.8902	1.8804
Oct-11	2.1425	2.1055	1.8134	2.0228	2.1796	2.0569	2.0309	2.0554	2.0571	2.0722
Nov-11	1.6148	1.5839	1.6176	1.5184	1.5126	1.6021	1.5513	1.6095	1.6106	1.5780
Dec-11	1.2712	1.2769	1.5775	1.5010	1.4986	1.5418	1.5003	1.5468	1.5403	1.5177
Overall Median	1.090	1.067	1.070	1.042	1.055	1.058	1.031	1.058	1.045	1.049
May-October Median	1.535	1.530	1.555	1.552	1.534	1.541	1.547	1.545	1.546	1.546
May-October Average	1.455	1.431	1.518	1.482	1.503	1.515	1.469	1.518	1.492	1.497
April-October Median	1.435	1.401	1.440	1.375	1.399	1.400	1.374	1.403	1.417	1.417
April-October Average	1.372	1.349	1.412	1.379	1.399	1.410	1.367	1.412	1.389	1.394
	JIM WOODRUFF-POOL NAA	**JIM WOODRUFF-POOL Alt1A**	**JIM WOODRUFF-POOL Alt7A**	**JIM WOODRUFF-POOL Alt7B**	**JIM WOODRUFF-POOL Alt7H**	**JIM WOODRUFF-POOL Alt7I**	**JIM WOODRUFF-POOL Alt7J**	**JIM WOODRUFF-POOL Alt7K**	**JIM WOODRUFF-POOL Alt7L**	**JIM WOODRUFF-POOL Alt7M**
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Dec-00	9.353	9.362	9.792	9.716	9.677	9.682	9.682	9.682	9.682	9.682
Jan-01	13.795	13.660	13.894	13.850	13.781	13.792	13.787	13.792	13.797	13.770
Feb-01	15.614	15.414	15.567	15.577	15.462	15.481	15.468	15.481	15.434	15.481
Mar-01	3.482	3.478	3.483	3.476	3.477	3.475	3.473	3.476	3.472	3.472
Apr-01	5.407	5.350	5.318	5.320	5.388	5.397	5.388	5.394	5.397	5.397
May-01	20.713	20.526	19.244	18.733	19.311	19.390	19.313	19.390	19.380	19.392
Jun-01	11.223	11.257	11.594	11.320	11.288	11.289	11.312	11.289	11.296	11.290
Jul-01	17.090	17.152	15.592	15.323	15.380	15.389	15.267	15.393	15.343	15.363
Aug-01	20.918	20.817	20.027	19.914	20.030	20.056	19.868	20.066	20.063	20.023
Sep-01	22.768	22.769	23.694	23.692	23.709	23.706	23.657	23.705	23.748	23.779
Oct-01	25.187	25.226	26.430	26.522	26.540	26.868	27.019	26.530	25.547	25.569
Nov-01	26.141	25.479	29.148	28.387	29.195	28.812	27.294	29.059	28.289	28.898
Dec-01	22.921	22.690	23.071	22.652	23.583	23.629	23.077	23.692	23.436	23.158

Month-Year	JIM WOODRUFF-POOL NAA days	JIM WOODRUFF-POOL Alt1A days	JIM WOODRUFF-POOL Alt7A days	JIM WOODRUFF-POOL Alt7B days	JIM WOODRUFF-POOL Alt7H days	JIM WOODRUFF-POOL Alt7I days	JIM WOODRUFF-POOL Alt7J days	JIM WOODRUFF-POOL Alt7K days	JIM WOODRUFF-POOL Alt7L days	JIM WOODRUFF-POOL Alt7M days
Jan-02	20.502	20.333	14.819	14.178	15.368	15.459	13.882	15.456	14.443	14.850
Feb-02	14.351	14.310	16.580	16.873	16.337	16.385	13.437	16.402	16.617	16.435
Mar-02	13.259	13.174	13.540	13.466	13.429	13.413	15.214	13.413	13.452	13.452
Apr-02	12.732	12.631	12.368	12.278	12.416	12.387	12.224	12.385	12.299	12.311
May-02	24.175	23.884	21.707	21.501	21.500	21.598	21.536	21.618	21.638	21.629
Jun-02	34.247	34.192	31.855	31.782	31.775	31.875	31.751	31.867	31.871	31.878
Jul-02	31.920	31.893	31.840	31.843	31.871	31.851	31.856	31.852	31.852	31.852
Aug-02	31.800	31.866	31.964	31.939	31.958	31.956	31.958	31.956	31.958	31.957
Sep-02	23.985	24.316	27.576	27.639	27.647	27.644	27.646	27.644	27.644	27.644
Oct-02	20.973	20.466	21.161	21.123	21.048	21.169	20.980	21.166	21.169	21.170
Nov-02	10.608	10.506	10.896	10.718	10.617	10.654	10.525	10.665	10.583	10.610
Dec-02	9.785	9.776	9.746	9.672	9.908	9.892	9.653	9.899	9.728	9.747
Jan-03	11.946	11.991	10.143	10.048	10.100	10.103	10.075	10.103	10.110	10.080
Feb-03	8.432	8.402	8.585	8.326	8.751	8.729	8.289	8.740	8.648	8.715
Mar-03	4.261	4.288	4.184	4.166	4.210	4.207	4.160	4.208	4.182	4.201
Apr-03	5.945	5.937	5.940	5.926	5.947	5.947	5.912	5.948	5.937	5.943
May-03	5.065	5.060	5.069	5.044	5.070	5.072	5.043	5.073	5.060	5.064
Jun-03	5.422	5.417	5.422	5.400	5.427	5.429	5.394	5.430	5.417	5.422
Jul-03	5.942	5.936	5.942	5.915	5.949	5.950	5.909	5.951	5.936	5.942
Aug-03	8.160	8.149	8.159	8.127	8.165	8.168	8.118	8.170	8.149	8.158
Sep-03	14.333	14.302	14.347	14.284	14.306	14.326	14.255	14.327	14.314	14.320
Oct-03	16.380	16.271	16.350	16.191	16.231	16.255	16.116	16.255	16.255	16.255
Nov-03	13.408	13.384	13.416	13.220	13.590	13.571	13.181	13.587	13.389	13.470
Dec-03	12.074	12.051	12.073	12.023	12.079	12.079	12.001	12.081	12.050	12.063
Jan-04	12.160	12.110	11.075	10.987	10.994	10.999	10.949	11.000	10.978	10.986
Feb-04	6.410	6.395	6.638	6.634	6.624	6.624	6.621	6.624	6.624	6.624
Mar-04	11.133	11.123	9.495	9.507	9.457	9.454	9.502	9.451	9.476	9.468
Apr-04	15.936	15.902	13.182	13.052	13.395	13.385	12.779	13.342	13.161	13.372
May-04	15.285	15.244	20.453	20.305	20.329	20.334	20.288	20.461	20.451	20.309
Jun-04	18.519	18.450	20.108	20.171	20.109	20.173	20.132	20.093	20.013	20.113
Jul-04	16.679	16.622	17.060	16.587	17.297	17.267	16.510	17.302	17.013	17.108
Aug-04	20.432	20.282	20.298	20.516	19.916	19.936	20.291	19.911	20.155	20.078

Month-Year	JIM WOODRUFF-POOL NAA days	JIM WOODRUFF-POOL Alt1A days	JIM WOODRUFF-POOL Alt7A days	JIM WOODRUFF-POOL Alt7B days	JIM WOODRUFF-POOL Alt7H days	JIM WOODRUFF-POOL Alt7I days	JIM WOODRUFF-POOL Alt7J days	JIM WOODRUFF-POOL Alt7K days	JIM WOODRUFF-POOL Alt7L days	JIM WOODRUFF-POOL Alt7M days
Sep-04	7.873	7.825	7.856	7.803	7.820	7.827	7.800	7.828	7.803	7.813
Oct-04	11.489	11.494	11.685	11.440	11.784	11.782	11.426	11.782	11.688	11.778
Nov-04	9.433	9.405	9.566	9.360	9.636	9.633	9.333	9.632	9.545	9.570
Dec-04	8.128	8.109	8.128	8.094	8.182	8.177	8.075	8.201	8.109	8.117
Jan-05	10.206	10.171	10.169	10.138	10.143	10.151	10.110	10.152	10.142	10.146
Feb-05	7.767	7.748	7.791	7.732	7.794	7.795	7.708	7.798	7.766	7.779
Mar-05	5.120	5.112	5.120	5.113	5.117	5.119	5.104	5.119	5.112	5.115
Apr-05	2.718	2.716	2.718	2.715	2.719	2.719	2.714	2.719	2.716	2.718
May-05	8.933	8.924	9.037	9.039	9.012	9.014	9.021	9.014	9.029	9.018
Jun-05	8.354	8.336	8.357	8.264	8.381	8.386	8.248	8.390	8.339	8.361
Jul-05	3.592	3.589	3.591	3.579	3.594	3.594	3.577	3.595	3.588	3.591
Aug-05	6.543	6.536	6.543	6.514	6.550	6.552	6.506	6.553	6.536	6.543
Sep-05	14.010	13.996	14.007	14.003	14.017	14.018	13.993	14.019	14.002	14.008
Oct-05	15.751	15.700	15.777	15.684	15.696	15.721	15.631	15.726	15.697	15.709
Nov-05	16.491	16.354	16.500	16.504	16.347	16.373	16.380	16.373	16.376	16.375
Dec-05	11.108	11.087	11.077	10.873	11.079	11.078	10.849	11.080	11.053	11.062
Jan-06	8.283	8.259	8.285	8.244	8.347	8.343	8.219	8.349	8.266	8.301
Feb-06	8.073	8.053	8.073	8.046	8.069	8.071	8.026	8.072	8.053	8.061
Mar-06	7.738	7.719	7.752	7.718	7.732	7.736	7.699	7.737	7.733	7.740
Apr-06	11.705	11.691	10.853	10.800	10.840	10.839	10.801	10.840	10.830	10.862
May-06	13.634	13.619	11.241	11.307	11.246	11.238	11.319	11.236	11.265	11.244
Jun-06	26.820	26.808	26.308	26.392	26.362	26.334	26.449	26.329	26.363	26.351
Jul-06	25.706	25.682	34.375	34.536	34.529	34.461	34.696	34.446	34.539	34.510
Aug-06	31.948	31.667	31.951	31.473	31.509	31.709	31.013	31.752	31.479	31.563
Sep-06	24.921	24.914	27.519	27.541	27.573	27.550	27.563	27.549	27.556	27.554
Oct-06	24.962	24.863	31.190	31.229	30.690	31.170	29.163	31.188	29.786	30.991
Nov-06	17.116	16.777	17.261	17.015	16.693	16.734	16.853	16.739	16.847	16.707
Dec-06	19.252	19.062	19.284	19.261	19.411	19.417	19.153	19.417	19.155	19.412
Jan-07	9.362	9.311	9.310	9.181	9.429	9.431	9.166	9.431	9.275	9.432
Feb-07	10.365	10.344	10.417	10.284	10.534	10.541	10.319	10.541	10.382	10.416
Mar-07	8.960	8.915	8.338	8.281	9.792	9.788	8.285	9.779	8.310	8.329
Apr-07	12.723	12.633	10.941	10.671	10.301	10.292	10.610	10.265	11.069	10.758

Month-Year	JIM WOODRUFF-POOL NAA days	JIM WOODRUFF-POOL Alt1A days	JIM WOODRUFF-POOL Alt7A days	JIM WOODRUFF-POOL Alt7B days	JIM WOODRUFF-POOL Alt7H days	JIM WOODRUFF-POOL Alt7I days	JIM WOODRUFF-POOL Alt7J days	JIM WOODRUFF-POOL Alt7K days	JIM WOODRUFF-POOL Alt7L days	JIM WOODRUFF-POOL Alt7M days
May-07	24.567	24.237	24.070	23.681	22.359	22.379	23.680	22.358	24.070	23.659
Jun-07	33.255	33.257	32.713	32.740	32.744	32.718	32.779	32.741	32.754	32.738
Jul-07	32.388	32.538	33.103	33.153	33.256	33.199	33.316	33.230	33.252	33.227
Aug-07	33.176	33.216	32.670	32.717	32.913	32.833	32.924	32.882	32.890	32.878
Sep-07	32.884	32.946	32.423	32.505	32.517	32.405	32.518	32.436	32.462	32.432
Oct-07	33.415	33.245	36.507	32.859	32.724	36.689	33.010	37.015	32.696	32.656
Nov-07	33.728	33.710	37.596	33.685	37.717	37.798	33.358	37.848	37.637	37.454
Dec-07	31.984	31.949	32.244	32.096	32.510	32.516	32.334	32.578	32.078	32.490
Jan-08	12.293	12.127	12.541	12.485	12.349	12.317	12.561	12.291	12.463	12.431
Feb-08	7.486	7.474	7.539	7.539	7.464	7.474	7.474	7.474	7.474	7.474
Mar-08	8.222	8.195	8.106	8.105	8.102	8.103	8.104	8.103	8.103	8.103
Apr-08	9.477	10.032	9.556	9.553	10.216	10.187	10.181	10.187	10.187	10.187
May-08	24.548	23.265	21.722	21.720	20.849	20.906	20.912	20.906	20.906	20.906
Jun-08	32.423	32.163	31.375	31.375	30.386	30.678	30.677	30.678	30.679	30.678
Jul-08	29.915	29.912	29.554	29.554	29.599	29.589	29.589	29.589	29.589	29.589
Aug-08	15.767	15.784	17.121	17.121	17.154	17.153	17.153	17.153	17.153	17.153
Sep-08	17.767	17.728	17.787	17.787	17.784	17.782	17.782	17.782	17.782	17.782
Oct-08	23.547	21.911	23.667	23.668	23.663	23.664	23.664	23.664	23.664	23.664
Nov-08	19.491	19.293	19.976	19.976	19.906	20.168	20.167	20.168	20.168	20.168
Dec-08	7.122	7.109	7.252	7.252	6.992	7.017	7.017	7.017	7.017	7.017
Jan-09	10.840	10.860	10.928	10.867	10.895	10.916	10.832	10.916	10.916	10.916
Feb-09	15.408	15.334	16.226	16.075	15.937	15.999	15.962	15.999	15.999	15.999
Mar-09	5.721	5.706	5.637	5.619	5.627	5.621	5.614	5.621	5.621	5.621
Apr-09	2.910	2.891	2.868	2.879	2.897	2.896	2.874	2.896	2.907	2.897
May-09	9.330	9.405	9.480	9.265	9.486	9.499	9.252	9.499	9.408	9.487
Jun-09	12.033	12.020	12.032	11.976	12.112	12.123	11.946	12.120	12.109	12.105
Jul-09	20.413	20.738	20.255	20.034	20.303	20.660	20.038	20.292	20.442	20.441
Aug-09	20.722	21.005	20.419	20.073	20.618	20.355	20.156	20.615	20.164	20.351
Sep-09	10.239	10.160	10.247	10.168	10.691	10.700	10.124	10.743	10.236	10.531
Oct-09	8.766	8.747	8.692	8.304	8.800	8.773	8.349	8.774	8.749	8.749
Nov-09	5.418	5.471	5.330	5.313	5.564	5.473	5.307	5.485	5.390	5.439
Dec-09	2.707	2.705	2.707	2.703	2.707	2.707	2.701	2.707	2.705	2.706

Month-Year	JIM WOODRUFF-POOL NAA days	JIM WOODRUFF-POOL Alt1A days	JIM WOODRUFF-POOL Alt7A days	JIM WOODRUFF-POOL Alt7B days	JIM WOODRUFF-POOL Alt7H days	JIM WOODRUFF-POOL Alt7I days	JIM WOODRUFF-POOL Alt7J days	JIM WOODRUFF-POOL Alt7K days	JIM WOODRUFF-POOL Alt7L days	JIM WOODRUFF-POOL Alt7M days
Jan-10	3.751	3.746	3.751	3.745	3.749	3.750	3.740	3.750	3.746	3.748
Feb-10	3.316	3.311	3.316	3.309	3.314	3.315	3.305	3.315	3.311	3.313
Mar-10	4.916	4.908	4.916	4.903	4.914	4.915	4.894	4.916	4.908	4.911
Apr-10	10.176	10.153	10.172	10.131	10.177	10.182	10.112	10.185	10.162	10.161
May-10	6.676	6.675	6.757	6.735	6.750	6.751	6.718	6.752	6.738	6.748
Jun-10	13.240	13.209	13.414	13.368	13.395	13.410	13.329	13.412	13.381	13.394
Jul-10	18.433	18.436	18.435	18.438	18.438	18.436	18.438	18.436	18.436	18.436
Aug-10	21.834	21.764	21.832	21.732	21.800	21.544	21.709	21.786	21.827	21.842
Sep-10	27.729	27.713	27.766	27.581	27.828	27.908	27.607	27.833	27.712	27.710
Oct-10	24.719	24.782	23.995	23.973	24.212	24.187	23.953	24.210	24.041	24.073
Nov-10	21.004	21.071	22.392	21.713	22.062	22.219	21.730	22.235	22.041	22.226
Dec-10	19.671	19.188	19.206	18.740	19.312	19.277	18.073	19.335	18.902	18.937
Jan-11	17.224	17.119	11.435	11.299	11.604	11.604	11.300	11.604	11.442	11.604
Feb-11	9.592	9.544	12.037	12.000	11.994	11.992	11.942	11.999	11.972	11.985
Mar-11	9.732	9.705	9.824	9.693	9.839	9.830	9.631	9.841	9.806	9.780
Apr-11	10.158	9.893	9.011	8.902	8.928	8.936	8.983	8.933	8.856	8.986
May-11	21.885	21.520	15.522	15.591	15.570	15.573	15.171	15.571	15.580	15.610
Jun-11	34.075	33.923	32.431	32.516	32.437	32.424	32.292	32.418	32.430	32.469
Jul-11	28.625	28.480	34.676	34.593	34.627	34.651	34.612	34.654	34.640	34.624
Aug-11	33.729	33.672	33.439	33.618	33.634	33.625	33.644	33.623	33.630	33.636
Sep-11	33.266	33.207	32.938	33.178	33.335	33.210	33.266	33.206	33.225	33.244
Oct-11	33.840	33.833	32.554	32.628	32.571	32.542	32.670	32.538	32.575	32.573
Nov-11	31.672	31.655	33.020	33.356	33.298	33.046	33.311	33.021	33.027	33.120
Dec-11	32.352	32.081	36.228	35.160	35.169	35.794	35.157	35.806	35.793	35.283
Overall Median	13.795	13.660	13.416	13.368	13.429	13.413	13.329	13.413	13.389	13.452
May-October Median	20.820	20.778	20.359	20.238	20.316	20.344	20.222	20.376	20.303	20.330
May-October Average	20.439	20.357	20.650	20.535	20.548	20.628	20.483	20.633	20.533	20.557
April-October Median	18.433	18.436	18.435	18.438	18.438	18.436	18.438	18.436	18.436	18.436

Month-Year	JIM WOODRUFF-POOL NAA days	JIM WOODRUFF-POOL Alt1A days	JIM WOODRUFF-POOL Alt7A days	JIM WOODRUFF-POOL Alt7B days	JIM WOODRUFF-POOL Alt7H days	JIM WOODRUFF-POOL Alt7I days	JIM WOODRUFF-POOL Alt7J days	JIM WOODRUFF-POOL Alt7K days	JIM WOODRUFF-POOL Alt7L days	JIM WOODRUFF-POOL Alt7M days
April-October Average	18.816	18.745	18.907	18.799	18.823	18.891	18.759	18.894	18.814	18.835
Month-Year	**MORGAN FALLS-POOL NAA days**	**MORGAN FALLS-POOL Alt1A days**	**MORGAN FALLS-POOL Alt7A days**	**MORGAN FALLS-POOL Alt7B days**	**MORGAN FALLS-POOL Alt7H days**	**MORGAN FALLS-POOL Alt7I days**	**MORGAN FALLS-POOL Alt7J days**	**MORGAN FALLS-POOL Alt7K days**	**MORGAN FALLS-POOL Alt7L days**	**MORGAN FALLS-POOL Alt7M days**
Dec-00	1.1739	1.1014	1.2979	1.2978	1.1828	1.2098	1.2098	1.2098	1.2098	1.2098
Jan-01	0.9479	0.9227	1.0638	0.9708	1.0183	1.0251	0.9945	1.0251	0.9440	1.0055
Feb-01	1.0151	0.9917	1.0407	1.0407	1.0183	1.0247	1.0247	1.0247	1.0247	1.0247
Mar-01	0.7080	0.7080	0.7080	0.6470	0.6760	0.6710	0.6516	0.6710	0.6564	0.6563
Apr-01	1.0134	0.9791	0.8910	0.8580	0.8479	0.8502	0.8514	0.8501	0.8509	0.8506
May-01	1.0060	0.9550	0.9373	0.6527	0.8585	0.8631	0.8546	0.8630	0.8639	0.8635
Jun-01	0.9145	0.8815	0.7665	0.6485	0.6401	0.6422	0.6445	0.6421	0.6430	0.6426
Jul-01	0.7472	0.7779	0.6443	0.6451	0.6434	0.6410	0.6427	0.6410	0.6412	0.6410
Aug-01	0.6830	0.6769	0.6823	0.6828	0.6742	0.6762	0.6775	0.6762	0.6758	0.6757
Sep-01	0.7607	0.7518	0.7598	0.7585	0.8618	0.8256	0.7497	0.8638	0.7500	0.7505
Oct-01	0.8114	0.8001	0.9383	0.8083	1.0058	1.0274	0.7962	1.0274	0.7980	0.8689
Nov-01	0.8263	0.8160	1.2084	0.8375	1.1021	1.1271	0.8259	1.1271	1.0288	1.1271
Dec-01	0.7908	0.7823	0.8359	0.8003	1.0455	0.9582	0.7910	0.9619	0.8323	0.9055
Jan-02	0.7087	0.7108	0.8074	0.6339	0.7982	0.8134	0.5920	0.8134	0.7941	0.7941
Feb-02	1.1063	1.0668	1.1473	1.0313	1.1123	1.1241	0.9435	1.1241	1.1241	1.1241
Mar-02	0.9384	0.9287	0.9384	0.8918	0.9384	0.9384	0.8918	0.9384	0.9384	0.9384
Apr-02	0.9848	0.9337	0.8648	0.7844	0.9031	0.8878	0.7973	0.8983	0.8532	0.8615
May-02	0.8954	0.8556	0.7828	0.7836	0.7700	0.7741	0.7756	0.7740	0.7744	0.7742
Jun-02	1.0697	0.9947	0.9964	0.9414	0.9588	0.9664	0.9595	0.9788	0.9620	0.9619
Jul-02	1.0428	0.9671	1.0428	0.9784	0.9440	0.9671	0.9430	0.9671	0.9671	0.9671
Aug-02	1.0149	0.9461	1.0149	1.0120	0.9251	0.9461	0.9461	0.9461	0.9461	0.9461
Sep-02	0.8865	0.9086	0.9432	0.8596	0.8967	0.9086	0.8498	0.9086	0.9086	0.9086
Oct-02	0.7027	0.7619	0.8619	0.8505	0.9338	0.9445	0.8439	0.9445	0.8861	0.9158
Nov-02	0.5581	0.5586	0.6472	0.6030	0.6574	0.6573	0.6071	0.6573	0.6473	0.6475
Dec-02	0.5072	0.5188	0.4786	0.4349	0.5716	0.5647	0.4508	0.5682	0.4830	0.4907
Jan-03	0.6540	0.6843	0.5264	0.4434	0.6193	0.6075	0.4431	0.6115	0.5548	0.5995

	MORGAN FALLS-POOL NAA	MORGAN FALLS-POOL Alt1A	MORGAN FALLS-POOL Alt7A	MORGAN FALLS-POOL Alt7B	MORGAN FALLS-POOL Alt7H	MORGAN FALLS-POOL Alt7I	MORGAN FALLS-POOL Alt7J	MORGAN FALLS-POOL Alt7K	MORGAN FALLS-POOL Alt7L	MORGAN FALLS-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Feb-03	0.5836	0.5870	0.4347	0.3666	0.5308	0.5240	0.3668	0.5274	0.4728	0.5119
Mar-03	0.3131	0.3452	0.2731	0.2652	0.2785	0.2762	0.2652	0.2771	0.2717	0.2733
Apr-03	0.4380	0.4379	0.4365	0.4266	0.4497	0.4485	0.4219	0.4494	0.4378	0.4427
May-03	0.2638	0.2637	0.2647	0.2535	0.2682	0.2686	0.2551	0.2691	0.2641	0.2661
Jun-03	0.2720	0.2722	0.2717	0.2622	0.2773	0.2771	0.2624	0.2776	0.2718	0.2742
Jul-03	0.2893	0.2893	0.2893	0.2791	0.2950	0.2950	0.2791	0.2955	0.2893	0.2918
Aug-03	0.4859	0.4870	0.4846	0.4660	0.4985	0.4975	0.4662	0.4986	0.4859	0.4910
Sep-03	0.6793	0.6721	0.6806	0.6611	0.6697	0.6726	0.6573	0.6726	0.6728	0.6727
Oct-03	0.6693	0.6663	0.6681	0.6322	0.6640	0.6658	0.6341	0.6658	0.6663	0.6661
Nov-03	0.4717	0.4757	0.4730	0.4332	0.5218	0.5187	0.4338	0.5228	0.4765	0.4945
Dec-03	0.5166	0.5166	0.5142	0.4942	0.5247	0.5254	0.4941	0.5264	0.5140	0.5191
Jan-04	0.5526	0.5554	0.3247	0.3149	0.3201	0.3196	0.3163	0.3198	0.3180	0.3185
Feb-04	0.3614	0.3601	0.5221	0.5189	0.5218	0.5218	0.5190	0.5218	0.5219	0.5218
Mar-04	0.4800	0.4827	0.4342	0.4158	0.4624	0.4618	0.4167	0.4641	0.4459	0.4529
Apr-04	0.5155	0.5204	0.3817	0.3665	0.4019	0.4005	0.3564	0.3983	0.3834	0.3975
May-04	0.5691	0.5642	0.8450	0.8451	0.8308	0.8349	0.8350	0.8349	0.8349	0.8349
Jun-04	0.6145	0.6128	0.7253	0.7256	0.7218	0.7227	0.7230	0.7227	0.7228	0.7228
Jul-04	0.6720	0.6649	0.6766	0.6780	0.6708	0.6723	0.6739	0.6722	0.6727	0.6727
Aug-04	0.7097	0.7055	0.7081	0.7095	0.7016	0.7037	0.7049	0.7037	0.7038	0.7038
Sep-04	0.3828	0.3851	0.4121	0.3683	0.4155	0.4157	0.3817	0.4156	0.4120	0.4139
Oct-04	0.5585	0.5599	0.5984	0.5459	0.6428	0.6445	0.5469	0.6443	0.6057	0.6360
Nov-04	0.3904	0.3897	0.4305	0.3691	0.4952	0.4944	0.3686	0.4955	0.4325	0.4426
Dec-04	0.2984	0.2984	0.2963	0.2898	0.3007	0.2999	0.2897	0.3050	0.2963	0.2979
Jan-05	0.5384	0.5385	0.5307	0.5142	0.5391	0.5390	0.5208	0.5393	0.5353	0.5370
Feb-05	0.3106	0.3106	0.3161	0.3050	0.3230	0.3228	0.3025	0.3236	0.3144	0.3181
Mar-05	0.2913	0.2913	0.2913	0.2838	0.2955	0.2955	0.2838	0.2959	0.2913	0.2932
Apr-05	0.3604	0.3604	0.3604	0.3522	0.3649	0.3649	0.3522	0.3653	0.3604	0.3624
May-05	0.4266	0.4283	0.4537	0.4385	0.4722	0.4712	0.4395	0.4723	0.4552	0.4601
Jun-05	0.4241	0.4222	0.4011	0.3709	0.4114	0.4117	0.3703	0.4132	0.3998	0.4068
Jul-05	0.2573	0.2574	0.2567	0.2480	0.2617	0.2617	0.2480	0.2621	0.2567	0.2589
Aug-05	0.3005	0.3005	0.3005	0.2908	0.3059	0.3059	0.2908	0.3064	0.3005	0.3029
Sep-05	0.5634	0.5646	0.5708	0.5511	0.5774	0.5770	0.5529	0.5785	0.5702	0.5736
Oct-05	0.6464	0.6398	0.6476	0.6449	0.6384	0.6407	0.6413	0.6407	0.6409	0.6408

	MORGAN FALLS-POOL NAA	MORGAN FALLS-POOL Alt1A	MORGAN FALLS-POOL Alt7A	MORGAN FALLS-POOL Alt7B	MORGAN FALLS-POOL Alt7H	MORGAN FALLS-POOL Alt7I	MORGAN FALLS-POOL Alt7J	MORGAN FALLS-POOL Alt7K	MORGAN FALLS-POOL Alt7L	MORGAN FALLS-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Nov-05	0.6439	0.6397	0.6487	0.6496	0.6435	0.6447	0.6462	0.6447	0.6453	0.6450
Dec-05	0.5215	0.5284	0.5018	0.4402	0.5246	0.5250	0.4428	0.5259	0.5065	0.5139
Jan-06	0.3587	0.3584	0.3638	0.3503	0.3879	0.3863	0.3500	0.3884	0.3648	0.3744
Feb-06	0.4087	0.4087	0.4087	0.3953	0.4164	0.4162	0.3953	0.4169	0.4087	0.4120
Mar-06	0.4865	0.4865	0.4619	0.4455	0.4891	0.4896	0.4480	0.4906	0.4629	0.4671
Apr-06	0.4786	0.4748	0.4458	0.4259	0.4420	0.4401	0.4263	0.4419	0.4421	0.4496
May-06	0.5531	0.5595	0.3943	0.3823	0.4039	0.4035	0.3833	0.4035	0.3973	0.3994
Jun-06	0.7816	0.7731	0.9913	0.9554	0.9696	0.9851	0.9249	0.9907	0.9532	0.9638
Jul-06	0.8639	0.8462	1.0488	1.0489	0.9535	0.9770	0.9770	0.9771	0.9770	0.9770
Aug-06	0.8286	0.8162	1.0988	1.0493	1.0040	1.0289	1.0150	1.0289	1.0289	1.0289
Sep-06	0.8282	0.8160	1.0370	1.0365	1.0237	1.0483	1.0010	1.0483	1.0271	1.0483
Oct-06	0.8046	0.7945	0.9828	0.9823	0.9758	0.9783	0.9543	0.9783	0.9547	0.9592
Nov-06	0.6821	0.6786	0.8293	0.8292	0.8227	0.8244	0.8237	0.8245	0.8241	0.8243
Dec-06	0.7944	0.7855	0.8111	0.7801	0.9852	0.9893	0.8039	0.9894	0.8046	0.9893
Jan-07	0.6732	0.6699	0.6776	0.5822	0.8061	0.8075	0.5803	0.8074	0.6748	0.8076
Feb-07	0.7205	0.7162	0.7264	0.6174	0.8774	0.8792	0.6772	0.8791	0.7233	0.7311
Mar-07	0.6909	0.7215	0.4796	0.4180	0.6035	0.5645	0.4229	0.5796	0.5147	0.4764
Apr-07	0.6657	0.6654	0.4358	0.4037	0.4037	0.4080	0.4016	0.4066	0.4504	0.4243
May-07	0.6763	0.6800	0.6609	0.6532	0.6273	0.6130	0.6650	0.6264	0.6921	0.6739
Jun-07	1.0668	0.9968	0.9970	0.9772	0.9063	1.0124	0.9139	0.9088	0.9091	0.9061
Jul-07	0.8963	0.9247	1.0644	1.0644	0.9704	0.9942	0.9942	0.9942	0.9941	0.9941
Aug-07	0.8531	0.8663	1.0420	1.0402	0.9476	0.9697	0.9697	0.9697	0.9697	0.9697
Sep-07	0.9242	0.9499	0.6792	0.6773	0.9672	0.9683	0.9710	0.9892	0.9892	0.9892
Oct-07	0.6704	0.7158	0.9640	0.6986	0.6951	0.8012	0.6064	0.7950	0.6776	0.6677
Nov-07	1.0045	1.0182	1.2297	0.8051	1.1221	1.1479	1.1317	1.1479	1.1479	1.1479
Dec-07	1.0645	1.0195	1.1563	1.1563	1.0823	1.1004	1.1004	1.1004	1.1004	1.1004
Jan-08	1.1384	1.0829	1.2124	1.2124	1.1455	1.1647	1.1647	1.1647	1.1647	1.1647
Feb-08	0.9497	0.9346	0.9632	0.9632	0.9516	0.9550	0.9550	0.9550	0.9550	0.9550
Mar-08	0.9725	0.9592	0.9769	0.9769	0.9740	0.9754	0.9754	0.9754	0.9754	0.9754
Apr-08	1.0699	1.0165	1.1308	1.1308	1.0611	1.0797	1.0798	1.0797	1.0797	1.0797
May-08	1.0952	1.0172	1.0952	1.0952	0.9933	1.0172	1.0172	1.0172	1.0172	1.0172
Jun-08	1.0585	0.9850	1.0585	1.0585	0.9626	0.9850	0.9850	0.9850	0.9850	0.9850
Jul-08	1.0503	0.9813	1.0503	1.0503	0.9590	0.9813	0.9812	0.9813	0.9812	0.9813

	MORGAN FALLS-POOL NAA	MORGAN FALLS-POOL Alt1A	MORGAN FALLS-POOL Alt7A	MORGAN FALLS-POOL Alt7B	MORGAN FALLS-POOL Alt7H	MORGAN FALLS-POOL Alt7I	MORGAN FALLS-POOL Alt7J	MORGAN FALLS-POOL Alt7K	MORGAN FALLS-POOL Alt7L	MORGAN FALLS-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Aug-08	1.0169	0.9624	1.0169	1.0169	0.9447	0.9624	0.9624	0.9624	0.9624	0.9624
Sep-08	1.0396	0.9707	1.0396	1.0396	0.9496	0.9707	0.9708	0.9707	0.9707	0.9707
Oct-08	1.0998	1.0296	1.1030	1.1030	1.0106	1.0324	1.0324	1.0324	1.0324	1.0324
Nov-08	1.1047	1.0363	1.2138	1.2137	1.1066	1.1317	1.1317	1.1317	1.1317	1.1317
Dec-08	0.8004	0.8684	1.0553	1.0478	1.0003	1.0139	1.0139	1.0139	1.0139	1.0139
Jan-09	0.7092	0.7366	0.9737	0.8235	0.9323	0.9424	0.8290	0.9424	0.9424	0.9424
Feb-09	1.0558	1.0064	1.1391	1.1104	1.0643	1.0824	1.0824	1.0824	1.0824	1.0824
Mar-09	0.8021	0.7926	0.8138	0.7402	0.8033	0.8064	0.7597	0.8064	0.8064	0.8064
Apr-09	0.8393	0.9527	0.8284	0.6114	0.9643	0.9691	0.6313	0.9691	0.9300	0.9691
May-09	0.7253	0.7384	0.7785	0.6214	0.9637	0.9804	0.6154	0.9804	0.8708	0.9283
Jun-09	0.8123	0.7974	0.7156	0.6856	0.9571	0.8289	0.6748	0.9555	0.7994	0.7971
Jul-09	0.7778	0.7686	0.7801	0.6606	0.9227	0.9432	0.6958	0.9432	0.7688	0.8226
Aug-09	0.7605	0.7506	0.7598	0.7618	0.9056	0.9212	0.7506	0.9212	0.7498	0.9212
Sep-09	0.3446	0.3465	0.3419	0.3410	0.3792	0.3775	0.3401	0.3775	0.3451	0.3619
Oct-09	0.4258	0.4248	0.3672	0.2766	0.4407	0.4305	0.2882	0.4310	0.4258	0.4253
Nov-09	0.2675	0.2938	0.2490	0.2435	0.3438	0.2951	0.2435	0.3008	0.2592	0.2793
Dec-09	0.1975	0.1975	0.1975	0.1943	0.1992	0.1993	0.1943	0.1994	0.1975	0.1983
Jan-10	0.2559	0.2559	0.2559	0.2508	0.2587	0.2588	0.2508	0.2590	0.2559	0.2572
Feb-10	0.2272	0.2272	0.2272	0.2228	0.2295	0.2295	0.2228	0.2297	0.2272	0.2282
Mar-10	0.2988	0.2988	0.2988	0.2910	0.3032	0.3032	0.2910	0.3036	0.2988	0.3008
Apr-10	0.4785	0.4785	0.4791	0.4640	0.4910	0.4912	0.4645	0.4921	0.4843	0.4839
May-10	0.3599	0.3612	0.3742	0.3566	0.3861	0.3852	0.3570	0.3862	0.3735	0.3807
Jun-10	0.6227	0.6166	0.6232	0.6236	0.6145	0.6169	0.6174	0.6169	0.6170	0.6170
Jul-10	0.6446	0.6365	0.6451	0.6244	0.6339	0.6366	0.6282	0.6365	0.6371	0.6369
Aug-10	0.6499	0.6420	0.6505	0.6350	0.6391	0.6418	0.6440	0.6417	0.6426	0.6422
Sep-10	0.6557	0.6496	0.6700	0.6156	0.7234	0.7199	0.6264	0.7259	0.6758	0.6916
Oct-10	0.7181	0.7401	0.7419	0.6467	0.8058	0.8019	0.6495	0.8019	0.7614	0.7811
Nov-10	0.7893	0.7879	0.8169	0.7876	0.8044	0.8075	0.7655	0.8074	0.8079	0.8077
Dec-10	0.6268	0.6211	0.6384	0.6303	0.7431	0.7393	0.6264	0.7454	0.6341	0.6734
Jan-11	0.7627	0.7617	0.5326	0.4831	0.5899	0.5854	0.4876	0.5875	0.5473	0.5859
Feb-11	0.6700	0.6664	0.7994	0.7998	0.7941	0.7957	0.7961	0.7957	0.7956	0.7958
Mar-11	0.3862	0.3920	0.4257	0.3733	0.4273	0.4268	0.3701	0.4303	0.4203	0.4136
Apr-11	0.2973	0.2944	0.2509	0.2459	0.2538	0.2535	0.2481	0.2535	0.2475	0.2538

	MORGAN FALLS-POOL NAA	MORGAN FALLS-POOL Alt1A	MORGAN FALLS-POOL Alt7A	MORGAN FALLS-POOL Alt7B	MORGAN FALLS-POOL Alt7H	MORGAN FALLS-POOL Alt7I	MORGAN FALLS-POOL Alt7J	MORGAN FALLS-POOL Alt7K	MORGAN FALLS-POOL Alt7L	MORGAN FALLS-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
May-11	0.4362	0.4314	0.3244	0.3265	0.3265	0.3239	0.3007	0.3239	0.3188	0.3261
Jun-11	0.7641	0.7693	0.9252	0.8773	0.9735	0.9736	0.9493	0.9750	0.9749	0.9464
Jul-11	0.8154	0.8010	1.0455	0.9555	0.9462	0.9694	0.9692	0.9694	0.9694	0.9694
Aug-11	0.8698	0.8545	1.0288	1.0094	0.9366	0.9582	0.9582	0.9582	0.9582	0.9582
Sep-11	0.8544	0.8416	1.0750	1.0084	0.9790	1.0015	1.0015	1.0015	1.0015	1.0015
Oct-11	0.9091	0.8932	0.7238	0.8068	1.0303	0.8876	0.8455	0.8902	0.8346	0.8831
Nov-11	0.8383	0.8290	0.7561	0.6829	0.6641	0.8123	0.7282	0.8211	0.8715	0.7784
Dec-11	0.6905	0.6857	0.9784	0.8110	1.0004	0.9988	0.8852	0.9988	0.9568	0.9568
Overall Median	0.691	0.705	0.708	0.650	0.722	0.739	0.652	0.745	0.692	0.704
May-October Median	0.736	0.751	0.751	0.684	0.818	0.814	0.700	0.818	0.756	0.778
May-October Average	0.721	0.709	0.750	0.717	0.746	0.752	0.710	0.754	0.732	0.740
April-October Median	0.718	0.740	0.725	0.677	0.770	0.801	0.675	0.795	0.750	0.750
April-October Average	0.711	0.700	0.728	0.694	0.725	0.730	0.687	0.732	0.712	0.719
	NORTH HIGHLANDS-POOL NAA	**NORTH HIGHLANDS-POOL Alt1A**	**NORTH HIGHLANDS-POOL Alt7A**	**NORTH HIGHLANDS-POOL Alt7B**	**NORTH HIGHLANDS-POOL Alt7H**	**NORTH HIGHLANDS-POOL Alt7I**	**NORTH HIGHLANDS-POOL Alt7J**	**NORTH HIGHLANDS-POOL Alt7K**	**NORTH HIGHLANDS-POOL Alt7L**	**NORTH HIGHLANDS-POOL Alt7M**
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Dec-00	0.28481	0.28481	0.28481	0.28481	0.28481	0.28481	0.28481	0.28481	0.28481	0.28481
Jan-01	0.18764	0.17613	0.18813	0.18262	0.18146	0.18230	0.18070	0.18230	0.17800	0.18128
Feb-01	0.15372	0.15020	0.15449	0.15438	0.15135	0.15177	0.15176	0.15177	0.15167	0.15177
Mar-01	0.05028	0.05005	0.05028	0.04982	0.04987	0.04982	0.04964	0.04982	0.04969	0.04968
Apr-01	0.10915	0.10711	0.10647	0.10470	0.10442	0.10448	0.10453	0.10448	0.10450	0.10449
May-01	0.29286	0.27650	0.26013	0.23011	0.26012	0.26079	0.26108	0.26078	0.26090	0.26085
Jun-01	0.17633	0.17866	0.18117	0.16827	0.16486	0.16621	0.16566	0.16621	0.16631	0.16626
Jul-01	0.22555	0.22247	0.21210	0.20473	0.20360	0.20378	0.20391	0.20377	0.20382	0.20380
Aug-01	0.24166	0.24165	0.24256	0.24255	0.24191	0.24233	0.24123	0.24238	0.24187	0.24203
Sep-01	0.30014	0.30055	0.30152	0.30150	0.30233	0.30219	0.30221	0.30213	0.30233	0.30235
Oct-01	0.28239	0.27880	0.39858	0.37200	0.41829	0.41843	0.34186	0.42912	0.33524	0.34912

Month-Year	NORTH HIGHLANDS-POOL NAA days	NORTH HIGHLANDS-POOL Alt1A days	NORTH HIGHLANDS-POOL Alt7A days	NORTH HIGHLANDS-POOL Alt7B days	NORTH HIGHLANDS-POOL Alt7H days	NORTH HIGHLANDS-POOL Alt7I days	NORTH HIGHLANDS-POOL Alt7J days	NORTH HIGHLANDS-POOL Alt7K days	NORTH HIGHLANDS-POOL Alt7L days	NORTH HIGHLANDS-POOL Alt7M days
Nov-01	0.23223	0.22205	0.27716	0.25537	0.27774	0.27766	0.24733	0.27756	0.27315	0.27768
Dec-01	0.27288	0.26005	0.31242	0.27106	0.31800	0.30567	0.26461	0.31391	0.27545	0.29833
Jan-02	0.21570	0.21341	0.15815	0.14185	0.15763	0.15952	0.14079	0.15800	0.15672	0.15841
Feb-02	0.17775	0.17475	0.22879	0.23237	0.21895	0.22071	0.18608	0.22107	0.22295	0.21925
Mar-02	0.18773	0.18394	0.17440	0.17210	0.17041	0.17042	0.18636	0.17042	0.17042	0.17042
Apr-02	0.23182	0.22719	0.22188	0.22102	0.22381	0.22347	0.21922	0.22420	0.22010	0.22101
May-02	0.27848	0.26616	0.24349	0.23289	0.23667	0.23992	0.23240	0.24028	0.23961	0.23960
Jun-02	0.40667	0.40738	0.40665	0.40690	0.40702	0.40711	0.40711	0.40704	0.40713	0.40713
Jul-02	0.34216	0.34344	0.34232	0.34295	0.34336	0.34327	0.34342	0.34319	0.34330	0.34330
Aug-02	0.39344	0.39679	0.39372	0.39513	0.39700	0.39651	0.39683	0.39637	0.39655	0.39656
Sep-02	0.33705	0.30937	0.33730	0.33879	0.34144	0.34075	0.34111	0.34063	0.34079	0.34079
Oct-02	0.18112	0.17482	0.20513	0.19679	0.18940	0.19338	0.18735	0.19368	0.19333	0.19328
Nov-02	0.10973	0.10874	0.11229	0.10798	0.10827	0.10889	0.10446	0.10908	0.10700	0.10773
Dec-02	0.07851	0.07847	0.07755	0.07609	0.08045	0.08017	0.07625	0.08029	0.07729	0.07761
Jan-03	0.14832	0.14868	0.13512	0.12478	0.13891	0.13873	0.12477	0.13876	0.13569	0.13814
Feb-03	0.08843	0.08792	0.08370	0.07836	0.08752	0.08707	0.07741	0.08735	0.08516	0.08662
Mar-03	0.05799	0.05934	0.05484	0.05438	0.05556	0.05544	0.05411	0.05549	0.05460	0.05514
Apr-03	0.07923	0.07885	0.07915	0.07854	0.07946	0.07945	0.07791	0.07950	0.07884	0.07912
May-03	0.03820	0.03812	0.03822	0.03784	0.03823	0.03827	0.03782	0.03828	0.03813	0.03819
Jun-03	0.04569	0.04560	0.04569	0.04526	0.04581	0.04583	0.04516	0.04585	0.04559	0.04570
Jul-03	0.06483	0.06464	0.06483	0.06398	0.06506	0.06509	0.06379	0.06514	0.06464	0.06484
Aug-03	0.11937	0.11877	0.11928	0.11714	0.11972	0.11989	0.11651	0.12000	0.11868	0.11922
Sep-03	0.19995	0.19780	0.20042	0.19794	0.19666	0.19797	0.19583	0.19797	0.19797	0.19797
Oct-03	0.23122	0.22683	0.23049	0.22329	0.22570	0.22657	0.22046	0.22656	0.22664	0.22661
Nov-03	0.09265	0.09230	0.09273	0.09018	0.09499	0.09473	0.08966	0.09495	0.09235	0.09341
Dec-03	0.11051	0.10963	0.11050	0.10918	0.11025	0.11030	0.10832	0.11036	0.10962	0.10992
Jan-04	0.12937	0.12794	0.10156	0.09971	0.09981	0.09989	0.09892	0.09993	0.09948	0.09963
Feb-04	0.07423	0.07370	0.08279	0.08266	0.08224	0.08223	0.08211	0.08223	0.08223	0.08223
Mar-04	0.14369	0.14235	0.13600	0.13377	0.13750	0.13786	0.13282	0.13782	0.13586	0.13680
Apr-04	0.16639	0.16585	0.13209	0.12811	0.13411	0.13413	0.12465	0.13395	0.13173	0.13434
May-04	0.18444	0.18124	0.26031	0.26106	0.25820	0.25963	0.25704	0.26147	0.25700	0.25694
Jun-04	0.21323	0.21103	0.21433	0.21433	0.21273	0.21410	0.21380	0.21324	0.21312	0.21354

Month-Year	NORTH HIGHLANDS-POOL NAA days	NORTH HIGHLANDS-POOL Alt1A days	NORTH HIGHLANDS-POOL Alt7A days	NORTH HIGHLANDS-POOL Alt7B days	NORTH HIGHLANDS-POOL Alt7H days	NORTH HIGHLANDS-POOL Alt7I days	NORTH HIGHLANDS-POOL Alt7J days	NORTH HIGHLANDS-POOL Alt7K days	NORTH HIGHLANDS-POOL Alt7L days	NORTH HIGHLANDS-POOL Alt7M days
Jul-04	0.16393	0.16403	0.17624	0.17624	0.17574	0.17597	0.17593	0.17588	0.17592	0.17590
Aug-04	0.17362	0.16955	0.17361	0.17491	0.16876	0.16973	0.16997	0.16969	0.16965	0.16975
Sep-04	0.08714	0.08687	0.08708	0.08430	0.08665	0.08663	0.08497	0.08663	0.08637	0.08651
Oct-04	0.16462	0.16317	0.17317	0.16246	0.17681	0.17723	0.16102	0.17720	0.17230	0.17618
Nov-04	0.06773	0.06742	0.06956	0.06668	0.07132	0.07124	0.06639	0.07124	0.06935	0.06975
Dec-04	0.07076	0.07039	0.07076	0.07010	0.07125	0.07114	0.06974	0.07164	0.07038	0.07054
Jan-05	0.12222	0.12087	0.12074	0.11931	0.11972	0.12000	0.11854	0.12003	0.11968	0.11983
Feb-05	0.07194	0.07148	0.07252	0.07159	0.07258	0.07263	0.07093	0.07269	0.07195	0.07225
Mar-05	0.04853	0.04832	0.04853	0.04819	0.04847	0.04850	0.04798	0.04852	0.04832	0.04840
Apr-05	0.06259	0.06235	0.06259	0.06215	0.06253	0.06259	0.06191	0.06262	0.06235	0.06246
May-05	0.12441	0.12391	0.12866	0.12681	0.12951	0.12973	0.12618	0.12984	0.12807	0.12859
Jun-05	0.11141	0.11062	0.10828	0.10495	0.10877	0.10894	0.10433	0.10909	0.10758	0.10835
Jul-05	0.04326	0.04316	0.04323	0.04276	0.04336	0.04338	0.04267	0.04340	0.04313	0.04324
Aug-05	0.08323	0.08289	0.08323	0.08199	0.08355	0.08361	0.08166	0.08368	0.08289	0.08321
Sep-05	0.19608	0.19558	0.19837	0.19576	0.19850	0.19877	0.19533	0.19887	0.19771	0.19821
Oct-05	0.25114	0.24767	0.25071	0.24720	0.24577	0.24708	0.24399	0.24734	0.24627	0.24668
Nov-05	0.14971	0.14664	0.14993	0.15002	0.14651	0.14709	0.14724	0.14708	0.14714	0.14712
Dec-05	0.12475	0.12408	0.12332	0.11661	0.12394	0.12394	0.11582	0.12401	0.12247	0.12304
Jan-06	0.09483	0.09399	0.09513	0.09379	0.09699	0.09684	0.09294	0.09706	0.09446	0.09555
Feb-06	0.08746	0.08684	0.08746	0.08641	0.08734	0.08740	0.08581	0.08745	0.08684	0.08709
Mar-06	0.10079	0.09987	0.10027	0.09889	0.10020	0.10041	0.09807	0.10047	0.09937	0.09970
Apr-06	0.16462	0.15921	0.14547	0.14308	0.14611	0.14634	0.14234	0.14623	0.14445	0.14544
May-06	0.18312	0.18648	0.14864	0.14570	0.14816	0.14840	0.14524	0.14865	0.14780	0.14836
Jun-06	0.27380	0.27013	0.28547	0.28694	0.27984	0.28127	0.28310	0.28135	0.28075	0.28133
Jul-06	0.28509	0.28208	0.40683	0.40535	0.39818	0.40079	0.39732	0.40161	0.39883	0.39873
Aug-06	0.38030	0.38093	0.37867	0.37961	0.38055	0.38001	0.38102	0.37995	0.38034	0.38022
Sep-06	0.28186	0.27478	0.37757	0.37864	0.37264	0.37928	0.36524	0.37922	0.37820	0.37948
Oct-06	0.24699	0.23670	0.32980	0.32438	0.30659	0.31712	0.29922	0.31826	0.30625	0.31054
Nov-06	0.17996	0.18030	0.17865	0.17395	0.16749	0.16818	0.16753	0.16818	0.16789	0.16806
Dec-06	0.18975	0.18164	0.18577	0.18368	0.19445	0.19494	0.18211	0.19494	0.18217	0.19493
Jan-07	0.10334	0.10236	0.10345	0.09975	0.10636	0.10638	0.09891	0.10638	0.10246	0.10638
Feb-07	0.14581	0.14475	0.14864	0.14094	0.15515	0.15556	0.14364	0.15556	0.14676	0.14856

Month-Year	NORTH HIGHLANDS-POOL NAA days	NORTH HIGHLANDS-POOL Alt1A days	NORTH HIGHLANDS-POOL Alt7A days	NORTH HIGHLANDS-POOL Alt7B days	NORTH HIGHLANDS-POOL Alt7H days	NORTH HIGHLANDS-POOL Alt7I days	NORTH HIGHLANDS-POOL Alt7J days	NORTH HIGHLANDS-POOL Alt7K days	NORTH HIGHLANDS-POOL Alt7L days	NORTH HIGHLANDS-POOL Alt7M days
Mar-07	0.15103	0.14857	0.13488	0.12799	0.15070	0.14928	0.12754	0.15133	0.13748	0.13299
Apr-07	0.26738	0.26279	0.17511	0.16733	0.17024	0.17045	0.16483	0.16946	0.17774	0.17282
May-07	0.25811	0.25599	0.28126	0.26716	0.23895	0.23742	0.26683	0.23784	0.28084	0.26720
Jun-07	0.37534	0.36652	0.37559	0.37465	0.36782	0.37789	0.36633	0.36886	0.36705	0.36835
Jul-07	0.40705	0.40752	0.42838	0.42446	0.40391	0.41122	0.40683	0.40809	0.40677	0.40837
Aug-07	0.39930	0.39587	0.39768	0.40076	0.38303	0.39465	0.38457	0.38782	0.38717	0.38805
Sep-07	0.38915	0.38456	0.34125	0.33815	0.37149	0.35935	0.37134	0.37155	0.37246	0.37050
Oct-07	0.31828	0.33432	0.44309	0.33831	0.34967	0.41964	0.32111	0.40793	0.34986	0.34908
Nov-07	0.38252	0.36980	0.41880	0.32444	0.38972	0.39381	0.38184	0.39370	0.39799	0.39936
Dec-07	0.36216	0.34781	0.37417	0.37417	0.35566	0.35890	0.35890	0.35890	0.35890	0.35890
Jan-08	0.20523	0.19686	0.21893	0.21893	0.21955	0.21949	0.21949	0.21949	0.21949	0.21949
Feb-08	0.16286	0.16178	0.16733	0.16733	0.15797	0.15917	0.15917	0.15917	0.15917	0.15917
Mar-08	0.16265	0.15981	0.15849	0.15848	0.15571	0.15602	0.15602	0.15602	0.15602	0.15602
Apr-08	0.20583	0.20251	0.20646	0.20647	0.20471	0.20518	0.20518	0.20518	0.20518	0.20518
May-08	0.29801	0.27878	0.27418	0.27418	0.25386	0.25900	0.25899	0.25900	0.25900	0.25900
Jun-08	0.37958	0.38018	0.37860	0.37860	0.37931	0.37913	0.37913	0.37913	0.37913	0.37913
Jul-08	0.36153	0.36287	0.36040	0.36040	0.36223	0.36181	0.36181	0.36181	0.36181	0.36181
Aug-08	0.25816	0.25927	0.25754	0.25754	0.25905	0.25871	0.25871	0.25871	0.25871	0.25871
Sep-08	0.35008	0.30018	0.34881	0.34881	0.35265	0.35183	0.35183	0.35183	0.35183	0.35183
Oct-08	0.30523	0.27442	0.34433	0.34433	0.32955	0.34945	0.34943	0.34945	0.34945	0.34945
Nov-08	0.35575	0.33939	0.35637	0.35637	0.36560	0.36485	0.36485	0.36485	0.36485	0.36485
Dec-08	0.18934	0.18673	0.21974	0.21974	0.16892	0.17280	0.17280	0.17280	0.17280	0.17280
Jan-09	0.15870	0.15980	0.17612	0.16886	0.16979	0.17194	0.16595	0.17194	0.17194	0.17194
Feb-09	0.21791	0.21399	0.22637	0.22055	0.21602	0.21621	0.21487	0.21621	0.21621	0.21621
Mar-09	0.06963	0.06897	0.06839	0.06756	0.06788	0.06788	0.06739	0.06788	0.06788	0.06788
Apr-09	0.09538	0.09640	0.09430	0.08945	0.09576	0.09586	0.08971	0.09586	0.09558	0.09586
May-09	0.17219	0.17353	0.17998	0.16145	0.19000	0.19172	0.15929	0.19172	0.18352	0.18867
Jun-09	0.23578	0.23592	0.23504	0.23392	0.23507	0.23559	0.23216	0.23820	0.23567	0.23566
Jul-09	0.35241	0.33376	0.31557	0.28034	0.40165	0.37653	0.28202	0.40252	0.33722	0.33714
Aug-09	0.33109	0.32365	0.36416	0.35676	0.37959	0.37959	0.34836	0.38789	0.35342	0.38012
Sep-09	0.06986	0.06971	0.06870	0.06854	0.07219	0.07226	0.06818	0.07212	0.06854	0.07132
Oct-09	0.07498	0.07459	0.07275	0.06585	0.07561	0.07509	0.06661	0.07511	0.07464	0.07464

Month-Year	NORTH HIGHLANDS-POOL NAA days	NORTH HIGHLANDS-POOL Alt1A days	NORTH HIGHLANDS-POOL Alt7A days	NORTH HIGHLANDS-POOL Alt7B days	NORTH HIGHLANDS-POOL Alt7H days	NORTH HIGHLANDS-POOL Alt7I days	NORTH HIGHLANDS-POOL Alt7J days	NORTH HIGHLANDS-POOL Alt7K days	NORTH HIGHLANDS-POOL Alt7L days	NORTH HIGHLANDS-POOL Alt7M days
Nov-09	0.04530	0.04631	0.04400	0.04371	0.04811	0.04635	0.04360	0.04658	0.04478	0.04570
Dec-09	0.03509	0.03499	0.03508	0.03492	0.03507	0.03508	0.03482	0.03509	0.03499	0.03503
Jan-10	0.05539	0.05509	0.05539	0.05499	0.05525	0.05531	0.05470	0.05533	0.05509	0.05519
Feb-10	0.05111	0.05090	0.05111	0.05075	0.05105	0.05109	0.05055	0.05111	0.05090	0.05099
Mar-10	0.05378	0.05351	0.05378	0.05336	0.05369	0.05374	0.05309	0.05376	0.05351	0.05361
Apr-10	0.12798	0.12702	0.12799	0.12621	0.12823	0.12843	0.12543	0.12853	0.12768	0.12757
May-10	0.09215	0.09190	0.09351	0.09171	0.09419	0.09428	0.09150	0.09437	0.09316	0.09388
Jun-10	0.20618	0.20418	0.20798	0.20733	0.20481	0.20562	0.20439	0.20565	0.20509	0.20536
Jul-10	0.25779	0.25472	0.26450	0.26354	0.26082	0.26281	0.26136	0.26280	0.26289	0.26286
Aug-10	0.27774	0.27829	0.27833	0.27870	0.27916	0.27900	0.27904	0.27900	0.27898	0.27899
Sep-10	0.27998	0.28104	0.28568	0.28182	0.28176	0.28152	0.28208	0.28146	0.28170	0.28164
Oct-10	0.27003	0.27187	0.30797	0.27386	0.31374	0.31972	0.27433	0.31963	0.29733	0.30817
Nov-10	0.22341	0.22529	0.22658	0.22803	0.22691	0.22701	0.22901	0.22689	0.22706	0.22714
Dec-10	0.18744	0.17366	0.17780	0.16760	0.18212	0.18145	0.15855	0.18275	0.17089	0.17425
Jan-11	0.19546	0.19389	0.12870	0.12404	0.13302	0.13292	0.12321	0.13303	0.12870	0.13280
Feb-11	0.12475	0.12271	0.17966	0.17893	0.17660	0.17648	0.17641	0.17661	0.17707	0.17631
Mar-11	0.09253	0.09184	0.09461	0.09033	0.09380	0.09384	0.08909	0.09411	0.09340	0.09279
Apr-11	0.10228	0.10122	0.09223	0.09207	0.09240	0.09235	0.09114	0.09237	0.09080	0.09238
May-11	0.18339	0.17718	0.13262	0.13122	0.13120	0.13118	0.12495	0.13116	0.13048	0.13176
Jun-11	0.34619	0.34203	0.34098	0.32702	0.34216	0.34471	0.33663	0.34468	0.34425	0.33911
Jul-11	0.36681	0.35497	0.38733	0.39211	0.38340	0.38385	0.39117	0.38378	0.38446	0.38866
Aug-11	0.36004	0.35555	0.44043	0.40256	0.39096	0.39019	0.39069	0.39016	0.39028	0.39067
Sep-11	0.26188	0.25975	0.32278	0.31764	0.30279	0.31626	0.31247	0.31655	0.31519	0.31360
Oct-11	0.35797	0.35195	0.30438	0.33849	0.36395	0.34409	0.33988	0.34386	0.34410	0.34656
Nov-11	0.27089	0.26584	0.27135	0.25511	0.25416	0.26882	0.26051	0.27003	0.27020	0.26487
Dec-11	0.21445	0.21539	0.26482	0.25230	0.25190	0.25898	0.25218	0.25980	0.25874	0.25504
Overall Median	0.184	0.180	0.180	0.175	0.177	0.176	0.173	0.177	0.176	0.176
May-October Median	0.258	0.258	0.262	0.262	0.259	0.259	0.260	0.260	0.260	0.260
May-October Average	0.245	0.241	0.256	0.250	0.253	0.255	0.248	0.256	0.252	0.252

Month-Year	NORTH HIGHLANDS-POOL NAA days	NORTH HIGHLANDS-POOL Alt1A days	NORTH HIGHLANDS-POOL Alt7A days	NORTH HIGHLANDS-POOL Alt7B days	NORTH HIGHLANDS-POOL Alt7H days	NORTH HIGHLANDS-POOL Alt7I days	NORTH HIGHLANDS-POOL Alt7J days	NORTH HIGHLANDS-POOL Alt7K days	NORTH HIGHLANDS-POOL Alt7L days	NORTH HIGHLANDS-POOL Alt7M days
April-October Median	0.242	0.237	0.243	0.233	0.237	0.237	0.232	0.238	0.240	0.240
April-October Average	0.231	0.228	0.238	0.233	0.236	0.238	0.231	0.238	0.234	0.235
Month-Year	**OLIVER-POOL NAA days**	**OLIVER-POOL Alt1A days**	**OLIVER-POOL Alt7A days**	**OLIVER-POOL Alt7B days**	**OLIVER-POOL Alt7H days**	**OLIVER-POOL Alt7I days**	**OLIVER-POOL Alt7J days**	**OLIVER-POOL Alt7K days**	**OLIVER-POOL Alt7L days**	**OLIVER-POOL Alt7M days**
Dec-00	6.2697	6.2697	6.2697	6.2697	6.2697	6.2697	6.2697	6.2697	6.2697	6.2697
Jan-01	4.0888	3.8335	4.0999	3.9774	3.9517	3.9703	3.9347	3.9703	3.8748	3.9476
Feb-01	3.3329	3.2555	3.3498	3.3474	3.2807	3.2899	3.2898	3.2899	3.2877	3.2899
Mar-01	1.0929	1.0878	1.0929	1.0829	1.0840	1.0828	1.0788	1.0828	1.0798	1.0798
Apr-01	2.3730	2.3278	2.3137	2.2753	2.2685	2.2697	2.2714	2.2697	2.2701	2.2699
May-01	6.3814	6.0182	5.6556	4.9925	5.6554	5.6701	5.6764	5.6699	5.6725	5.6714
Jun-01	3.8440	3.8959	3.9517	3.6649	3.5891	3.6192	3.6069	3.6191	3.6213	3.6202
Jul-01	4.9046	4.8365	4.6071	4.4445	4.4197	4.4235	4.4265	4.4234	4.4244	4.4240
Aug-01	5.2593	5.2592	5.2794	5.2791	5.2648	5.2742	5.2497	5.2754	5.2640	5.2676
Sep-01	6.4876	6.4967	6.5179	6.5175	6.5355	6.5326	6.5330	6.5312	6.5357	6.5360
Oct-01	6.0910	6.0127	8.6316	8.0485	9.0646	9.0677	7.3887	9.3026	7.2441	7.5475
Nov-01	5.0454	4.8206	6.0413	5.5576	6.0542	6.0526	5.3803	6.0502	5.9522	6.0529
Dec-01	5.9124	5.6306	6.7830	5.8723	6.9061	6.6342	5.7307	6.8159	5.9687	6.4723
Jan-02	4.6946	4.6437	3.4247	3.0675	3.4134	3.4549	3.0442	3.4215	3.3934	3.4307
Feb-02	3.8604	3.7941	4.9925	5.0723	4.7735	4.8125	4.0444	4.8207	4.8624	4.7802
Mar-02	4.0816	3.9976	3.7870	3.7362	3.6988	3.6991	4.0513	3.6991	3.6991	3.6991
Apr-02	5.0476	4.9448	4.8272	4.8080	4.8699	4.8623	4.7682	4.8786	4.7877	4.8078
May-02	6.0609	5.7881	5.2869	5.0531	5.1365	5.2082	5.0424	5.2162	5.2014	5.2010
Jun-02	8.8628	8.8785	8.8623	8.8678	8.8704	8.8726	8.8724	8.8710	8.8729	8.8730
Jul-02	7.4436	7.4719	7.4471	7.4612	7.4700	7.4681	7.4715	7.4663	7.4687	7.4688
Aug-02	8.5693	8.6437	8.5755	8.6068	8.6482	8.6375	8.6447	8.6344	8.6384	8.6385
Sep-02	7.3333	6.7208	7.3387	7.3717	7.4305	7.4152	7.4232	7.4125	7.4161	7.4162
Oct-02	3.9241	3.7858	4.4528	4.2688	4.1062	4.1937	4.0611	4.2003	4.1928	4.1916
Nov-02	2.3872	2.3652	2.4438	2.3484	2.3547	2.3685	2.2705	2.3726	2.3267	2.3427
Dec-02	1.7060	1.7050	1.6848	1.6525	1.7487	1.7427	1.6560	1.7453	1.6789	1.6860

	OLIVER-POOL NAA	OLIVER-POOL Alt1A	OLIVER-POOL Alt7A	OLIVER-POOL Alt7B	OLIVER-POOL Alt7H	OLIVER-POOL Alt7I	OLIVER-POOL Alt7J	OLIVER-POOL Alt7K	OLIVER-POOL Alt7L	OLIVER-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Jan-03	3.2234	3.2312	2.9318	2.7044	3.0156	3.0115	2.7041	3.0123	2.9444	2.9984
Feb-03	1.9228	1.9115	1.8181	1.7004	1.9026	1.8926	1.6794	1.8990	1.8506	1.8828
Mar-03	1.2619	1.2917	1.1922	1.1820	1.2080	1.2053	1.1760	1.2066	1.1869	1.1988
Apr-03	1.7199	1.7113	1.7181	1.7047	1.7249	1.7247	1.6907	1.7258	1.7112	1.7174
May-03	0.8319	0.8302	0.8324	0.8240	0.8326	0.8334	0.8235	0.8338	0.8303	0.8316
Jun-03	0.9934	0.9912	0.9933	0.9837	0.9959	0.9964	0.9816	0.9969	0.9911	0.9935
Jul-03	1.4102	1.4058	1.4102	1.3914	1.4153	1.4160	1.3871	1.4169	1.4058	1.4104
Aug-03	2.5988	2.5854	2.5968	2.5494	2.6066	2.6103	2.5354	2.6127	2.5835	2.5954
Sep-03	4.3530	4.3054	4.3636	4.3084	4.2801	4.3092	4.2618	4.3092	4.3092	4.3092
Oct-03	5.0386	4.9408	5.0221	4.8622	4.9158	4.9352	4.7994	4.9350	4.9368	4.9361
Nov-03	2.0087	2.0011	2.0106	1.9544	2.0603	2.0547	1.9430	2.0594	2.0023	2.0254
Dec-03	2.4099	2.3903	2.4097	2.3803	2.4041	2.4053	2.3611	2.4067	2.3901	2.3969
Jan-04	2.8107	2.7791	2.1986	2.1578	2.1600	2.1619	2.1406	2.1628	2.1528	2.1561
Feb-04	1.6116	1.5999	1.8009	1.7980	1.7888	1.7884	1.7859	1.7884	1.7885	1.7885
Mar-04	3.1140	3.0846	2.9451	2.8967	2.9778	2.9852	2.8758	2.9848	2.9424	2.9624
Apr-04	3.6101	3.5982	2.8568	2.7696	2.9009	2.9014	2.6939	2.8975	2.8488	2.9060
May-04	3.9817	3.9120	5.6430	5.6598	5.5979	5.6293	5.5724	5.6699	5.5714	5.5701
Jun-04	4.6273	4.5789	4.6516	4.6515	4.6162	4.6465	4.6399	4.6275	4.6249	4.6341
Jul-04	3.5685	3.5707	3.8421	3.8419	3.8310	3.8359	3.8350	3.8341	3.8350	3.8344
Aug-04	3.7841	3.6935	3.7840	3.8128	3.6760	3.6977	3.7030	3.6966	3.6959	3.6980
Sep-04	1.9042	1.8982	1.9030	1.8408	1.8933	1.8930	1.8558	1.8929	1.8871	1.8901
Oct-04	3.5861	3.5538	3.7763	3.5381	3.8573	3.8666	3.5062	3.8659	3.7568	3.8432
Nov-04	1.4687	1.4618	1.5090	1.4457	1.5476	1.5459	1.4393	1.5458	1.5043	1.5132
Dec-04	1.5396	1.5313	1.5394	1.5250	1.5503	1.5478	1.5168	1.5589	1.5311	1.5345
Jan-05	2.6625	2.6324	2.6298	2.5980	2.6070	2.6134	2.5809	2.6140	2.6062	2.6095
Feb-05	1.5602	1.5502	1.5730	1.5526	1.5744	1.5755	1.5381	1.5769	1.5606	1.5672
Mar-05	1.0541	1.0493	1.0541	1.0465	1.0527	1.0534	1.0418	1.0538	1.0493	1.0512
Apr-05	1.3630	1.3577	1.3630	1.3531	1.3615	1.3630	1.3479	1.3635	1.3577	1.3601
May-05	2.7010	2.6900	2.7948	2.7539	2.8136	2.8182	2.7399	2.8207	2.7816	2.7930
Jun-05	2.4275	2.4098	2.3579	2.2840	2.3688	2.3726	2.2702	2.3759	2.3423	2.3594
Jul-05	0.9406	0.9384	0.9400	0.9297	0.9429	0.9432	0.9275	0.9437	0.9379	0.9403
Aug-05	1.8095	1.8021	1.8095	1.7821	1.8166	1.8179	1.7748	1.8194	1.8020	1.8090
Sep-05	4.2741	4.2631	4.3250	4.2670	4.3280	4.3339	4.2573	4.3363	4.3103	4.3215

	OLIVER-POOL NAA	OLIVER-POOL Alt1A	OLIVER-POOL Alt7A	OLIVER-POOL Alt7B	OLIVER-POOL Alt7H	OLIVER-POOL Alt7I	OLIVER-POOL Alt7J	OLIVER-POOL Alt7K	OLIVER-POOL Alt7L	OLIVER-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Oct-05	5.4448	5.3683	5.4352	5.3581	5.3267	5.3554	5.2875	5.3612	5.3376	5.3466
Nov-05	3.2494	3.1816	3.2542	3.2562	3.1788	3.1915	3.1948	3.1914	3.1927	3.1922
Dec-05	2.7147	2.6997	2.6831	2.5345	2.6966	2.6966	2.5170	2.6982	2.6640	2.6768
Jan-06	2.0628	2.0442	2.0696	2.0397	2.1107	2.1073	2.0209	2.1122	2.0547	2.0787
Feb-06	1.8978	1.8843	1.8978	1.8748	1.8953	1.8967	1.8616	1.8978	1.8843	1.8898
Mar-06	2.1909	2.1706	2.1795	2.1488	2.1780	2.1825	2.1307	2.1840	2.1595	2.1669
Apr-06	3.5847	3.4633	3.1598	3.1071	3.1747	3.1798	3.0907	3.1774	3.1375	3.1593
May-06	3.9889	4.0637	3.2260	3.1620	3.2168	3.2219	3.1512	3.2275	3.2087	3.2211
Jun-06	5.9667	5.8852	6.2260	6.2588	6.1008	6.1327	6.1734	6.1345	6.1210	6.1341
Jul-06	6.1848	6.1186	8.8851	8.8521	8.6922	8.7504	8.6730	8.7686	8.7067	8.7044
Aug-06	8.2637	8.2776	8.2276	8.2485	8.2692	8.2572	8.2797	8.2559	8.2645	8.2619
Sep-06	6.1106	5.9550	8.2271	8.2509	8.1177	8.2652	7.9534	8.2639	8.2411	8.2696
Oct-06	5.3577	5.1312	7.1910	7.0706	6.6755	6.9093	6.5120	6.9344	6.6679	6.7631
Nov-06	3.9168	3.9242	3.8878	3.7837	3.6406	3.6560	3.6416	3.6558	3.6494	3.6533
Dec-06	4.1212	3.9423	4.0334	3.9874	4.2251	4.2359	3.9527	4.2360	3.9540	4.2359
Jan-07	2.2436	2.2220	2.2460	2.1645	2.3103	2.3108	2.1460	2.3107	2.2242	2.3108
Feb-07	3.1665	3.1431	3.2290	3.0591	3.3730	3.3821	3.1186	3.3820	3.1875	3.2274
Mar-07	3.2795	3.2253	2.9236	2.7728	3.2722	3.2410	2.7627	3.2862	2.9811	2.8814
Apr-07	5.8028	5.7017	3.7806	3.6111	3.6743	3.6789	3.5566	3.6573	3.8380	3.7308
May-07	5.6024	5.5556	6.1134	5.8045	5.1821	5.1456	5.7944	5.1564	6.1057	5.8043
Jun-07	8.1967	7.9998	8.2021	8.1812	8.0293	8.2533	7.9957	8.0526	8.0117	8.0403
Jul-07	8.8580	8.8684	9.3313	9.2444	8.7886	8.9506	8.8532	8.8811	8.8518	8.8873
Aug-07	8.7122	8.6358	8.6780	8.7447	8.3498	8.6107	8.3842	8.4563	8.4420	8.4615
Sep-07	8.5084	8.4059	7.4394	7.3709	8.1145	7.8421	8.1111	8.1152	8.1359	8.0914
Oct-07	6.9142	7.2690	9.6889	7.3579	7.6091	9.1650	6.9768	8.9035	7.6127	7.5957
Nov-07	8.3690	8.0842	9.1840	7.0724	8.5305	8.6223	8.3538	8.6196	8.7161	8.7469
Dec-07	7.8620	7.5456	8.1272	8.1272	7.7187	7.7901	7.7902	7.7901	7.7901	7.7901
Jan-08	4.4365	4.2537	4.7367	4.7367	4.7503	4.7490	4.7489	4.7490	4.7490	4.7490
Feb-08	3.5507	3.5268	3.6503	3.6503	3.4420	3.4685	3.4686	3.4685	3.4685	3.4685
Mar-08	3.5381	3.4753	3.4460	3.4459	3.3846	3.3913	3.3913	3.3913	3.3913	3.3913
Apr-08	4.4734	4.4001	4.4872	4.4875	4.4486	4.4590	4.4591	4.4590	4.4590	4.4590
May-08	6.5004	6.0727	5.9706	5.9704	5.5202	5.6338	5.6337	5.6338	5.6338	5.6338
Jun-08	8.2296	8.2428	8.2081	8.2081	8.2236	8.2198	8.2198	8.2198	8.2198	8.2198

	OLIVER-POOL NAA	OLIVER-POOL Alt1A	OLIVER-POOL Alt7A	OLIVER-POOL Alt7B	OLIVER-POOL Alt7H	OLIVER-POOL Alt7I	OLIVER-POOL Alt7J	OLIVER-POOL Alt7K	OLIVER-POOL Alt7L	OLIVER-POOL Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Jul-08	7.8225	7.8519	7.7977	7.7977	7.8379	7.8287	7.8287	7.8287	7.8287	7.8287
Aug-08	5.6215	5.6461	5.6078	5.6078	5.6412	5.6336	5.6336	5.6336	5.6336	5.6336
Sep-08	7.5750	6.4833	7.5472	7.5472	7.6313	7.6133	7.6133	7.6133	7.6133	7.6133
Oct-08	6.5995	5.9261	7.4564	7.4564	7.1320	7.5687	7.5684	7.5687	7.5687	7.5687
Nov-08	7.7901	7.4234	7.8040	7.8041	8.0113	7.9946	7.9945	7.9946	7.9946	7.9946
Dec-08	4.1320	4.0739	4.8121	4.8121	3.6777	3.7639	3.7640	3.7639	3.7639	3.7639
Jan-09	3.4439	3.4679	3.8284	3.6681	3.6886	3.7361	3.6036	3.7361	3.7361	3.7361
Feb-09	4.7192	4.6332	4.9050	4.7772	4.6777	4.6818	4.6526	4.6818	4.6818	4.6818
Mar-09	1.5133	1.4988	1.4858	1.4675	1.4746	1.4745	1.4639	1.4745	1.4745	1.4745
Apr-09	2.0798	2.1025	2.0557	1.9480	2.0884	2.0906	1.9539	2.0906	2.0843	2.0904
May-09	3.7418	3.7713	3.9140	3.5045	4.1360	4.1742	3.4569	4.1743	3.9924	4.1065
Jun-09	5.0972	5.1003	5.0809	5.0564	5.0816	5.0931	5.0179	5.1530	5.0948	5.0945
Jul-09	7.6271	7.2186	6.8205	6.0511	8.7089	8.1565	6.0875	8.7279	7.2943	7.2924
Aug-09	7.1755	7.0120	7.9036	7.7406	8.2441	8.2433	7.5555	8.4275	7.6670	8.2559
Sep-09	1.5209	1.5176	1.4951	1.4915	1.5725	1.5742	1.4837	1.5711	1.4917	1.5533
Oct-09	1.6319	1.6231	1.5824	1.4298	1.6457	1.6343	1.4466	1.6348	1.6242	1.6242
Nov-09	0.9836	1.0060	0.9550	0.9486	1.0457	1.0069	0.9461	1.0119	0.9721	0.9924
Dec-09	0.7625	0.7604	0.7624	0.7588	0.7621	0.7623	0.7567	0.7625	0.7603	0.7612
Jan-10	1.2045	1.1980	1.2045	1.1957	1.2015	1.2027	1.1893	1.2032	1.1980	1.2001
Feb-10	1.1123	1.1076	1.1123	1.1044	1.1110	1.1119	1.0998	1.1123	1.1076	1.1096
Mar-10	1.1699	1.1641	1.1699	1.1606	1.1680	1.1691	1.1548	1.1695	1.1641	1.1663
Apr-10	2.7756	2.7545	2.7757	2.7366	2.7811	2.7855	2.7193	2.7877	2.7690	2.7664
May-10	2.0044	1.9989	2.0349	1.9949	2.0496	2.0515	1.9898	2.0535	2.0267	2.0427
Jun-10	4.4869	4.4425	4.5269	4.5123	4.4565	4.4744	4.4472	4.4752	4.4627	4.4687
Jul-10	5.5990	5.5312	5.7472	5.7261	5.6659	5.7098	5.6777	5.7097	5.7116	5.7108
Aug-10	6.0355	6.0478	6.0487	6.0568	6.0669	6.0634	6.0643	6.0634	6.0631	6.0632
Sep-10	6.0377	6.0608	6.1619	6.0779	6.0765	6.0713	6.0836	6.0700	6.0753	6.0739
Oct-10	5.8499	5.8903	6.6850	5.9341	6.8123	6.9445	5.9444	6.9424	6.4505	6.6895
Nov-10	4.8515	4.8929	4.9215	4.9534	4.9287	4.9308	4.9751	4.9283	4.9321	4.9338
Dec-10	4.0800	3.7747	3.8664	3.6409	3.9621	3.9471	3.4411	3.9760	3.7135	3.7877
Jan-11	4.2474	4.2127	2.7803	2.6785	2.8747	2.8726	2.6604	2.8749	2.7802	2.8700
Feb-11	2.7098	2.6647	3.9316	3.9153	3.8630	3.8602	3.8588	3.8632	3.8735	3.8564
Mar-11	2.0172	2.0017	2.0632	1.9684	2.0458	2.0466	1.9408	2.0524	2.0362	2.0232

	OLIVER-POOL NAA	OLIVER-POOL Alt1A	OLIVER-POOL Alt7A	OLIVER-POOL Alt7B	OLIVER-POOL Alt7H	OLIVER-POOL Alt7I	OLIVER-POOL Alt7J	OLIVER-POOL Alt7K	OLIVER-POOL Alt7L	OLIVER-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Apr-11	2.2263	2.2030	2.0037	2.0010	2.0084	2.0072	1.9796	2.0077	1.9721	2.0071
May-11	3.9888	3.8514	2.8713	2.8406	2.8401	2.8398	2.7032	2.8393	2.8244	2.8525
Jun-11	7.5644	7.4715	7.4489	7.1348	7.4785	7.5346	7.3495	7.5342	7.5250	7.4044
Jul-11	7.9864	7.7235	8.4418	8.5482	8.3545	8.3644	8.5273	8.3629	8.3780	8.4713
Aug-11	7.8516	7.7524	9.6545	8.8006	8.5422	8.5250	8.5347	8.5244	8.5271	8.5346
Sep-11	5.7071	5.6596	7.0675	6.9520	6.6194	6.9211	6.8361	6.9275	6.8970	6.8614
Oct-11	7.8364	7.7015	6.6382	7.4007	7.9712	7.5248	7.4302	7.5195	7.5255	7.5803
Nov-11	5.8996	5.7874	5.9098	5.5496	5.5284	5.8535	5.6692	5.8804	5.8843	5.7660
Dec-11	4.6464	4.6670	5.7570	5.4802	5.4714	5.6278	5.4776	5.6459	5.6225	5.5407
Overall Median	3.989	3.912	3.914	3.813	3.857	3.860	3.764	3.863	3.835	3.834
May-October Median	5.612	5.601	5.701	5.693	5.620	5.634	5.655	5.652	5.653	5.653
May-October Average	5.336	5.247	5.564	5.433	5.512	5.554	5.387	5.566	5.470	5.491
April-October Median	5.259	5.131	5.279	5.053	5.137	5.146	5.042	5.156	5.201	5.201
April-October Average	5.029	4.946	5.176	5.057	5.131	5.168	5.014	5.177	5.094	5.112
	WALTER F GEORGE-POOL NAA	**WALTER F GEORGE-POOL Alt1A**	**WALTER F GEORGE-POOL Alt7A**	**WALTER F GEORGE-POOL Alt7B**	**WALTER F GEORGE-POOL Alt7H**	**WALTER F GEORGE-POOL Alt7I**	**WALTER F GEORGE-POOL Alt7J**	**WALTER F GEORGE-POOL Alt7K**	**WALTER F GEORGE-POOL Alt7L**	**WALTER F GEORGE-POOL Alt7M**
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Dec-00	43.81	43.83	44.78	44.63	44.56	44.57	44.57	44.57	44.57	44.57
Jan-01	73.22	70.06	73.37	71.87	71.55	71.78	71.34	71.78	70.60	71.50
Feb-01	69.60	69.52	71.11	69.84	69.95	70.11	70.11	70.11	70.07	70.11
Mar-01	14.93	14.86	14.99	14.96	14.93	14.83	14.90	14.93	14.81	14.81
Apr-01	35.31	34.63	34.34	33.94	34.06	34.08	34.06	33.91	34.08	34.08
May-01	169.49	162.67	128.54	121.11	133.96	136.42	133.03	136.42	136.19	136.47
Jun-01	68.13	68.75	74.56	69.49	68.69	68.82	69.20	68.82	68.91	68.83
Jul-01	129.88	129.07	121.01	116.81	115.99	116.21	115.90	116.20	116.24	116.23
Aug-01	128.81	128.11	114.30	112.39	115.13	115.46	111.64	115.63	114.94	114.29
Sep-01	146.02	146.03	154.95	153.10	155.17	155.21	152.17	155.25	155.61	156.17

Month-Year	WALTER F GEORGE-POOL NAA days	WALTER F GEORGE-POOL Alt1A days	WALTER F GEORGE-POOL Alt7A days	WALTER F GEORGE-POOL Alt7B days	WALTER F GEORGE-POOL Alt7H days	WALTER F GEORGE-POOL Alt7I days	WALTER F GEORGE-POOL Alt7J days	WALTER F GEORGE-POOL Alt7K days	WALTER F GEORGE-POOL Alt7L days	WALTER F GEORGE-POOL Alt7M days
Oct-01	115.52	116.00	139.22	141.32	140.07	138.35	138.75	139.64	131.51	130.99
Nov-01	113.54	107.35	132.19	126.40	134.14	135.19	120.26	135.07	124.00	129.35
Dec-01	130.49	128.16	149.05	133.65	150.71	149.38	132.91	150.59	143.24	148.98
Jan-02	93.07	91.28	64.05	58.02	67.00	66.53	56.45	66.48	62.27	63.83
Feb-02	63.79	63.43	83.26	84.05	77.99	79.26	58.15	79.43	81.79	80.40
Mar-02	65.58	64.48	64.02	64.81	62.70	62.50	80.25	62.49	62.67	62.67
Apr-02	75.02	74.03	71.84	70.29	72.46	72.39	69.82	72.52	71.68	71.86
May-02	163.94	159.71	108.65	104.80	106.11	107.33	104.69	107.46	107.32	107.31
Jun-02	294.71	287.20	230.06	230.20	230.29	230.34	230.32	230.30	230.35	230.35
Jul-02	195.32	196.00	181.15	181.46	181.66	181.62	181.69	181.57	181.63	181.63
Aug-02	223.27	223.12	241.93	241.85	242.46	242.33	242.42	242.30	242.37	242.35
Sep-02	165.12	164.16	233.82	235.52	235.21	235.30	235.25	235.32	235.30	235.30
Oct-02	147.26	140.91	150.29	150.96	150.32	152.84	149.01	152.68	152.87	152.89
Nov-02	64.14	62.30	69.93	65.67	64.74	65.38	62.31	65.57	64.17	64.62
Dec-02	41.67	41.63	41.24	40.65	42.67	42.54	40.59	42.59	41.10	41.26
Jan-03	76.65	77.10	66.68	63.88	66.82	66.83	64.07	66.83	66.46	66.49
Feb-03	38.17	37.93	37.67	35.30	39.09	38.89	34.99	39.00	38.25	38.76
Mar-03	25.03	25.48	23.85	23.67	24.22	24.18	23.58	24.20	23.81	24.08
Apr-03	33.62	33.50	33.27	33.07	33.36	33.36	32.87	33.38	33.49	33.58
May-03	25.15	25.10	25.24	24.99	25.29	25.31	24.98	25.32	25.09	25.17
Jun-03	25.12	25.07	25.13	24.92	25.17	25.18	24.87	25.19	25.08	25.11
Jul-03	30.12	30.05	30.12	29.83	30.20	30.21	29.76	30.22	30.05	30.12
Aug-03	53.27	53.08	53.27	52.58	53.37	53.41	52.38	53.46	53.07	53.23
Sep-03	110.90	110.22	111.31	110.00	110.00	110.64	109.20	110.66	110.41	110.50
Oct-03	89.89	88.55	89.55	87.67	88.13	88.37	86.79	88.37	88.39	88.39
Nov-03	51.01	50.83	51.05	49.71	52.26	52.12	49.44	52.24	50.86	51.42
Dec-03	56.66	56.24	56.65	56.01	56.55	56.57	55.60	56.60	56.23	56.38
Jan-04	48.00	47.67	40.65	40.12	40.16	40.18	39.90	40.19	40.06	40.10
Feb-04	28.30	28.16	30.48	30.45	30.35	30.34	30.31	30.34	30.34	30.34
Mar-04	65.09	64.61	56.25	56.14	56.03	56.05	56.07	55.98	56.15	56.04
Apr-04	82.98	82.45	63.92	61.79	65.27	65.33	59.99	65.29	63.78	65.27
May-04	96.94	96.07	142.72	140.85	140.38	141.18	139.45	142.85	142.77	139.98

Month-Year	WALTER F GEORGE-POOL NAA days	WALTER F GEORGE-POOL Alt1A days	WALTER F GEORGE-POOL Alt7A days	WALTER F GEORGE-POOL Alt7B days	WALTER F GEORGE-POOL Alt7H days	WALTER F GEORGE-POOL Alt7I days	WALTER F GEORGE-POOL Alt7J days	WALTER F GEORGE-POOL Alt7K days	WALTER F GEORGE-POOL Alt7L days	WALTER F GEORGE-POOL Alt7M days
Jun-04	150.03	149.43	149.39	150.88	149.46	150.54	149.94	149.01	147.21	149.50
Jul-04	120.72	119.77	140.50	140.38	140.33	140.63	140.10	140.55	140.37	140.57
Aug-04	121.49	121.91	121.19	120.47	119.26	119.44	119.71	119.21	122.37	121.30
Sep-04	45.31	44.66	45.17	44.34	44.74	44.81	44.30	44.83	44.37	44.55
Oct-04	74.48	74.37	77.87	73.64	79.16	79.27	73.17	79.27	77.60	78.92
Nov-04	33.15	33.02	33.92	32.72	34.49	34.46	32.59	34.45	33.83	34.00
Dec-04	34.88	34.72	34.88	34.59	35.25	35.21	34.43	35.42	34.71	34.78
Jan-05	51.28	50.87	50.83	50.41	50.52	50.61	50.15	50.62	50.51	50.56
Feb-05	31.55	31.40	31.74	30.68	31.79	31.78	30.48	31.80	31.56	31.66
Mar-05	22.82	22.75	22.82	22.88	22.78	22.80	22.81	22.81	22.75	22.77
Apr-05	17.97	17.94	17.97	17.90	17.97	17.98	17.87	17.98	17.94	17.95
May-05	70.19	69.93	68.55	68.16	68.70	68.77	67.90	68.80	68.29	68.41
Jun-05	49.96	49.69	50.28	48.94	50.54	50.61	48.70	50.67	50.02	50.34
Jul-05	22.01	21.97	22.00	21.82	22.06	22.06	21.78	22.07	21.96	22.01
Aug-05	36.72	36.61	36.72	36.32	36.81	36.83	36.22	36.85	36.61	36.71
Sep-05	117.54	117.24	118.86	117.22	119.02	119.17	116.94	119.24	118.46	118.79
Oct-05	89.28	88.54	89.19	88.44	88.13	88.41	87.74	88.47	88.24	88.32
Nov-05	68.43	67.32	68.51	68.54	67.26	67.47	67.53	67.47	67.49	67.48
Dec-05	53.54	53.32	53.18	51.01	53.24	53.23	50.77	53.25	52.92	53.04
Jan-06	40.24	39.97	40.28	39.82	40.95	40.90	39.53	40.97	40.05	40.44
Feb-06	35.36	35.18	35.36	35.40	35.33	35.35	35.24	35.36	35.18	35.26
Mar-06	38.68	38.45	38.47	37.88	38.56	38.61	37.68	38.62	38.21	38.31
Apr-06	61.28	59.81	55.96	55.58	55.96	56.05	55.39	55.99	55.69	55.99
May-06	89.12	90.21	56.33	55.94	56.40	56.38	55.92	56.40	55.98	56.37
Jun-06	177.68	176.91	155.90	159.31	155.13	155.02	159.56	154.97	157.43	155.28
Jul-06	137.06	137.05	255.18	255.00	254.15	254.49	254.01	254.58	254.01	254.16
Aug-06	195.04	191.06	200.43	194.83	195.51	197.79	189.64	198.31	195.08	196.07
Sep-06	149.78	150.38	204.33	204.74	202.98	204.98	199.30	204.96	205.22	205.06
Oct-06	143.73	143.49	196.54	197.67	189.80	196.98	185.88	197.61	190.66	193.85
Nov-06	81.71	79.34	86.14	83.44	80.06	80.48	79.83	80.50	80.09	80.23
Dec-06	87.76	85.38	88.21	87.66	90.77	91.01	86.80	91.01	86.82	91.01
Jan-07	45.82	45.28	45.32	43.99	46.51	46.52	43.78	46.52	44.97	46.52

Month-Year	WALTER F GEORGE-POOL NAA days	WALTER F GEORGE-POOL Alt1A days	WALTER F GEORGE-POOL Alt7A days	WALTER F GEORGE-POOL Alt7B days	WALTER F GEORGE-POOL Alt7H days	WALTER F GEORGE-POOL Alt7I days	WALTER F GEORGE-POOL Alt7J days	WALTER F GEORGE-POOL Alt7K days	WALTER F GEORGE-POOL Alt7L days	WALTER F GEORGE-POOL Alt7M days
Feb-07	59.15	58.84	59.97	57.91	61.82	61.94	58.46	61.93	59.43	59.95
Mar-07	52.17	51.62	46.02	45.89	53.82	53.62	45.95	53.90	45.86	45.95
Apr-07	78.86	78.72	60.21	56.56	56.02	56.00	55.99	56.27	61.52	59.13
May-07	160.26	154.14	148.12	143.16	125.16	125.29	142.78	123.45	148.21	140.50
Jun-07	191.39	190.29	181.94	182.28	181.96	182.30	182.21	181.99	181.99	181.76
Jul-07	195.18	197.63	200.08	200.19	199.80	199.60	199.48	199.90	199.98	199.92
Aug-07	156.34	156.43	153.14	153.45	153.50	152.62	154.13	153.01	153.41	152.97
Sep-07	175.35	175.43	167.85	168.09	171.25	170.64	171.01	171.51	171.34	171.39
Oct-07	183.27	185.25	240.59	183.09	183.44	236.91	181.75	229.96	183.74	184.13
Nov-07	168.59	167.45	202.22	162.12	199.63	204.58	166.19	210.18	198.51	195.82
Dec-07	255.23	246.48	263.64	255.80	264.22	257.80	252.59	250.50	261.78	274.09
Jan-08	71.15	68.97	75.46	74.50	73.12	73.11	75.81	73.11	74.15	73.64
Feb-08	46.41	46.24	47.27	47.27	45.92	46.09	46.09	46.09	46.09	46.09
Mar-08	55.49	54.90	54.47	54.47	53.93	53.99	54.00	53.99	53.99	53.99
Apr-08	63.83	63.25	64.04	64.11	63.74	63.83	63.83	63.83	63.83	63.83
May-08	250.22	234.57	147.08	146.87	146.16	145.81	145.82	145.81	145.81	145.81
Jun-08	276.46	268.39	226.49	226.49	207.08	212.95	212.92	212.95	212.95	212.95
Jul-08	216.92	218.53	200.64	200.64	201.52	201.32	201.32	201.32	201.32	201.32
Aug-08	108.54	108.71	142.34	142.34	143.20	143.01	143.01	143.01	143.01	143.01
Sep-08	146.50	148.69	146.59	146.59	146.34	146.39	146.39	146.39	146.39	146.39
Oct-08	140.96	118.40	140.50	140.50	141.22	139.91	139.91	139.91	139.91	139.91
Nov-08	94.33	92.25	99.70	99.70	99.16	102.17	102.17	102.17	102.17	102.17
Dec-08	45.21	44.94	47.79	47.79	42.83	43.27	43.27	43.27	43.27	43.27
Jan-09	57.74	57.99	61.96	60.34	60.55	61.03	59.68	61.03	61.03	61.03
Feb-09	80.24	79.30	87.36	85.90	81.68	84.78	84.42	84.78	84.79	84.79
Mar-09	24.68	24.57	24.09	23.99	24.16	24.00	23.97	24.00	24.00	24.00
Apr-09	22.87	22.86	22.67	22.19	22.86	22.87	22.19	22.87	22.86	22.87
May-09	61.07	61.82	62.26	58.75	63.08	63.34	58.42	63.34	61.82	62.69
Jun-09	96.09	95.95	96.73	95.50	98.63	98.82	94.82	98.72	98.63	98.81
Jul-09	146.55	143.54	133.94	134.63	146.04	140.55	134.57	145.43	139.14	139.15
Aug-09	159.23	154.09	165.53	156.58	161.82	161.84	154.73	161.05	165.98	164.20
Sep-09	38.26	38.19	38.07	37.62	40.74	40.79	37.45	41.07	37.85	39.72

Month-Year	WALTER F GEORGE-POOL NAA days	WALTER F GEORGE-POOL Alt1A days	WALTER F GEORGE-POOL Alt7A days	WALTER F GEORGE-POOL Alt7B days	WALTER F GEORGE-POOL Alt7H days	WALTER F GEORGE-POOL Alt7I days	WALTER F GEORGE-POOL Alt7J days	WALTER F GEORGE-POOL Alt7K days	WALTER F GEORGE-POOL Alt7L days	WALTER F GEORGE-POOL Alt7M days
Oct-09	33.17	33.05	32.59	30.21	33.39	33.21	30.48	33.22	33.06	33.06
Nov-09	18.97	19.28	18.50	18.41	19.82	19.29	18.38	19.36	18.80	19.09
Dec-09	11.37	11.35	11.37	11.34	11.37	11.37	11.32	11.37	11.35	11.36
Jan-10	19.58	19.55	19.58	19.53	19.57	19.57	19.50	19.58	19.55	19.56
Feb-10	19.04	18.98	19.04	18.94	19.01	19.03	18.90	19.04	18.98	19.00
Mar-10	22.52	22.44	22.52	22.39	22.50	22.51	22.30	22.52	22.44	22.47
Apr-10	54.05	53.74	53.69	53.46	53.75	53.82	53.21	53.85	53.57	53.54
May-10	40.61	40.57	39.89	39.38	39.87	39.88	39.16	39.90	39.63	39.80
Jun-10	96.19	95.41	101.37	100.55	100.80	101.14	99.68	101.19	100.62	100.87
Jul-10	136.73	137.16	136.18	136.34	136.70	136.43	136.61	136.44	136.42	136.43
Aug-10	145.26	144.17	144.28	141.90	146.56	148.40	141.75	146.26	143.72	144.43
Sep-10	151.90	151.88	150.24	150.12	151.53	150.34	150.29	151.26	150.62	150.80
Oct-10	124.81	125.58	129.23	130.64	132.88	132.07	130.69	132.27	131.04	130.63
Nov-10	100.89	101.53	109.79	102.86	106.36	107.99	103.00	108.16	106.09	108.03
Dec-10	95.73	89.57	88.98	84.71	89.71	89.35	80.90	89.91	86.29	86.28
Jan-11	88.31	87.58	45.64	44.48	46.87	46.88	44.28	46.85	45.68	46.89
Feb-11	46.47	45.96	76.25	75.82	75.45	75.40	74.82	75.51	75.18	75.25
Mar-11	37.60	37.40	38.27	37.25	38.23	38.26	37.05	38.28	38.12	37.88
Apr-11	47.26	46.70	42.98	42.22	42.43	42.43	42.27	42.47	41.53	42.70
May-11	125.34	117.00	62.79	62.57	62.58	62.58	59.69	62.58	62.64	62.68
Jun-11	177.61	176.44	155.03	155.54	156.74	156.78	155.17	156.79	157.08	156.25
Jul-11	176.79	174.27	221.18	222.10	220.85	220.81	221.68	220.71	220.84	221.42
Aug-11	164.94	164.10	173.51	173.48	173.56	173.56	173.62	173.56	173.56	173.61
Sep-11	131.75	131.25	132.83	134.25	134.32	134.26	134.39	134.25	134.30	134.32
Oct-11	162.82	162.48	152.62	155.88	157.66	156.32	155.85	156.29	156.48	156.51
Nov-11	136.43	135.52	150.35	148.30	148.62	149.77	150.04	149.85	150.24	149.86
Dec-11	142.57	141.03	212.18	198.12	197.32	204.95	196.38	204.39	204.66	199.12
Overall Median	78.864	78.716	73.370	70.292	71.552	71.782	70.108	71.782	70.595	71.501
May-October Median	136.893	134.152	139.855	140.439	140.197	139.131	139.099	139.776	139.528	139.531
May-October Average	129.387	127.826	129.816	128.147	128.457	129.525	127.456	129.500	128.689	128.651

Month-Year	WALTER F GEORGE-POOL NAA days	WALTER F GEORGE-POOL Alt1A days	WALTER F GEORGE-POOL Alt7A days	WALTER F GEORGE-POOL Alt7B days	WALTER F GEORGE-POOL Alt7H days	WALTER F GEORGE-POOL Alt7I days	WALTER F GEORGE-POOL Alt7J days	WALTER F GEORGE-POOL Alt7K days	WALTER F GEORGE-POOL Alt7L days	WALTER F GEORGE-POOL Alt7M days
April-October Median	124.806	119.766	128.536	121.110	125.163	125.289	130.695	123.450	131.040	130.625
April-October Average	118.345	116.937	118.036	116.478	116.831	117.750	115.839	117.732	117.058	117.035
Month-Year	**WEST POINT-POOL NAA days**	**WEST POINT-POOL Alt1A days**	**WEST POINT-POOL Alt7A days**	**WEST POINT-POOL Alt7B days**	**WEST POINT-POOL Alt7H days**	**WEST POINT-POOL Alt7I days**	**WEST POINT-POOL Alt7J days**	**WEST POINT-POOL Alt7K days**	**WEST POINT-POOL Alt7L days**	**WEST POINT-POOL Alt7M days**
Dec-00	319.68	327.75	327.06	327.27	327.45	327.44	327.44	327.44	327.44	327.44
Jan-01	76.96	70.68	77.30	74.18	73.59	74.05	73.15	74.05	71.67	73.47
Feb-01	68.43	66.19	68.92	68.85	66.91	67.17	67.17	67.17	67.11	67.17
Mar-01	28.80	28.57	28.80	28.36	28.41	28.36	28.19	28.36	28.23	28.23
Apr-01	64.76	62.42	62.10	60.21	60.23	60.23	60.32	60.23	60.24	60.24
May-01	157.59	144.10	130.06	112.53	132.83	132.86	133.35	132.86	132.93	132.90
Jun-01	82.21	83.93	85.72	79.40	77.60	78.33	78.02	78.32	78.38	78.35
Jul-01	110.22	108.03	103.90	99.43	99.22	99.25	99.30	99.25	99.28	99.27
Aug-01	103.75	104.08	106.37	106.33	107.35	107.27	106.44	107.31	106.97	107.09
Sep-01	101.46	102.64	104.38	104.36	104.50	104.80	106.18	103.99	106.44	106.47
Oct-01	76.30	76.67	119.21	112.14	125.23	125.28	103.57	128.05	101.23	105.19
Nov-01	82.12	77.48	122.89	112.04	126.28	125.79	106.66	125.37	123.83	125.85
Dec-01	87.45	81.76	123.86	102.22	126.54	119.54	99.01	124.67	104.31	115.96
Jan-02	78.49	77.51	50.94	43.54	51.23	51.97	44.29	51.35	50.67	51.71
Feb-02	64.63	63.51	97.01	99.25	91.43	92.56	68.84	92.77	93.89	91.69
Mar-02	112.66	109.06	100.41	98.17	96.56	96.57	112.73	96.57	96.57	96.57
Apr-02	106.41	104.50	101.97	102.87	103.54	103.29	101.77	103.68	101.31	101.86
May-02	109.52	104.83	93.94	89.50	91.33	92.92	89.74	93.07	92.78	92.78
Jun-02	166.77	170.54	167.30	168.72	169.67	169.76	169.85	169.41	169.87	169.88
Jul-02	147.21	153.62	147.82	150.95	153.61	152.89	153.70	152.54	153.01	153.02
Aug-02	133.41	143.10	134.07	137.60	144.03	142.34	143.22	141.96	142.45	142.47
Sep-02	140.46	129.72	139.79	145.95	153.30	150.82	153.47	150.41	150.94	150.96
Oct-02	90.94	86.21	113.84	108.12	102.82	105.82	102.15	105.94	106.63	105.98
Nov-02	58.45	57.59	60.70	56.95	57.19	57.72	54.01	57.88	56.12	56.73
Dec-02	33.66	33.63	33.07	32.22	34.88	34.71	32.28	34.78	32.91	33.11

	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL
	NAA	Alt1A	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K	Alt7L	Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Jan-03	67.87	68.12	58.08	52.28	60.00	59.89	52.34	59.90	58.29	59.57
Feb-03	47.64	47.16	43.35	38.90	46.78	46.37	38.14	46.63	44.64	45.96
Mar-03	32.37	33.63	29.57	29.17	30.19	30.08	28.95	30.13	29.36	29.83
Apr-03	52.94	52.47	52.84	52.11	53.21	53.20	51.36	53.26	52.46	52.80
May-03	20.49	20.44	20.51	20.24	20.52	20.54	20.23	20.55	20.44	20.49
Jun-03	23.71	23.65	23.71	23.42	23.79	23.80	23.36	23.82	23.64	23.71
Jul-03	34.61	34.47	34.61	34.01	34.77	34.79	33.88	34.82	34.47	34.62
Aug-03	68.31	67.82	68.24	66.52	68.60	68.74	66.02	68.82	67.75	68.19
Sep-03	106.32	104.93	106.74	104.99	104.19	105.08	103.58	105.09	105.08	105.08
Oct-03	107.08	104.81	106.69	102.87	104.22	104.68	101.45	104.68	104.72	104.70
Nov-03	37.24	37.07	37.28	36.03	38.40	38.27	35.77	38.38	37.09	37.61
Dec-03	36.58	36.28	36.59	36.18	36.47	36.48	35.88	36.50	36.28	36.37
Jan-04	50.74	50.00	37.20	36.36	36.41	36.45	36.01	36.46	36.26	36.33
Feb-04	33.46	33.11	39.40	39.31	39.00	38.99	38.91	38.99	39.00	39.00
Mar-04	69.01	68.14	62.66	61.48	63.68	63.92	61.01	63.94	62.58	63.26
Apr-04	88.77	88.36	61.45	58.57	62.41	62.42	56.81	62.29	61.27	62.86
May-04	84.61	82.83	137.87	138.46	136.56	137.41	135.53	139.11	135.70	135.52
Jun-04	127.86	125.93	126.94	126.93	126.20	127.33	127.07	126.58	126.49	126.84
Jul-04	99.65	100.44	113.99	113.93	114.63	114.71	114.63	114.63	114.70	114.64
Aug-04	116.57	111.59	118.52	120.53	112.81	114.01	114.31	113.95	113.91	114.03
Sep-04	54.47	54.21	54.42	51.77	54.00	53.99	52.40	53.98	53.73	53.86
Oct-04	90.99	89.89	97.59	89.36	100.48	100.81	88.29	100.79	96.90	99.97
Nov-04	28.72	28.55	29.74	28.15	30.72	30.68	27.99	30.68	29.62	29.84
Dec-04	26.73	26.56	26.75	26.43	27.00	26.94	26.26	27.18	26.57	26.65
Jan-05	52.73	51.89	51.81	50.92	51.17	51.35	50.45	51.37	51.15	51.24
Feb-05	30.87	30.60	31.22	30.66	31.25	31.28	30.27	31.32	30.88	31.06
Mar-05	25.76	25.58	25.76	25.48	25.71	25.73	25.30	25.75	25.58	25.65
Apr-05	34.28	34.09	34.28	33.92	34.23	34.28	33.73	34.30	34.09	34.17
May-05	65.04	64.72	68.27	66.99	68.79	68.94	66.57	69.02	67.87	68.21
Jun-05	69.34	68.62	66.34	63.38	66.83	66.97	62.85	67.10	65.73	66.43
Jul-05	22.14	22.07	22.12	21.82	22.20	22.21	21.76	22.23	22.06	22.13
Aug-05	43.54	43.31	43.54	42.70	43.76	43.80	42.48	43.85	43.31	43.53
Sep-05	96.08	96.00	97.67	96.39	98.05	98.08	96.33	98.11	97.52	97.78

	WEST POINT-POOL NAA	WEST POINT-POOL Alt1A	WEST POINT-POOL Alt7A	WEST POINT-POOL Alt7B	WEST POINT-POOL Alt7H	WEST POINT-POOL Alt7I	WEST POINT-POOL Alt7J	WEST POINT-POOL Alt7K	WEST POINT-POOL Alt7L	WEST POINT-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Oct-05	121.57	120.03	121.43	119.35	119.07	119.71	117.87	119.87	119.22	119.47
Nov-05	57.18	55.81	57.28	57.32	55.76	56.01	56.08	56.01	56.03	56.02
Dec-05	42.88	42.61	42.31	39.65	42.55	42.55	39.34	42.58	41.97	42.19
Jan-06	31.28	30.97	31.39	30.90	32.08	32.02	30.58	32.11	31.15	31.55
Feb-06	33.86	33.56	33.86	33.35	33.81	33.83	33.06	33.86	33.56	33.68
Mar-06	52.32	51.60	52.05	50.96	51.95	52.11	50.32	52.17	51.34	51.60
Apr-06	75.10	71.51	62.62	61.62	63.22	63.32	61.27	63.24	62.25	62.71
May-06	74.96	76.54	56.69	55.76	56.48	56.57	55.67	56.65	56.40	56.61
Jun-06	120.42	118.71	118.82	120.91	116.65	116.98	119.78	116.96	117.25	117.35
Jul-06	96.10	95.64	139.04	140.03	138.43	138.51	139.45	138.67	138.52	138.21
Aug-06	148.42	150.85	140.78	143.78	147.39	145.47	148.54	145.30	146.42	146.07
Sep-06	104.31	102.68	147.40	150.71	151.36	152.92	148.36	152.73	153.53	153.55
Oct-06	88.96	84.92	137.33	136.28	128.47	134.00	124.44	134.63	128.12	130.40
Nov-06	87.47	88.85	88.10	84.65	80.14	80.63	80.17	80.62	80.42	80.54
Dec-06	77.49	72.98	75.26	74.10	80.17	80.45	73.24	80.45	73.27	80.45
Jan-07	47.04	46.43	47.09	44.64	49.14	49.14	44.09	49.14	46.46	49.14
Feb-07	71.58	71.14	74.58	68.78	79.96	80.29	70.79	80.28	73.17	74.64
Mar-07	81.16	79.27	69.37	65.00	84.45	83.83	64.68	85.59	71.42	68.02
Apr-07	146.66	140.97	76.82	74.08	75.21	75.62	72.53	75.12	78.58	75.79
May-07	99.96	98.46	111.02	104.92	91.41	91.22	104.94	90.57	111.13	104.16
Jun-07	143.85	139.97	146.42	147.04	143.88	147.77	144.27	144.28	143.83	143.89
Jul-07	135.07	135.56	143.24	142.55	136.18	137.90	138.00	137.37	137.20	137.38
Aug-07	112.39	111.70	107.99	109.77	107.10	109.90	107.67	107.90	107.95	107.91
Sep-07	107.52	106.17	88.98	88.55	99.72	93.81	99.18	98.52	99.13	98.05
Oct-07	77.67	82.46	112.56	83.66	86.59	105.92	79.68	102.66	86.45	86.15
Nov-07	97.66	93.73	109.17	80.19	99.90	101.19	97.45	101.15	102.51	102.94
Dec-07	121.19	114.95	126.37	126.37	118.14	119.63	119.63	119.63	119.63	119.63
Jan-08	89.45	83.14	102.99	102.99	106.58	106.13	106.12	106.13	106.13	106.13
Feb-08	97.35	96.67	106.20	106.20	94.65	96.06	96.06	96.06	96.06	96.06
Mar-08	87.55	85.58	85.03	85.02	82.69	82.91	82.91	82.91	82.91	82.91
Apr-08	120.03	118.10	121.47	121.48	121.06	121.18	121.19	121.18	121.18	121.18
May-08	168.44	152.94	145.75	145.74	130.95	134.60	134.59	134.60	134.60	134.60
Jun-08	160.65	164.13	156.91	156.91	161.21	160.14	160.14	160.14	160.14	160.14

	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL	WEST POINT-POOL
	NAA	Alt1A	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	Alt7K	Alt7L	Alt7M
Month-Year	days	days	days	days	days	days	days	days	days	days
Jul-08	147.17	153.16	143.41	143.41	151.10	149.23	149.23	149.23	149.23	149.23
Aug-08	159.22	168.42	155.04	155.04	166.89	164.06	164.06	164.06	164.06	164.06
Sep-08	138.52	116.82	134.44	134.44	149.29	145.77	145.77	145.77	145.77	145.77
Oct-08	103.17	90.96	121.57	121.57	127.75	136.34	136.34	136.34	136.34	136.34
Nov-08	112.07	106.28	112.39	112.39	134.11	131.97	131.97	131.97	131.97	131.97
Dec-08	76.44	74.11	98.51	98.52	67.41	69.52	69.52	69.52	69.52	69.52
Jan-09	60.81	61.03	72.14	68.38	68.58	70.06	66.81	70.06	70.05	70.06
Feb-09	97.06	94.68	105.87	101.79	98.69	98.82	97.92	98.82	98.82	98.82
Mar-09	43.21	42.47	41.82	40.91	41.26	41.25	40.73	41.25	41.25	41.25
Apr-09	63.37	64.55	61.77	56.56	63.37	63.46	56.90	63.46	63.26	63.44
May-09	102.64	103.80	109.74	93.53	118.74	120.39	91.74	120.39	112.55	117.40
Jun-09	107.99	108.82	109.85	109.97	104.96	107.26	109.43	106.96	108.00	107.98
Jul-09	141.73	133.45	124.56	110.25	161.60	150.31	110.96	161.59	134.46	133.25
Aug-09	144.14	140.40	164.27	160.51	168.64	167.99	156.13	172.92	158.87	168.75
Sep-09	29.72	29.65	29.19	29.11	30.76	30.78	28.96	30.72	29.13	30.36
Oct-09	39.90	39.62	38.35	33.73	40.34	39.97	34.22	39.99	39.66	39.66
Nov-09	20.14	20.76	19.37	19.20	21.88	20.78	19.13	20.92	19.83	20.39
Dec-09	14.96	14.90	14.96	14.85	14.94	14.95	14.79	14.96	14.90	14.92
Jan-10	23.72	23.54	23.72	23.47	23.63	23.67	23.29	23.68	23.54	23.59
Feb-10	22.23	22.10	22.23	22.01	22.19	22.21	21.88	22.22	22.10	22.15
Mar-10	27.21	27.01	27.21	26.89	27.14	27.18	26.69	27.19	27.01	27.08
Apr-10	65.34	64.67	65.35	64.10	65.52	65.66	63.55	65.73	65.13	65.05
May-10	46.06	45.87	46.89	45.79	47.35	47.40	45.74	47.46	46.72	47.17
Jun-10	98.36	97.47	99.57	99.18	98.11	98.44	97.73	98.46	98.13	98.29
Jul-10	113.15	112.23	117.55	117.70	116.71	117.52	116.90	117.51	117.55	117.53
Aug-10	111.66	113.29	113.04	114.41	115.42	114.95	115.01	114.95	114.90	114.92
Sep-10	95.62	98.08	98.83	99.92	98.32	97.81	100.59	97.63	98.81	98.35
Oct-10	90.61	93.72	110.21	98.72	112.58	115.19	99.96	114.94	106.48	110.88
Nov-10	77.98	81.75	83.84	86.98	84.89	85.05	89.57	84.82	85.18	85.34
Dec-10	68.89	62.66	65.60	60.86	67.65	67.33	56.79	67.95	62.37	63.93
Jan-11	78.67	78.52	37.54	35.94	39.28	39.25	35.71	39.26	37.60	39.23
Feb-11	54.64	53.60	103.90	103.09	100.88	100.66	100.58	100.80	101.29	100.47
Mar-11	41.83	41.41	43.06	40.52	42.61	42.63	39.78	42.79	42.35	41.99

	WEST POINT-POOL NAA	WEST POINT-POOL Alt1A	WEST POINT-POOL Alt7A	WEST POINT-POOL Alt7B	WEST POINT-POOL Alt7H	WEST POINT-POOL Alt7I	WEST POINT-POOL Alt7J	WEST POINT-POOL Alt7K	WEST POINT-POOL Alt7L	WEST POINT-POOL Alt7M
Month-Year	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**	**days**
Apr-11	45.76	45.40	39.44	39.89	39.76	39.71	39.02	39.72	38.84	39.69
May-11	74.61	71.36	49.22	48.74	48.68	48.67	46.20	48.67	48.44	48.87
Jun-11	127.84	125.28	114.03	108.98	114.58	115.36	112.26	115.33	115.28	113.19
Jul-11	140.81	134.53	131.22	135.63	132.34	131.80	135.14	131.74	132.17	134.00
Aug-11	120.53	118.37	133.60	120.69	118.50	116.77	117.41	116.72	116.94	117.26
Sep-11	99.01	97.94	121.75	119.55	112.49	119.64	117.52	119.81	119.04	118.14
Oct-11	106.48	104.92	77.93	91.02	98.17	89.63	89.59	89.50	90.28	90.70
Nov-11	78.52	77.31	72.58	68.59	68.55	71.90	70.76	72.18	72.41	71.19
Dec-11	88.37	90.72	117.77	112.49	109.15	113.43	111.75	114.03	113.98	111.29
Overall Median	82.121	81.764	88.099	85.020	84.888	85.054	80.172	85.589	85.179	85.343
May-October Median	104.030	103.938	112.796	109.377	112.534	114.359	107.056	114.293	109.565	109.431
May-October Average	102.271	100.941	105.647	103.594	106.213	106.650	103.836	106.845	105.419	105.760
April-October Median	102.637	102.635	109.741	104.920	104.499	105.916	103.574	105.944	106.476	105.978
April-October Average	98.874	97.522	100.167	98.216	100.673	101.056	98.333	101.221	99.952	100.259

Table 6.1-25.
Growing Season (Apr–Oct) Average and Annual Geometric Mean of Chlorophyll *a* at the Lakes in the ACF Basin

	Growing Season Average (µg/L)										Growing Season Geomean (µg/L)									
Year	**NAA**	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**PAA**	**Alt7L**	**Alt7M**	**NAA**	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**PAA**	**Alt7L**	**Alt7M**
Lake Lanier																				
2000	5.2	5.1	5.3	5.1	5.7	5.7	5.0	5.8	5.2	5.6	4.1	4.1	4.2	4.0	4.6	4.6	4.0	4.7	4.1	4.4
2001	3.8	3.8	3.8	4.2	4.2	4.2	4.2	4.3	3.7	4.1	3.2	3.2	3.2	3.6	3.6	3.6	3.6	3.7	3.2	3.5
2002	4.2	4.2	4.3	4.2	4.9	4.9	4.2	5.1	4.2	4.7	3.4	3.5	3.5	3.5	4.0	4.0	3.5	4.2	3.4	3.8
2003	3.8	3.8	3.9	4.1	4.4	4.3	4.0	4.5	3.8	4.1	3.2	3.2	3.2	3.5	3.7	3.7	3.5	3.8	3.2	3.5
2004	4.6	4.5	4.6	4.5	5.2	5.2	4.5	5.4	4.6	5.1	3.7	3.7	3.8	3.7	4.3	4.3	3.7	4.5	3.8	4.2
2005	4.3	4.3	4.3	4.1	4.8	4.8	4.1	5.0	4.3	4.7	3.6	3.6	3.6	3.4	4.0	4.1	3.4	4.2	3.6	3.9
2006	4.1	4.1	4.1	3.9	4.7	4.8	3.9	4.9	4.1	4.6	3.4	3.4	3.4	3.2	3.9	4.0	3.2	4.1	3.4	3.8
2007	4.2	4.2	4.3	4.2	4.9	5.0	4.2	5.2	4.3	4.8	3.4	3.4	3.5	3.5	4.1	4.1	3.5	4.3	3.5	3.9
2008	4.0	4.1	4.1	4.0	4.7	4.8	4.0	5.0	4.1	4.6	3.2	3.3	3.3	3.2	3.8	3.9	3.2	4.0	3.3	3.7
2009	4.2	4.2	4.2	4.1	4.8	4.7	4.1	5.0	4.3	4.7	3.4	3.4	3.5	3.4	4.0	3.9	3.4	4.1	3.5	3.8
2010	4.0	4.0	4.0	3.9	4.6	4.5	3.9	4.7	4.0	4.4	3.3	3.3	3.3	3.2	3.9	3.8	3.2	3.9	3.3	3.7
2011	4.3	4.3	4.3	4.2	4.9	4.9	4.1	5.1	4.3	4.7	3.4	3.4	3.4	3.2	4.0	3.9	3.2	4.1	3.4	3.8
West Point Mid-Lake																				
2000	8.5	10.1	7.8	8.3	12.6	11.8	8.7	11.8	10.9	11.2	6.3	6.9	5.7	6.0	9.4	8.0	6.2	8.0	7.5	7.6
2001	7.1	7.3	6.8	6.3	8.3	7.0	6.8	7.0	6.8	6.9	5.8	5.9	5.6	5.3	7.2	5.8	5.6	5.8	5.6	5.7
2002	10.8	11.1	10.6	10.4	12.0	11.0	10.9	11.1	11.0	11.0	7.5	7.7	7.5	7.5	9.2	7.8	7.6	7.8	7.7	7.7
2003	2.9	2.9	2.9	2.8	4.5	3.0	2.8	3.0	2.9	2.9	2.5	2.6	2.6	2.4	4.1	2.6	2.5	2.6	2.6	2.6
2004	4.6	4.8	4.9	4.9	6.5	5.2	5.2	5.1	5.2	5.2	3.6	3.7	3.8	3.7	5.4	3.9	3.9	3.9	3.9	3.9
2005	2.9	3.0	2.9	2.8	4.3	3.0	2.9	3.1	3.0	3.0	2.6	2.6	2.6	2.5	3.8	2.7	2.6	2.7	2.6	2.7
2006	6.3	6.6	6.4	6.4	7.6	6.7	6.5	6.7	6.6	6.6	5.1	5.3	5.1	5.0	6.3	5.3	5.1	5.3	5.2	5.3
2007	9.2	9.7	9.5	9.1	10.0	9.8	9.5	9.6	9.8	9.7	6.4	6.6	6.1	5.7	6.6	6.3	6.0	6.3	6.3	6.3
2008	10.0	10.3	10.0	10.0	11.3	10.3	10.3	10.4	10.3	10.3	7.8	7.8	7.8	7.8	9.0	7.9	7.8	7.9	7.8	7.9
2009	6.9	7.4	7.0	6.6	9.3	8.1	7.1	8.1	7.5	7.8	4.4	4.7	4.5	4.3	6.8	5.0	4.4	5.0	4.7	4.9
2010	5.3	5.6	5.3	5.2	6.7	5.7	5.5	5.7	5.6	5.7	3.9	4.0	3.9	3.8	5.2	4.2	3.9	4.2	4.0	4.1
2011	7.5	7.7	9.0	8.9	9.9	9.4	9.2	9.3	9.3	9.4	5.7	5.8	6.0	5.9	7.3	6.4	6.2	6.5	6.4	6.5

	Growing Season Average (µg/L)										Growing Season Geomean (µg/L)									
Year	**NAA**	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**PAA**	**Alt7L**	**Alt7M**	**NAA**	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**PAA**	**Alt7L**	**Alt7M**
West Point Dam																				
2000	9.8	11.2	9.1	8.9	11.2	11.0	10.4	10.9	10.8	10.9	7.8	8.7	7.2	7.1	8.8	8.6	8.2	8.6	8.5	8.5
2001	8.2	9.2	8.2	8.1	9.3	9.2	9.2	9.2	9.2	9.2	5.7	6.3	5.7	5.7	6.8	6.3	6.2	6.3	6.3	6.3
2002	9.1	10.3	9.0	8.8	10.5	10.3	10.1	10.3	10.3	10.3	7.1	7.9	7.0	6.9	8.0	7.9	7.7	7.9	7.8	7.9
2003	8.4	9.2	8.3	8.2	10.0	9.3	8.9	9.3	9.0	9.1	6.1	6.6	6.0	5.9	7.3	6.7	6.4	6.7	6.5	6.6
2004	7.0	8.2	6.8	6.8	8.3	8.1	7.9	8.1	8.0	8.1	5.5	6.2	5.3	5.3	6.4	6.1	6.0	6.1	6.0	6.1
2005	7.8	8.6	7.8	7.7	9.0	8.7	8.5	8.7	8.6	8.6	5.4	5.9	5.4	5.4	6.4	5.9	5.8	5.9	5.9	5.9
2006	7.9	9.0	7.6	7.5	8.9	8.8	8.6	8.8	8.7	8.7	6.4	7.2	6.2	6.1	7.1	7.0	6.9	7.1	7.0	7.0
2007	7.7	9.2	6.9	6.7	8.8	8.5	8.0	8.6	8.4	8.3	5.8	6.9	5.4	5.2	6.6	6.4	6.1	6.4	6.3	6.3
2008	8.5	9.8	8.6	8.6	10.0	9.9	9.9	9.9	9.8	9.9	7.0	7.9	7.1	7.0	8.0	7.9	7.9	8.0	7.9	7.9
2009	7.0	7.9	7.0	6.8	8.2	7.9	7.7	7.9	8.0	8.0	5.0	5.5	5.0	4.9	5.9	5.5	5.4	5.5	5.5	5.5
2010	6.5	7.3	6.5	6.5	7.8	7.5	7.3	7.5	7.4	7.5	4.7	5.2	4.7	4.6	5.5	5.2	5.1	5.3	5.2	5.2
2011	8.0	9.2	7.7	7.6	9.4	9.1	8.8	9.1	9.0	9.1	6.8	7.8	6.6	6.5	7.9	7.7	7.5	7.7	7.6	7.7
Walter F. George Mid-Lake																				
2000	9.1	9.6	8.5	8.9	10.0	9.6	9.3	9.6	9.6	9.6	7.0	7.4	6.7	6.8	8.1	7.4	7.2	7.4	7.4	7.4
2001	7.3	7.6	7.2	7.0	8.4	7.7	7.6	7.7	7.7	7.7	5.9	6.2	5.9	5.8	7.2	6.3	6.2	6.3	6.2	6.2
2002	8.0	8.4	8.3	8.2	9.0	8.7	8.5	8.7	8.7	8.7	6.4	6.7	6.6	6.5	7.2	6.9	6.8	6.9	6.9	6.9
2003	4.1	4.3	4.0	4.0	5.2	4.3	4.2	4.3	4.2	4.3	3.4	3.6	3.4	3.4	4.5	3.6	3.5	3.6	3.6	3.6
2004	6.9	7.3	6.8	6.7	7.8	7.3	7.1	7.3	7.2	7.2	5.5	5.8	5.2	5.2	6.4	5.6	5.5	5.6	5.6	5.6
2005	4.2	4.5	4.2	4.2	5.3	4.5	4.4	4.5	4.5	4.5	3.7	3.9	3.7	3.7	4.9	3.9	3.9	3.9	3.9	3.9
2006	8.1	8.4	8.5	8.5	9.3	9.0	8.8	9.0	8.9	8.9	6.6	6.9	6.9	6.9	7.8	7.3	7.2	7.3	7.2	7.2
2007	8.8	9.3	9.0	8.8	9.6	9.4	9.3	9.3	9.3	9.5	7.0	7.5	6.9	6.7	7.7	7.4	7.2	7.4	7.3	7.4
2008	9.1	9.4	9.3	9.3	10.2	9.8	9.7	9.8	9.8	9.8	7.3	7.6	7.6	7.6	8.5	7.9	7.9	7.9	7.9	7.9
2009	6.5	6.8	6.3	6.2	7.5	6.8	6.8	6.8	6.8	6.8	4.4	4.7	4.4	4.3	5.7	4.7	4.6	4.7	4.6	4.6
2010	5.6	5.9	5.5	5.5	6.4	5.9	5.8	5.9	5.8	5.9	4.2	4.4	4.1	4.1	5.1	4.5	4.4	4.5	4.4	4.5
2011	8.0	8.3	7.9	7.9	8.7	8.4	8.3	8.4	8.3	8.4	6.5	6.8	6.5	6.5	7.4	6.9	6.9	6.9	6.9	7.0

	Growing Season Average (µg/L)										Growing Season Geomean (µg/L)									
Year	**NAA**	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**PAA**	**Alt7L**	**Alt7M**	**NAA**	**Alt1L**	**Alt7A**	**Alt7B**	**Alt7H**	**Alt7I**	**Alt7J**	**PAA**	**Alt7L**	**Alt7M**
Lake Seminole Mid-Lake																				
2000	6.1	6.5	6.3	6.1	6.5	6.3	6.5	6.3	6.3	6.3	5.4	5.9	5.6	5.5	6.0	5.7	5.9	5.7	5.8	5.8
2001	3.8	4.0	4.1	4.1	4.5	4.1	4.1	4.1	4.1	4.1	3.4	3.6	3.6	3.6	4.1	3.6	3.6	3.6	3.6	3.6
2002	5.4	5.8	5.6	5.5	6.3	6.0	6.0	6.0	6.0	6.0	4.8	5.2	5.0	5.0	5.7	5.4	5.4	5.4	5.4	5.4
2003	5.5	5.7	5.4	5.4	6.4	5.7	5.6	5.7	5.7	5.7	5.0	5.2	5.0	5.0	5.9	5.2	5.2	5.2	5.2	5.2
2004	5.3	5.6	5.2	5.2	5.9	5.5	5.4	5.5	5.4	5.5	5.0	5.2	4.9	4.9	5.6	5.2	5.1	5.2	5.1	5.1
2005	5.2	5.3	5.2	5.2	5.9	5.4	5.4	5.4	5.3	5.4	4.6	4.7	4.6	4.6	5.5	4.8	4.7	4.8	4.7	4.8
2006	5.3	5.6	5.8	5.7	6.3	6.1	6.1	6.1	6.1	6.1	4.9	5.1	5.3	5.3	5.9	5.6	5.6	5.6	5.6	5.6
2007	6.1	6.6	6.7	6.6	7.4	7.3	7.2	7.1	7.1	7.1	5.5	6.1	6.3	6.2	6.8	6.7	6.8	6.6	6.6	6.7
2008	5.4	5.7	5.7	5.7	6.3	6.1	6.1	6.1	6.1	6.1	5.1	5.4	5.3	5.3	6.0	5.7	5.7	5.8	5.7	5.7
2009	4.1	4.2	4.1	4.1	4.8	4.2	4.2	4.2	4.2	4.2	3.6	3.6	3.5	3.5	4.3	3.7	3.6	3.7	3.7	3.7
2010	4.4	4.5	4.4	4.4	4.9	4.5	4.5	4.6	4.5	4.6	4.0	4.2	4.0	4.0	4.5	4.2	4.2	4.2	4.2	4.2
2011	5.8	6.3	6.1	5.9	6.8	6.7	6.5	6.7	6.6	6.7	5.3	5.8	5.5	5.3	6.3	6.1	5.9	6.1	6.0	6.1

Modeled results indicate that during the growing season, chlorophyll *a* would be expected to be maintained around 2.7 µg/L in Lake Lanier (Figure 6.1-176).

In the Chattahoochee River reach from Buford Dam to Atlanta, the median growing season concentration of chlorophyll *a* during the modeled period and representative wet and dry weather years would be expected to be less than 2.5 µg/L (Figure 6.1-176 through Figure 6.1-184). In addition, the concentrations at the 95th percent occurrence would be expected to be less than 5 µg/L, indicating low phytoplankton growth.

In the reach from Atlanta to West Point Lake, the median growing season concentration of chlorophyll *a* from Atlanta to Whitesburg would be maintained at less than or equal to 5 µg/L. However, further downstream of Whitesburg at RM 340, a rapid increase in median chlorophyll *a* concentrations would be expected during the growing season and, by RM 330, would be near 10 µg/L (Figure 6.1-176), the result of upstream nutrient loading. At the mid-reservoir location in West Point Lake, water quality standards are based on the growing season average. Growing season averages were calculated for each modeled year at locations with reservoir chlorophyll *a* standards (Table 6.1-25). Chlorophyll *a* in West Point Lake would be expected to meet water quality standards. Even the highest values in the 95th percent occurrence during the growing season of a representative dry weather year would be expected to be less than 24 µg/L.

6.1.2.5.2 Alternative 1L

Negligible change would be expected in median chlorophyll *a* over the modeled period when compared with the NAA (Figure 6.1-185). Increased wastewater returns downstream of Buford Dam would be expected to increase the highest concentrations of chlorophyll *a* in West Point Lake and Lake Harding by more than 2 µg/L over the modeled period (Figure 6.1-185). The higher chlorophyll *a* concentrations would be passed downstream and into the Apalachola River. Based on comments received by USFWS (appendix J), the higher concentrations might provide some short-term benefits to aquatic resources throughout the system.

Median growing season chlorophyll *a* would be expected to increase from the NAA in West Point Lake and downstream over the modeled period (Figure 6.1-188) and during representative wet and dry weather years (Figure 6.1-191 and Figure 6.1-194, respectively). The water management operations in Alt1L are consistent with operations in the NAA; therefore, the differences illustrate the effect of increased wastewater returns downstream of Buford Dam consistent with Georgia's 2015 water supply request. Despite the increased median concentrations in West Point Lake and Lake Harding, average growing season concentrations would remain well below standards (Table 6.1-25). Concentrations of chorophyll *a* would continue to decrease as they pass downstream into the Apalachicola River.

6.1.2.5.3 Alternative 7A

Negligible change would be expected in median chlorophyll *a* over the modeled period under Alt7A when compared with the NAA (Figure 6.1-185). Proposed water management operations would be expected to effect the highest chlorophyll *a* level (95th percent occurrence) over the modeled period in West Point Lake and downstream to Lake Seminole. Changes over the modeled period would fluctuate with increased concentrations less than 2 µg/L in the headwaters of West Point Lake and in Walter F. George Lake downstream to Lake Seminole, but changes also would be expected to decrease in West Point Lake downstream to Walter F. George Lake (Figure 6.1-185). Growing season concentrations over the modeled period (Figure 6.1-188) and a representative dry weather year (Figure 6.1-194) would show similar trends. In the growing season of a representative dry weather year, the deltas from the NAA would be greater than over the modeled period, deviating by ± 2 µg/L. The 95th percent occurrence of chlorophyll *a* would be expected to increase at points consistent with trends over the modeled period, but

the median chlorophyll *a* concentration would be expected also to decrease from West Point Lake downstream to Walter F. George and downstream of Jim Woodruff Lock and Dam (Figure 6.1-194). Median growing season concentrations in a representative wet weather year would be similar to those for the NAA down the Chattahoochee and Apalachicola rivers (Figure 6.1-191).

6.1.2.5.4 Alternative 7B

Negligible change would be expected in median chlorophyll *a* levels over the modeled period under Alt7B when compared with the NAA (Figure 6.1-185). Decreased withdrawals and returns in Lake Lanier would be expected to increase the median reservoir chlorophyll *a* slightly during the growing season of a representative dry weather year (Figure 6.1-194) and over the modeled period (Figure 6.1-188). The median chlorophyll *a* would be expected to decrease slightly during the growing season of a representative wet weather year (Figure 6.1-191).

Comparing this alternative with the NAA illustrates differences in reduced withdrawals and returns from Lake Lanier and proposed changes to water management operations. Alt7B includes the same water withdrawals and returns as the NAA downstream of Buford Dam. Differences between Alt7B and Alt7A illustrate the effects from current withdrawals and returns at Lake Lanier and those authorized under relocation contracts. Changes between Alt7B and Alt7J illustrate differences due to changes in withdrawals and returns downstream of Buford Dam consistent with Georgia's 2015 request (GAEPD 2015a).

Given the consistency in modeled changes between Alt7B and Alt7A, changes in water withdrawals and returns from Lake Lanier have little effect on chlorophyll *a* concentrations (Figure 6.1-185). Median concentrations of chlorophyll *a* in the growing season of a representative wet year could decrease downstream of Walter F. George Lock and Dam (Figure 6.1-191). That change would be expected from the availability of more water throughout the system. Even during a representative dry weather year, chlorophyll *a* concentrations do not increase from the NAA as much as they do in Alt7A and the reduced concentrations are slightly greater (Figure 6.1-194).

As a result, the effects would be expected from changes to water management operations. Deltas from the NAA would be the greatest in the highest chlorophyll *a* level (95th percent occurrence) in the growing season of a representative dry weather year ± 2 µg/L from West Point Lake to Walter F. George Lake (Figure 6.1-194). Changes over the modeled period would fluxuate with increased concentrations less 1 µg/L in the headwaters of West Point Lake and in Walter F. George Lake downstream to Lake Seminole. Changes also would be expected to decrease in West Point Lake downstream to Walter F. George Lake (Figure 6.1-185). Growing season concentrations over the modeled period (Figure 6.1-188) and a representative dry weather year (Figure 6.1-194) would show similar trends. Median growing season concentrations in a representative wet weather year would be similar to those for the NAA down the Chattahoochee and Apalachicola rivers (Figure 6.1-191).

6.1.2.5.5 Alternative 7H

Changes in median chlorophyll *a* over the modeled period would be expected for much of the Chattahoochee River when compared with the NAA. Median Under Alt7H, median concentrations of chlorophyll *a* over the modeled period would be expected to exceed 0.5 µg/L from Buford Dam downstream into the Apalachicola River (Figure 6.1-186). Therefore, slightly adverse effects would be expected from implementing Alt7H. Differences in the effects of Alt7H from the draft EIS are attributed to changes in modeled assumptions described in the HEC-5Q modeling report included in appendix K of this final EIS.

Modeled chlorophyll *a* concentrations in Lake Lanier for Alt7H would be slightly higher than for the NAA (Figure 6.1-186) but would remain lower than the water quality standards at various points in Lake Lanier (Figure 6.1-174). Median concentrations downstream of Buford Dam into West Point Lake over the modeled period would be expected to increase by as much as 1.0 µg/L downstream of Atlanta (Figure 6.1-186). Increased chlorophyll *a* levels under Alt7H from the NAA would be expected from increased wasteload returns in the reach from Buford Dam to Whitesburg. That increased load would be passed downstream, and median changes between zero and 1.0 µg/L would be expected into the Apalachicola River.

6.1.2.5.6 Alternative 7I

Negligible change would be expected in median chlorophyll *a* levels over the modeled period under Alt7I when compared with the NAA (Figure 6.1-186). Alt7I is a revised version of the Alt7H alternative presented in the draft EIS, where 40 mgd of additional withdrawals are taken from Lake Lanier to account for elimination of Glades Reservoir. Alt7I also includes the water withdrawals and returns from Georgia's 2015 request. It supports comparison of the 2013 Georgia water supply request from Lake Lanier (plus the 40 mgd that was requested from Glades Reservoir) with other alternatives that assume variations in withdrawals from Lake Lanier consistent with Georgia's 2015 water supply request.

Modeled chlorophyll *a* concentrations in Lake Lanier for Alt7I would be slightly higher than for the NAA (Figure 6.1-186), but would remain lower than the water quality standards at various points in Lake Lanier (Figure 6.1-174). The highest concentrations of chlorophyll *a* (95th percent occurrence) over the modeled period would be higher than 10 µg/L (Figure 6.1-174) in Lake Lanier because of increased returns to Lake Lanier from the NAA. The 95th percent occurrences increase in reservoirs downstream but generally have negligible change from the NAA in riverine reaches, including in the Apalachicola River (Figure 6.1-189). The largest delta from the NAA would be expected in West Point Lake when return loads from upstream sources are assimilated, consistent with other alternatives that meet Georgia's 2015 water supply request for withdrawals and returns downstream of Buford Dam.

In the growing season (April–October) of a representative dry weather year, the highest concentrations of chlorophyll *a* (95th percent occurrence) would be expected to increase by nearly 4 µg/L in West Point Lake and Lake Harding (Figure 6.1-195). Median concentrations in West Point Lake would be expected to increase by as much as 2 µg/L, with the greatest change being expected during a dry weather year. Chlorophyll *a* concentrations have greater variability throughout the system during a representative dry weather year when compared to conditions during a representative wet weather year (Figure 6.1-192 with Figure 6.1-195).

Deltas from the NAA in the growing season of a representative wet weather year have little change in riverine portions of the system with increased concentrations in West Point Lake, Lake Harding, and Walter F. George Lake (Figure 6.1-195). Those changes from the NAA would be expected from the return rates assumed downstream of Buford Dam.

6.1.2.5.7 Alternative 7J

Negligible change would be expected in median chlorophyll *a* levels over the modeled period under Alt7J when compared with the NAA (Figure 6.1-186). Alt7J assumes water withdrawals from Lake Lanier are limit to currently authorized relocation contracts. Comparing this alternative with Alt7B allows comparison of the effects of increased water withdrawals and returns downstream of Buford Dam. Comparing it with Alt7I supports comparison of the effects of increased water withdrawals and returns from Lake Lanier.

Given the consistency in modeled changes between Alt7J and Alt7I versus comparisons between Alt7J and Alt7B, changes in water withdrawals and returns from Lake Lanier have little effect on chlorophyll *a* concentrations downstream of Buford Dam (Figure 6.1-185 and Figure 6.1-186).

The 95th percent occurrences in Alt7J increase in reservoirs but generally have negligible change from the NAA in riverine reaches, including in the Apalachicola River (Figure 6.1-186 and Figure 6.1-189). The largest delta from the NAA would be expected in West Point Lake when return loads from upstream sources are assimilated, consistent with other alternatives that meet Georgia's 2015 water supply request for withdrawals and returns downstream of Buford Dam.

In the growing season (April–October) of a representative dry weather year, water quality standards would be expected to be met despite changes from the NAA in the highest concentrations (95th percent occurrence) by nearly 3 µg/L in West Point Lake (Table 6.1-25 and Figure 6.1-195).

6.1.2.5.8 Alternative 7K (PAA)

The PAA would be expected to result in negligible change in median chlorophyll *a* levels over the modeled period when compared with the NAA (Figure 6.1-187). Increased phosphorus and nitrogen from the NAA would not be expected to result in increased growth in the Chattahoochee River or the Apalachicola River.

In Lake Lanier, increased water returns would be expected to increase median chlorophyll *a* by nearly 0.3 µg/L over the modeled period (Figure 6.1-187). Similar changes would be expected over the growing season of the modeled period and a representative wet weather year (Figure 6.1-189 and Figure 6.1-193). During the most critical period for growth—the growing season of a representative dry weather year—chlorophyll *a* concentrations would be expected to increase by 4.5 µg/L in Lake Lanier (Figure 6.1-196).

Chlorophyll *a* from Buford Dam into West Point Lake would have little change from the NAA, particularly over the modeled period (Figure 6.1-175). Downstream of West Point Lake, increased growing season chlorophyll *a* would be expected to be transported through the system (Figure 6.1-178, Figure 6.1-181, and Figure 6.1-184). The greatest differences from the NAA would be expected in the growing season of a representative dry weather year. During that period, median chlorophyll *a* levels would be expected to increase by as much as 1 µg/L downstream of Walter F. George Lock and Dam and in Lake Seminole. In the Apalachicola River during this period, chlorophyll *a* would be expected to increase by 0.5 µg/L (Figure 6.1-184).

6.1.2.5.9 Alternative 7L

Negligible change in median chlorophyll *a* levels would be expected over the modeled period under Alt7L when compared with the NAA (Figure 6.1-187). Chlorophyll *a* concentrations, and deltas from the NAA, would be expected to be similar to those under the PAA. The changes in Lake Lanier water withdrawal and return rates when compared with the PAA have little effect on chlorophyll *a* concentrations downstream of Buford Dam (Figure 6.1-187, Figure 6.1-190, Figure 6.1-193, and Figure 6.1-18). The greatest differences between the Alt7L and PAA would be expected to occur during the growing season of a representative dry weather year (Figure 6.1-196).

6.1.2.5.10 Alternative 7M

Negligible change would be expected in median chlorophyll *a* levels over the modeled period under Alt7M when compared with the NAA (Figure 6.1-187). Changes in chlorophyll *a* from the NAA would be expected to be similar to those under the PAA (Figure 6.1-187, Figure 6.1-190, Figure 6.1-193, and Figure 6.1-18). Comparing those alternatives illustrates that changes in Lake Lanier water withdrawal and

return rates have little effect on chlorophyll *a* concentrations downstream of Buford Dam. The greatest differences between the Alt7M and PAA would be expected to occur during the growing season of a representative dry weather year (Figure 6.1-196).

6.2 Geology and Soils

Effects on geology and soils that can be influenced by USACE water management activities are limited to sedimentation and erosion of the riverbeds, lakebeds, and shorelines. USACE has no control over the management of soils and underlying geology on land outside USACE jurisdiction. Sources of sediment related to agricultural practices, land development, and activities along tributaries are considered a background condition within which the management measures must function. Therefore, prime and unique farmland resources within the ACF Basin would not be affected under the NAA or any of the other alternatives.

Sedimentation and erosion activity in river networks modified by locks and dams and hydropower facilities, such as the USACE ACF Basin projects, can be divided into two general types: (1) river bed shoaling and bank erosion, and (2) lakebed sedimentation and shoreline erosion. In general, riverine sedimentation and bank erosion processes are active only during floods. Studies of rivers throughout the world indicate that high flows, with recurrence intervals of about 1.5 years, are dominant in shaping the channel (Dunne and Leopold 1978). Flows of such magnitude are termed *channel forming discharge*. Generally, typical channel-forming discharges can be thought of as the annual peak flood. Additionally, sediments eroded from landscapes during intense rainfalls and eroded from stream and river banks during high-flow events are transported in the greatest quantities and distances during floods. The sediment is deposited as shoals where the rivers and tributaries enter the lakes.

Important channel-forming processes related to the USACE ACF Basin projects include tailwater degradation downstream of projects (as discussed in sections 2.2.2.4.2 and 2.2.2.4.3) and bank erosion within the river portions above the project pools and downstream of Jim Woodruff Lock and Dam. Similarly, lake sedimentation is dominated by flood events, when the erosive forces throughout the watershed are most severe and the most sediment is delivered to the rivers and lakes.

In the ACF Basin, the average annual floods at locations described in this section are far in excess of the typical annual low flows. Because the management measures pertain, in particular, to low flow conditions experienced during droughts, their potential effect on sedimentation and erosion would be considered negligible and unpredictable when compared to the NAA. Therefore, the management measures for drought conditions, described in section 4.1.2.2, are not discussed with regard to lake sedimentation and channel-forming processes for any of the alternatives.

Lake shoreline erosion activity is not limited to times of high flows and can occur at all water levels and flow conditions. The shoreline erosion rate is a balance between erosive forces— waves that are driven by wind and boat traffic—and stabilizing forces—density of shoreline vegetation and durability of shoreline soils. Thus, management measures within the control of USACE that influence shoreline erosion include water surface elevation and duration at any given elevation and are discussed in relation to their respective alternatives. Table 6.2-1 presents a summary of the effects of the alternatives on geology and soils.

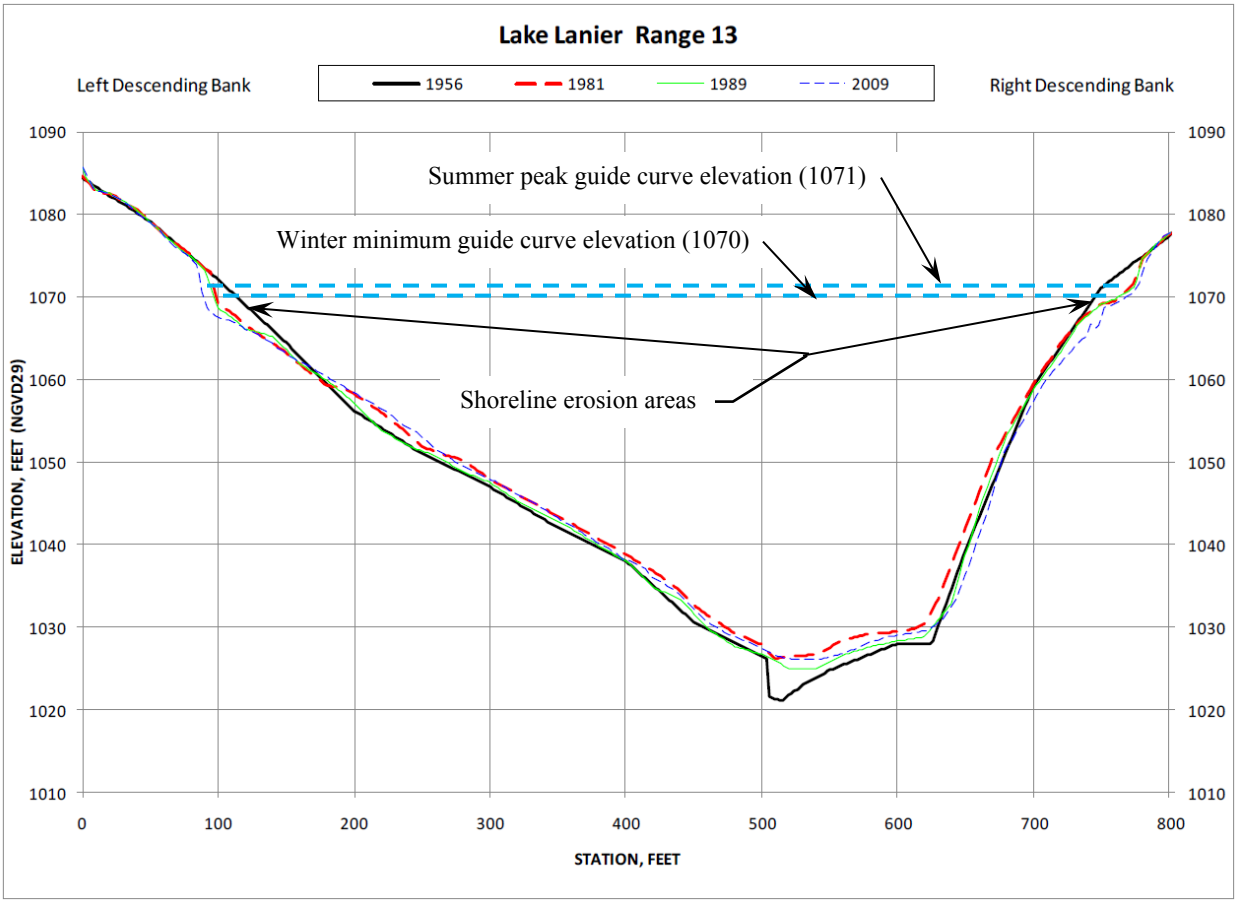
Table 6.2-1.
Summary of the Effects of Alternatives on Geology and Soils

Reservoir	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
West Point Lake	Baseline	Negligible/ No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lake	Baseline	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Lake George W. Andrews	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Nonfederal Reservoirs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.
Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

6.2.1 Lake Lanier

The shoreline erosion trends on Lake Lanier indicate that the highest rates occurred during the first 25 years since impoundment and have since slowed (Figure 6.2-1). The change in rate is the result of the winnowing of fine soil particles by wave action over the first several years after impoundment. Erosion-resistant gravel, cobble, and bedrock shorelines are left behind (Tetra Tech 2011b).



Source: Tetra Tech 2011

Figure 6.2-1. Sedimentation Range Cross Section from Lake Lanier (Typical for the Four Largeest ACF Reservoirs)

6.2.1.1 No Action Alternative

Over the past several decades, the range of annual lake-level fluctuation has been sufficient to already have exposed and eroded the shorelines down to more erosion-resistant materials. Therefore, the wave erosion from raising and lowering of long-term median water surface elevations would be expected to continue to be negligible compared with the highest rates that occur during the first 25 years since impoundment.

6.2.1.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

For six of the nine alternatives, little change would be expected compared to the NAA during typical conditions (Table 6.2-1). The slightly elevated lake levels of Alt7A, Alt7B, and Alt7J are considered slightly beneficial because the shorelines are less exposed to erosion during the fall and winter months (Figure 6.1-1 and Figure 6.1-2). Under extreme drought conditions, eight of the nine alternatives would be expected to be slightly beneficial compared to the NAA with shorelines being less exposed to erosion during the fall, winter, and spring. Negligible change would be expected between Alt1L and the NAA for drought conditions (Figure 6.1-3 and Figure 6.1-4). Under the NAA or any of the other alternatives, both lake shoreline erosion and lake sedimentation would continue at nearly the present rate.

6.2.2 West Point Lake

The shoreline erosion trends on West Point Lake indicate that the highest rates occurred during the first 20 years since impoundment and have since slowed. The process is described in section 6.2.1 and represented in Figure 6.2-1. Sedimentation range cross section figures specific to West Point Lake are provided in Tetra Tech's analysis (2011c).

6.2.2.1 No Action Alternative

Erosion and sedimentation rates that have occured since the 1997 survey would be expected to continue under the NAA. Shorelines are expected to continue to slowly erode since topographic relief and underlying geology dominate the process as described in section 2.2.2.4.1.2.

6.2.2.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Alternatives with proposed updated water management operations (Alt7A, Alt7B, Alt7H, Alt7I, Alt 7J, PAA, Alt7L, and Alt7M) are considered slightly beneficial compared to the NAA (Table 6.2-1). The more consistent lake elevations that occur during extreme drought under those alternatives help protect the shorelines from erosion from October through December more effectively than under the NAA (Figure 6.1-9 and Figure 6.1-10). Negligible change is expected between the NAA and Alt1L for extreme drought conditions because both alternatives have the same water management operations. Under typical conditions, the water elevations are similar for all alternatives, thus shoreline erosion effects for all alternatives would be expected to be the same as for the NAA (Figure 6.1-7 and Figure 6.1-8). Under the NAA or any of the other alternatives, both lake shoreline erosion and lake sedimentation would continue at nearly the present rate.

6.2.3 Walter F. George Lake

6.2.3.1 No Action Alternative

Under the NAA, both lake shoreline erosion and lake sedimentation would continue at the present rate. In general, the shoreline erosion trends on Walter F. George Lake indicate that the highest rates occurred during the first 20 years since impoundment and have since slowed. The process is described in section 6.2.1 and represented in Figure 6.2-1. Sedimentation range cross section figures specific to Walter F. George Lake are provided in Tetra Tech's analysis (2011d).

6.2.3.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Alternatives with proposed updated water management operations (Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M) are considered slightly adverse compared to the NAA. The lowered lake elevations of those alternatives during extreme drought conditions expose the shorelines to greater erosion potential from May through October than with the NAA (Figure 6.1-15 and Figure 6.1-16). For one alternative, Alt1L, negligible change is expected compared to the NAA under extreme drought conditions because both alternatives have the same water management operations. The difference between the mean daily water surface elevations is negligible between the NAA and all of the other alternatives, thus the effects would be expected to be about the same as for the NAA for all the alternatives with the erosion and sedimentation rates continuing as in the past (Figure 6.1-13 and Figure 6.1-14).

6.2.4 Lake George W. Andrews

In general, the shoreline erosion trends on Lake George W. Andrews indicate that the highest rates occurred during the first 20 years since impoundment and have since slowed. The process is described in section 6.2.1 and represented in Figure 6.2-1. Lake George W. Andrews is a run-of-river project where flood flows are the dominant force in shoreline erosion and sediment deposition processes. Sedimentation range cross section figures specific to Lake George W. Andrews are provided in Tetra Tech's analysis (2011e).

6.2.4.1 No Action Alternative

Under the NAA, both shoreline erosion and lake sedimentation would continue at the present rate.

6.2.4.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Effects for all alternatives would be expected to be the same as for the NAA. All the alternatives have a negligible influence on changes to water levels and flow velocities, thus any changes to the existing erosion and sedimentation processes would be negligible.

6.2.5 Lake Seminole (Jim Woodruff Lock and Dam)

6.2.5.1 No Action Alternative

The NAA would see the continuation of the current water control operations that entail little variation in lake levels. Negligible change in erosion and sedimentation patterns in Lake Seminole would be expected.

6.2.5.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Negligible change in erosion and sedimentation patterns in Lake Seminole would be expected from any of the alternatives. Only small variations in lake levels would be expected from any of the alternatives. The shorelines tend to have low slopes and are protected from wave erosion by dense aquatic and bank vegetation. Lake-level conditions under all alternatives would essentially be the same as those for the NAA. Thus, any changes in shoreline erosion and lakebed sedimentation would be expected to be negligible.

Downstream of Jim Woodruff Lock and Dam, erosion and sedimentation patterns in the Apalachicola River for all of the alternatives likely would not differ from patterns that would continue under the NAA. As discussed in detail in section 6.1.1.2.5, no appreciable differences in discharges from Jim Woodruff Lock and Dam and flow conditions in the Apalachicola River would occur over the modeled period of record for any of the nine other alternatives when compared to conditions under the NAA.

6.2.6 Nonfederal Reservoirs

6.2.6.1 No Action Alternative

Nonfedeeral reservoirs are generally run-of-river impoundments, with flood flows the dominant force in shoreline erosion and sedimentation. Negligible changes in their patterns of erosion or sedimentation would be expected under the NAA.

6.2.6.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

The effects of alternatives on Chattahoochee River nonfederal reservoirs would be expected to be negligible given they are generally run-of-river impoundments. Negligible change in erosion and sedimentation patterns would be expected from any of the alternatives compared to the NAA.

The Flint River above Lake Seminole would not be expected to be affected by any of the alternatives. Thus the shoreline erosion and sedimentation patterns for the two Flint River impoundments, Lake Blackshear and Lake Worth, are not affected by the NAA or the other alternatives.

6.3 Land Use

Adverse effects on land use are the result of a change in the use of land that would be incompatible with adjacent land uses experienced with lower water surface elevation conditions. The degree to which the PAA and the other alternatives would conflict with established land uses in the area, disrupt or divide established land-use configurations, or represent a substantial change in existing land uses; or are inconsistent with adopted land-use plans determine the severity of the adverse effects.

Effects on land use are described in the subsequent subsections and summarized in Table 6.3-1. The lower water levels can diminish or impair the shoreline for its intended land use because of exposed shoreline and lakebed. Although lower water levels would not change a land-use designation (e.g., an area designated for public recreation such as a boat ramp or marina, or a fishing, swimming, or picnic area), they could make the land less desirable or unusable. As water surface elevations decline, boat launching ramps, beaches, and shoreline fishing areas can become unusable; navigation hazards can surface; channels to marinas can become impassable; and private boat docks can become unusable. Levels at which recreational use of the land would be affected are the IIL, RIL, and WAL, which are defined in section 2.1.1.2.4.5.

Table 6.3-1.
Summary of the Effects of Alternatives on Land Use

Reservoir	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Buford Dam / Lake Lanier	Baseline	Slightly adverse	Slightly beneficial	Beneficial	Slightly adverse	Slightly adverse	Beneficial	Slightly adverse	Slightly beneficial	Slightly adverse
West Point Dam and Lake	Baseline	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lock and Dam and Lake	Baseline	Negligible/ No change	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
George W. Andrews Lock and Dam / Lake George W. Andrews	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Jim Woodruff Lock and Dam / Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Nonfederal Reservoirs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.
Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.
Adverse—Any adverse impact is clearly detectable and would have an appreciable effect.
Beneficial—Any beneficial impact is clearly detectable and would have an appreciable effect.

6.3.1 Lake Lanier and Downstream of Buford Dam

6.3.1.1 No Action Alternative

Negligible change would be expected. The NAA would see the continuation of the current water control operations at each project. Effects on land use along project shorelines would be the same as in the past, with deviations in lake levels and shoreline caused by seasonal and yearly variations in flow and climatic conditions (see section 6.1.1.1.1.1). Negligible change would be expected along the river shoreline or in the CRNRA downstream of Buford Dam. Under the NAA, flow conditions in the river necessary to successfully pursue a quality water-based recreation experience in the CRNRA (e.g., wade fishing) would continue to be available essentially at all times (except for extreme high flow conditions during major flood events) (see section 6.1.1.2.2.1).

6.3.1.2 Alternative 1L

Under Alt1L, slightly adverse effects along the project shoreline would be expected compared to the NAA. Lake Lanier water surface elevations would likely fall below designated impact levels for public use and recreational activities for slightly longer amounts of time for Alt1L than for the NAA, meaning less time during which the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Lake Lanier pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be higher under Alt1L (ranging from 1 to 6 years higher) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be the same or 1 year more under Alt1L than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be 0.5 percent to about 2 percent higher under Alt1L than under the NAA (Table 6.1-3). Adverse effects from dropping below the IIL, RIL, and WAL would make shoreline land use less desirable or unusable. As lake levels drop, boat launching ramps and beaches would become unusable, and navigation hazards would surface as the result of exposed shoreline and lakebed.

Slightly beneficial effects would be expected along the river shoreline in the CRNRA downstream of Buford Dam because of slight increases in modeled flow values under Alt1L compared to the NAA. Those minor improvements in flow conditions could have a slightly beneficial effect on recreational land uses in the CRNRA between Buford Dam and Bull Sluice Lake.

6.3.1.3 Alternative 7A

Under Alt7A, slightly beneficial effects along the project shoreline would be expected compared to the NAA. Lake Lanier water surface elevations would be expected to fall below designated impact levels for public use and recreational activities, for the most part, slightly shorter amount of time for Alt7A than for the NAA. The number of years the Lake Lanier pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be lower under Alt7A (ranging from 1 to 6 years lower) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be the same for the IIL or 2–3 years lower for the RIL and WAL under Alt7A than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be about 1 percent higher for the IIL but lower (less than 1 percent) for the RIL and WAL under Alt7A than under the NAA (Table 6.1-3).

Slightly adverse effects would be expected under Alt7A along the river shoreline in the CRNRA downstream of Buford Dam compared to the NAA. Slight decreases in modeled flow values under Alt7A would represent a minor decline in flow conditions in the CRNRA relative to NPS-recommended goals

for CRNRA recreation flows. Exposed shoreline under low flow conditions could reduce or eliminate the usability of the shoreline or river for public recreation uses such as fishing, picnicking, or boating.

6.3.1.4 Alternative 7B

Beneficial effects along the project shoreline would be expectedunder Alt7b compared to the NAA. The amount of time that Lake Lanier water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for shorter amounts of time for Alt7B than for the NAA. The number of years the Lake Lanier pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be lower under Alt7B (ranging from 5 to 13 years lower) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be 3–7 years lower under Alt7B than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be 2- to 3-percent less under Alt7B than under the NAA (Table 6.1-3).

Slightly beneficial effects would be expected along the river shoreline in the CRNRA downstream of Buford Dam because of slight increases in modeled flow values under Alt7B over the NAA. Those minor improvements in flow conditions could have a slightly beneficial effect on recreational land uses in the CRNRA between Buford Dam and Bull Sluice Lake.

6.3.1.5 Alternative 7H

Under Alt7H, slightly adverse effects on project shoreline land use would be expected compared to the NAA. Lake Lanier water surface elevations would fall below the impact thresholds for public use and recreational activities for slightly longer amounts of time for Alt7H than for the NAA, meaning less time during which the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Lake Lanier pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7H (by about 5–6 years) than under the NAA (Table 6.1-2). Looking at just the summer season (May–September), the number of years the pool would drop below the IIL and RIL would be higher under Alt7H (by 1-4 years) than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be about 1- to 5-percent higher under Alt7H than under the NAA (Table 6.1-3).

Slightly adverse effects would be expected on land use along the river shoreline downstream of Buford Dam. Under Alt7H, minor decreases in modeled flow values at Buford Dam and Peachtree Creek compared to the NAA would represent a slightly adverse effect on flow conditions in the CRNRA relative to NPS-recommended goals for recreation flows in the area (see section 6.1.1.2.2.5).

6.3.1.6 Alternative 7I

Under Alt7I, slightly adverse effects on project shoreline land use would be expected compared to the NAA. Lake Lanier water surface elevations would fall below the impact thresholds for public use and recreational activities for slightly longer amounts of time for Alt7I than for the NAA, resulting in less time the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Lake Lanier pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7I (by about 5 years) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL and RIL would be higher under Alt7I (by 1–4 years) than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be about 1- to 4-percent higher under Alt7I than under the NAA (Table 6.1-3).

Slightly adverse effects would be expected on land use along the river shoreline downstream of Buford Dam. Under Alt7I, minor decreases in modeled flow values at Buford Dam and Peachtree Creek compared to the NAA would represent a slightly adverse effect on flow conditions in the CRNRA relative to NPS-recommended goals for recreation flows in the area (see section 6.1.1.2.2.6).

6.3.1.7 Alternative 7J

Beneficial effects along the project shoreline would be expected under Alt7J compared to the NAA. Lake Lanier water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for shorter amounts of time for Alt7J than for the NAA. The number of years the Lake Lanier pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be lower under Alt7J (ranging from 4 to 10 years lower) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be 3–7 years lower under Alt7J than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be about 2- to 3-percent less under Alt7J than under the NAA (Table 6.1-3).

Slightly beneficial effects would be expected along the river shoreline in the CRNRA downstream of Buford Dam because of slight increases in modeled flow values under Alt7J compared to the NAA. Those minor improvements in flow conditions could have a slightly beneficial effect on recreational land uses in the CRNRA.

6.3.1.8 Alternative 7K (PAA)

Beneficial effects along the project shoreline would be expected under the PAA compared to the NAA. Lake Lanier water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for shorter amounts of time for the PAA than for the NAA. The number of years the Lake Lanier pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be lower under the PAA (ranging from 4 to 10 years lower) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be 3–7 years lower under the PAA than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be about 2- to 3-percent less under the PAA than under the NAA (Table 6.1-3).

Slightly beneficial effects would be expected along the river shoreline in the CRNRA downstream of Buford Dam because of slight increases in modeled flow values under the PAA than under to the NAA. Those minor improvements in flow conditions could have a slightly beneficial effect on recreational land uses in the CRNRA.

6.3.1.9 Alternative 7L

Slightly beneficial effects along the project shoreline would be expected under Alt7L than under the NAA. Lake Lanier water surface elevations would be expected to fall below designated impact levels for public use and recreational activities, for the most part, for slightly shorter amounts of time for Alt7L than for the NAA. The number of years the Lake Lanier pool would drop below the IIL and WAL (based on a full 12-month period of analysis) would be lower under Alt7L (ranging from 2 to 6 years lower) than under the NAA; the number of years for the RIL would be about the same (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be the same or 2–3 years lower under Alt7L than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be slightly

higher (0.5 percent) for the IIL but lower (about 1 percent or less) for the RIL and WAL under Alt7L than under the NAA (Table 6.1-3).

Slightly adverse effects would be expected on land use along the river shoreline downstream of Morgan Falls Dam. Under Alt7L, the changes in modeled flow conditions could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

6.3.1.10 Alternative 7M

Slightly adverse effects on project shoreline land use would be expected under Alt7M compared to the NAA. Lake Lanier water surface elevations would fall below the impact thresholds for public use and recreational activities for slightly longer amounts of time for Alt7M than for the NAA. The number of years the Lake Lanier pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be about the same or higher under Alt7M (by about 5 years) than under the NAA (Table 6.1-2). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL and RIL would be higher under Alt7M (by 1 year) than under the NAA (Table 6.1-2). The percentage of days the Lake Lanier pool would fall below the impact levels during the summer season would be very similar to that under the NAA for the RIL and WAL, but the percentabe of days below the IIL would be about 3 percent higher (Table 6.1-3).

Slightly adverse effects would be expected on land use along the river shoreline downstream of Morgan Falls Dam. Under Alt7M, the changes in modeled flow conditions could have a slightly adverse effect on the CRNRA between Morgan Falls Dam and Peachtree Creek relative to NPS-recommended goals for recreation flows in the area.

6.3.2 West Point Lake and Downstream of West Point Dam

6.3.2.1 No Action Alternative

Negligible change would be expected. The NAA would see the continuation of the current water control operations at West Point Dam and Lake. Effects on land use along the project shoreline and the river shoreline downstream of West Point Dam would be the same as they have been in the past, with deviations in lake levels and shoreline caused by seasonal and yearly variations in flow and climatic conditions (see sections 6.1.1.1.2.1 and 6.1.1.2.3.1).

6.3.2.2 Alternative 1L

Slightly beneficial effects along the project shoreline would be expected under Alt1L compared to the NAA. West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for slightly shorter amounts of time for Alt1L than for the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt1L (by about 5 years) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be 2–3 years lower under Alt1L than under the NAA (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the impact levels during the summer season would be about 1 percent less under Alt1L than under the NAA (Table 6.1-6). In general, under Alt1L there would be more days the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses than under the NAA.

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam under Alt1L. Effects on flow conditions downstream of West Point Dam would be about the same as under the NAA (see section 6.1.1.2.3.2).

6.3.2.3 Alternative 7A

Slightly beneficial effects along the project shoreline would be expected under Alt7A compared to the NAA. West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for the most part, about the same amount or slightly shorter amounts of time under Alt7A than under the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7A (by about 8 years) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the RIL or WAL would be the same or lower under Alt7A (by 1 year) than under the NAA; however, the IIL would be 4 years higher than under the NAA (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the RIL and WAL during the summer season would be very similar to the NAA, but the percentage of days below the IIL would be about 1 percent higher (Table 6.1-6).

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam under Alt7A, and effects on flow conditions downstream of West Point Dam would be about the same as under the NAA (see section 6.1.1.2.3.2).

6.3.2.4 Alternative 7B

Slightly beneficial effects along the project shoreline would be expected under Alt7B compared to the NAA. West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities about the same or slightly shorter amounts of time for Alt7B than for the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7B (by about 10 years for the WAL) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the impact threshold levels would be the same or lower under Alt7B (by 1–2 years) than under the NAA (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the RIL and WAL during the summer season would be about the same under Alt7B as under the NAA, but the percentage of days below the IIL would be slightly higher (1.5 percent) (Table 6.1-6).

Slightly beneficial effects would be expected on land use along the river shoreline downstream of West Point Dam under Alt7B compared to the NAA. Marginally higher flows would be expected for the river reach from West Point Dam to Walter F. George Lake, principally attributable to updates to systemwide water management practices and to water supply withdrawal assumptions for Lake Lanier.

6.3.2.5 Alternative 7H

Slightly beneficial effects along the project shoreline would be expected under Alt7H compared to the NAA. West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for the most part, about the same or shorter amounts of time than under the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7H (by about 14 years for the WAL) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the RIL and WAL would be lower under Alt7H (by 3–4 years) than under the NAA; however, the IIL would be 4 years more than under the NAA (Table 6.1-4).

The percentage of days the West Point Lake pool would fall below the IIL, RIL, and WAL during the summer season would be about the same or less (around 1 percent or less) under Alt7H than under the NAA (Table 6.1-6).

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam, as effects on downstream flow conditions under Alt7H would be about the same as under the NAA (see section 6.1.1.2.3.5).

6.3.2.6 Alternative 7I

Slightly beneficial effects along the project shoreline would be expected under Alt7I compared to the NAA. West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities, for the most part, about the same or slightly shorter amounts of time for Alt7I than for the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7I (by about 11 years for the WAL) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the RIL and WAL would be lower under Alt7I (by 3–4 years) than under the NAA; however, the number of years below the IIL would be 5 years higher than under the NAA (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the IIL, RIL, and WAL during the summer season would be the same or lower (around 1 percent or less) under Alt7I than under the NAA (Table 6.1-6).

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam under Alt7I, as effects on downstream flow conditions would be about the same as under the NAA (see section 6.1.1.2.3.6).

6.3.2.7 Alternative 7J

Slightly beneficial effects along the project shoreline would be expected under Alt7J compared to the NAA. Lake Lanier water surface elevations would be expected to fall below designated impact levels for public use and recreational activities for about the same or shorter amounts of time under Alt7J than under the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7J (by 11 years for the WAL) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the impact levels would be 2–4 years lower under Alt7J than under the NAA (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the impact levels during the summer season would be around 1 percent less under Alt7J than under the NAA (Table 6.1-6).

Slightly beneficial effects would be expected on land use along the river shoreline downstream of West Point Dam under Alt7J than under the NAA. Slightly higher flows would be expected for the river reach from West Point Dam to Walter F. George Lake, principally attributable to updates to systemwide water management practices and to water supply withdrawal assumptions for Lake Lanier and the Chattahoochee River.

6.3.2.8 Alternative 7K (PAA)

Slightly beneficial effects along the project shoreline would be expected under the PAA compared to the NAA. West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities, for the most part, shorter amounts of time for the PAA than for the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under the PAA (by about

11 years for the WAL) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the RIL and WAL would be lower under the PAA (3–4 years lower) than under the NAA; the number of years below IIL would be slightly higher (by about 4 years) (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the IIL, RIL, and WAL during the summer season would be about the same or lower under the PAA (around 1 percent less for the RIL) than under the NAA (Table 6.1-6).

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam under the PAA, as effects on downstream flow conditions would be about the same as under the NAA (see section 6.1.1.2.3.8).

6.3.2.9 Alternative 7L

Slightly beneficial effects along the project shoreline would be expected under Alt7L compared to the NAA. Under Alt7L, West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities, for the most part, about the same or shorter amounts of time than under the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7L (by about 11 years for the WAL) than under the NAA (Table 6.1-4). Looking at only the summer season (May–September), the number of years the pool would drop below the RIL and WAL would be lower under Alt7L (by 3–4 years) than under the NAA; however, the number of years below IIL would be slightly higher (about 2 years more) (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the IIL, RIL, and WAL during the summer season would be lower under Alt7L (around 1 percent less) than under the NAA (Table 6.1-6).

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam under Alt7L, as effects on downstream flow conditions would be about the same as under the NAA (see section 6.1.1.2.3.9).

6.3.2.10 Alternative 7M

Slightly beneficial effects along the project shoreline would be expected under Alt7M compared to the NAA. Under Alt7M, West Point Lake water surface elevations would be expected to fall below designated impact levels for public use and recreational activities, for the most part, about the same or shorter amounts of time than under the NAA. The number of years the West Point Lake pool would drop below the IIL, RIL, and WAL (based on a full 12-month period of analysis) would be the same or lower under Alt7M (by about 11 years for the WAL) than under the NAA (Table 6.1-4). Looking at just the summer season (May–September), the number of years the pool would drop below the RIL and WAL would be lower under Alt7M (by 3–4 years) than under the NAA; however, the number of years below the IIL would be slightly higher (by about 2 years) (Table 6.1-4). The percentage of days the West Point Lake pool would fall below the impact thresholds during the summer season would be similar for the IIL and WAL compared to the NAA, and lower (about 1 percent less) for the RIL (Table 6.1-6).

Negligible change would be expected on land use along the river shoreline downstream of West Point Dam under Alt7M, as effects on downstream flow conditions would be about the same as under the NAA (see section 6.1.1.2.3.10).

6.3.3 Walter F. George Lake and Downstream of Walter F. George Lock and Dam

6.3.3.1 No Action Alternative

Negligible change would be expected. The NAA would see the continuation of the current water control operations at Walter F. George Lock and Dam. Effects on land use along the project shoreline and the river shoreline downstream of the dam would be the same as they have been in the past, with deviations in lake levels and shoreline caused by seasonal and yearly variations in flow and climatic conditions (see sections 6.1.1.1.3.1 and 6.1.1.2.4.1).

6.3.3.2 Alternative 1L

Negligible change would be expected. Alt1L would have about the same effects on the level of Walter F. George Lake and downstream flow conditions from Walter F. George Lock and Dam as the NAA. Effects on land use along the project shoreline and the river shoreline downstream of the dam would be about the same as they have been in the past under the NAA (see sections 6.1.1.1.3.2 and 6.1.1.2.4.2).

6.3.3.3 Alternative 7A

Adverse effects on project shoreline land use would be expected under Alt7A compared to the NAA. Walter F. George Lake water surface elevations would likely fall below the impact threshold levels for public use and recreational activities for longer amounts of time for Alt7A than for the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7A (by about 1 year for the RIL and 15 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL and RIL would be higher under Alt7A (by 2 years for the RIL and 10 years for the IIL) than under the NAA (Table 6.1-5). The percentage of days the Walter F. George Lake pool would fall below the IIL and RIL during the summer season would be higher under Alt7A (by about 1- to 3-percent) than under the NAA (Table 6.1-8). There would be negligible change for the WAL compared to the NAA. Adverse effects from dropping below the IIL, RIL, or WAL would make shoreline land use less desirable or unusable. As the lake levels drop below the thresholds, boat launching ramps and beaches would become unusable, and navigation hazards would surface as a result of exposed shoreline and lakebed.

Under Alt7A, slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions compared to the NAA. The flow changes would be attributable to updated water management practices, including provision of increased reservoir releases as needed from January through May to support downstream navigation, revised action zones in USACE reservoirs, and drought operations provisions (section 6.1.1.2.4.3). Flow conditions that are too low (or too high) could reduce the usability of the river shoreline for public recreation land uses (e.g., fishing).

6.3.3.4 Alternative 7B

Adverse effects on project shoreline land use would be expected under Alt7B compared to the NAA. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher for Alt7B than for the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7B (by about 1 year for the RIL and 14 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the

summer season (May–September), the number of years the pool would drop below the IIL and RIL would be higher under Alt7B (by 1 year for the RIL and 10 years for the IIL) than under the NAA (Table 6.1-5). The percentage of days the Walter F. George Lake pool would fall below the IIL during the summer season would be higher (by about 3 percent) and below the RIL would be about the same as under the NAA (Table 6.1-8). There would be negligible change for the WAL.

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions under Alt7B than under the NAA. The flow changes would be attributable to updated water management practices (section 6.1.1.2.4.4).

6.3.3.5 Alternative 7H

Adverse effects on land use along the project shoreline would be expected for Alt7H. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher for Alt7H than for the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7H (by about 1 year for the RIL and 15 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL and RIL would be higher under Alt7H (by 1 year for the RIL and 9 years for the IIL) than under the NAA (Table 6.1-5). The percentage of days the lake pool would fall below the IIL during the summer season would be higher (by about 2 percent) and below the RIL would be about the same, compared to the NAA (Table 6.1-8). There would be negligible change for the WAL.

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions under under Alt7H than under the NAA. The flow changes would be attributable to updated water management practices (section 6.1.1.2.4.5).

6.3.3.6 Alternative 7I

Adverse effects on land use along the project shoreline would be expected under Alt7I. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher for Alt7I than for the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7I (by about 1 year for the RIL and 15 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL, RIL, and WAL would be slightly higher under Alt7I (by 1–2 years) than under the NAA (Table 6.1-5). The percentage of days the lake pool would fall below the IIL, RIL, and WAL during the summer season would be about the same under Alt7I as under the NAA Table 6.1-8).

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions compared to the NAA. The flow changes would be attributable to updated water management practices, including provision of increased reservoir releases as needed from January through May to support downstream navigation, revised action zones in USACE reservoirs, and drought operations provisions (section 6.1.1.2.4.6).

6.3.3.7 Alternative 7J

Adverse effects on land use along the project shoreline would be expected under Alt7J. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher for Alt7J than for the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL impact levels under Alt7J (based on a full 12-month period of analysis) would be higher (by about 1 year for the RIL and 13 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL, RIL, and WAL would be slightly higher under Alt7J (by 1–2 years) than under the NAA (Table 6.1-5). The percentage of days the lake pool would fall below the IIL during the summer season would be higher under Alt7J (by about 2 percent), and below the RIL about the same as under the NAA (Table 6.1-8). There would be negligible change for the WAL.

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions under Alt7J compared to the NAA. The flow changes would be attributable to updated water management practices (section 6.1.1.2.4.7).

6.3.3.8 Alternative 7K (PAA)

Adverse effects on land use along the project shoreline would be expected under the PAA. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher for the PAA than for the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under the PAA (by about 1 year for the RIL and 14 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL, RIL, and WAL would be slightly higher under the PAA (by 1–2 years) than under the NAA (Table 6.1-5). The percentage of days the lake pool would fall below the IIL during the summer season would be higher under the PAA (by about 2 percent), and below the RIL about the same as under the NAA (Table 6.1-8). There would be negligible change for the WAL.

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions under the PAA compared to the NAA. The flow changes would be attributable to updated water management practices, including provision of increased reservoir releases as needed from January through May to support downstream navigation, revised action zones in USACE reservoirs, and drought operations provisions (section 6.1.1.2.4.8).

6.3.3.9 Alternative 7L

Adverse effects on land use along the project shoreline would be expected under Alt7L. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher under Alt7L than under the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7L (by about 1 year for the RIL and 14 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL, RIL, and WAL would be slightly higher under Alt7L (by 1–2 years) than under the NAA (Table 6.1-5). The percentage of days

the lake pool would fall below the IIL during the summer season would be higher under Alt7L (by about 1 percent) than under the NAA (Table 6.1-8). There would be negligible change for the RIL or WAL.

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions under Alt7L than under the NAA. The flow changes would be attributable to updated water management practices (section 6.1.1.2.4.9).

6.3.3.10 Alternative 7M

Adverse effects on land use along the project shoreline would be expected under Alt7M. The amount of time that Walter F. George Lake water surface elevations would fall below the impact thresholds for public use and recreational activities would be higher under Alt7M than under the NAA, meaning less time that the project shoreline could be used for its intended public recreation, limited development, or protected shoreline land uses. The number of years the Walter F. George Lake pool would drop below the IIL and RIL (based on a full 12-month period of analysis) would be higher under Alt7M (by about 1 year for the RIL and 15 years for the IIL) than under the NAA (Table 6.1-5). Looking at only the summer season (May–September), the number of years the pool would drop below the IIL, RIL, and WAL would be slightly more under Alt7M (by 1–2 years) than under the NAA (Table 6.1-5). The percentage of days the lake pool would fall below the IIL during the summer season would be higher under Alt7M (by about 2 percent) than under the NAA (Table 6.1-8). The RIL would be about the same, and there would be negligible change for the WAL.

Slightly adverse effects would be expected on land use along the river shoreline downstream of the dam because of changes in flow conditions under Alt7M compared to the NAA. The flow changes would be attributable to updated water management practices (section 6.1.1.2.4.10).

6.3.4 Lake George W. Andrews and Downstream of George W. Andrews Lock and Dam

Negligible change in land use would be expected. Effects under all the alternatives would be the same as under the NAA, as George W. Andrews Lock and Dam and Lake is a run-of-river project normally operating at 102 ft (with minor variations) and no conservation storage (see section 6.1.1.1.4). Implementing the NAA or any of the alternatives would not have any effect on lake level at Lake George W. Andrews or flow conditions below the dam. Negligible change would be expected to land use along the project shoreline or downstream along the river shoreline.

6.3.5 Lake Seminole (Jim Woodruff Lock and Dam)

Negligible change in land use would be expected. Effects under all the alternatives would be the same as under the NAA, as Jim Woodruff Lock and Dam and Lake Seminole is a run-of-river project normally operating at 77 ft (with minor variations) and no conservation storage (see section 6.1.1.1.5). Implementing the NAA or any of the alternatives would not have any effect on lake level at Lake Seminole or flow conditions below the dam. Negligible change would be expected to land use along the project shoreline or downstream along the river shoreline.

Downstream of Jim Woodruff Lock and Dam along the banks of the Apalachicola River, current land use would not be affected by any of the alternatives. Section 6.1.1.2.5 provides information that demonstrates that flow conditions in the Apalachicola River would not change appreciably for the alternatives compared to the NAA. Thus, negligible change in land-use patterns would be expected.

6.3.6 Nonfederal Reservoirs

Negligible change would be expected. Effects under all the alternatives would be the same as under the NAA. The NAA and other alternatives would see the continuation of the current water control operations at nonfederal reservoirs (see section 6.1.1.1.6). Implementing the NAA or any of the alternatives would not have any effect on lake-level conditions at the nonfederal reservoirs or flow conditions downstream of the reservoirs. Negligible change would be expected to land use along the project shorelines or downstream along the river shoreline.

6.4 Biological Resources

This section discusses the environmental consequences of the NAA and Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M on biological resources in the ACF Basin described in section 2.5, including vegetation/wetland, wildlife, fish and aquatic resources, protected species, and fish and wildlife management facilities. This section also includes a detailed summary of coordination activities with the USFWS on the WCM update process in accordance with the Fish and Wildlife Coordination Act (FWCA) (see section 6.4.1) and formal consultation with the USFWS in accordance with section 7 of the Endangered Species Act (ESA) (see section 6.4.4). All documentation associated with FWCA and ESA activities is included in appendix J.

6.4.1 Consideration of Effects on Fish and Wildlife Resources in Accordance with the Fish and Wildlife Coordination Act

Throughout the entire Master Manual update process, USACE has coordinated its activities closely with USFWS in accordance with the FWCA and ESA. USACE has engaged USFWS since 2006 to seek input on the potential effects of proposed operational modifications to USACE ACF Basin projects on fish and wildlife resources in the basin, including federally listed threatened and endangered species. Endangered species consultation for conservation of protected species in the Apalachicola River below Jim Woodruff Lock and Dam, in accordance with section 7 of the ESA as described in section 2.1.1.2.4.4, was initiated in March 2006 and has been ongoing. ESA section 7 consultation in 2016 for the PAA for the WCM update is described in detail in section 6.4.3. In addition, USACE received USFWS input during three rounds of EIS scoping for the Master Manual update between 2008 and early 2013. Multiple rounds of scoping were triggered by court decisions, all of which influenced or altered the scope of the proposed Master Manual update. As agency and public input was considered and alternative water management plans were developed and evaluated, coordination with USFWS has continued throughout the process.

The WCM update process is to determine how the federal projects in the ACF Basin should be operated to meet all authorized purposes and to implement these operations by way of the updated WCMs. Fish and wildlife conservation is an authorized purpose of the USACE ACF Basin system. Although the PAA does not include any construction or structural modifications to the ACF Basin projects, nor is a report or a recommendation to Congress part of this effort, USACE used the general framework of the FWCA to solicit input from USFWS and state agencies and to organize the information provided.

USFWS provided a Planning Aid Letter (PAL) in April 2010 and an updated PAL in March 2011. Subsequently, USFWS submitted a draft Fish and Wildlife Coordination Act Report (FWCAR) to USACE, Mobile District in June 2011. Due to a change in scope of the Master WCM update resulting from the June 2011 opinion of the U.S. Court of Appeals for the 11th Circuit (see section 3.5.2.8.2), USFWS provided a new PAL to USACE in August 2013; USACE responded to the recommendations in the PAL by letter dated January 21, 2015. Subsequently, USFWS submitted a second draft FWCAR to USACE on July 31, 2015.

The July 2015 draft FWCAR recommended evaluations and analyses to address the following issues: flow conditions, water quality, fish passage, climate change, reservoir and riverine fisheries management, Apalachicola Bay resources, the inclusion of a decision support model and adaptive management, federally petitioned species under the ESA, impacts to the Chattahoochee River National Recreation Area (CRNRA), and ecosystem services. Specifically, USFWS included recommendations to address concerns about water quality conditions in project tailraces and to modify flow regimes downstream of the reservoir projects to improve habitat conditions for fish and wildlife. USFWS recommendations for hydrologic modeling included addressing the impacts of increasing consumptive demands and evaluating alternative models to reflect flow extremes and climate change. A number of the recommended conservation measures were determined to be beyond the scope of the Master WCM update process and were addressed in the August 2015 USACE response to the draft FWCAR, which was included in the draft EIS when it was filed and available for public review in October 2015.

Following public review of the draft EIS, USACE conducted further coordination with the USFWS to share additional information and revisions to the WCM update process resulting from the draft EIS review. The updated information was formally transmitted to the USFWS by letter dated July 25, 2016, although much of the information was shared with the USFWS in advance of the formal transmittal. Accordingly, the USFWS submitted a final FWCAR to USACE on September 14, 2016.

The USFWS provided a number of specific conservation recommendations in the final FWCAR. These recommendations have been offered to USACE in various coordination documents since 2010, and all the recommendations, including several new ones, were consolidated in the final FWCAR. Table 6.4-1 contains a complete summary of all USFWS conservation recommendations in the final FWCAR. The table also indicates whether the recommendation was adopted by USACE and, if not, provides the rationale for not adopting it (USFWS 2016a).

Additionally, the USFWS identified four principle areas of concern with the USACE adoption of the PAA (Alt7K) in the final FWCAR summary. Those general areas of concern are summarized below, along with the USACE response (USFWS 2016a).

- *USFWS concern* – The USFWS maintains that the USACE alternatives selection process, specifically the water management ranking methodology, was flawed because: (a) small differences in model results within project purposes are treated the same as large differences; (b) an incomplete set of fish and wildlife performance measures was used to score and then rank alternatives for the fish and wildlife conservation project purpose; and (c) there is no consideration regarding the uncertainty or precision of model output in the USACE ranking process.

  USACE response – USACE used a straightforward and transparent approach to ranking the alternatives. Since USACE treats all authorized project purposes as equal, it would not be appropriate to weight some project purposes more than others. USACE acknowledges that relatively small differences occurred among some of the alternatives. However, USACE maintains that the HEC-ResSim model is capable of simulating these small differences and that these small differences may be significant to the relevant stakeholder for that resource. Because USACE used an equal ranking methodology, the number of performance measures for a particular project purpose becomes irrelevant. While the choice of the most appropriate performance measures is relevant, when averaged, a single number representing each project purpose was used in the final ranking. USACE chose a number of performance measures that it believed adequately represented the fish and wildlife conservation project purpose. Whether performance metrics were weighted according to magnitude of differences or analyzed statistically to compare those differences, both attempt to address the concern that small differences are treated the same as large differences. The ranking methodology has adequate precision to rank water management alternatives.

- *USFWS concern* – USACE failed to adequately address conservation measures recommended in multiple PALs and draft FWCARs since 2010 and consolidated in the September 2016 final FWCAR.

  USACE response – USACE has fully addressed the USFWS conservation recommendations and incorporated appropriate measures wherever possible. A large number of the recommendations were outside the scope of the WCM update process and/or would specifically require additional authority and funding to implement. As stated above, Table 6.4-1 contains a complete summary of all USFWS conservation recommendations included in the final FWCAR and USACE responses.

- *USFWS concern* – The increased frequency of low flows associated with the PAA may cause negative impacts to basin-wide distributed at-risk and federally-listed species.

  USACE response – The analysis of flow conditions downstream of Jim Woodruff Lock and Dam in the EIS indicates that, over 73-year modeled period of record, there would be no appreciable change in flow conditions for the PAA compared to the NAA. There are likely to be slight deviations between the PAA and NAA over relatively short periods of time, including a small increase in days (0.3 percent of days over the period of record) where Apalachicola River flows downstream of Jim Woodruff Lock and Dam would likely decline to 4,500 cfs for the PAA compared to 5,000 cfs for the NAA. These potential effects on at-risk and listed species have been addressed in more detail during the 2016 section 7 consultation under the ESA, and the associated results are discussed in more detail in section 6.4.3.

- *USFWS concern* – The PAA may possibly result in slightly higher salinities (1 ppt) at the mouth of Apalachicola River and East Bay.

  USACE response – Modeling for the WCM update has indicated that flow conditions in the Apalachicola River under the PAA are not expected to differ appreciably from those under the NAA. Consequently, freshwater inflows to the Apalachicola Bay estuary are not expected to differ appreciably from the NAA. Thus, USACE determined that salinity conditions are not likely to be affected by the PAA compared to the NAA. Nonetheless, USFWS has concluded that there may be a slight increase in salinity values that may have some implications for Gulf sturgeon habitat in the estuary. To determine the effect of the PAA on the salinity in the Apalachicola Bay, the USACE requested that USFWS do additional modeling. USFWS commissioned a report from Dr. Sheng to measure differences in salinity in the Apalachicola Bay between the NAA and the PAA. The USFWS September 2016 Biological Opinion concluded that only minor changes in salinity regimes or estuarine habitat were anticipated due to the PAA (USFWS 2016b).

The PALs, FWCARs, and USACE responses described above are all included in appendix J of this final EIS. In addition, USFWS comments on the draft EIS were incorporated into the January 29, 2016 comment letter of the U.S. Department of Interior, Office of Environmental Policy and Compliance. The USACE response to the U.S. Department of Interior comments are included in the portion of appendix C (Pertinent Correspondence) reserved for comments received on the draft EIS and USACE responses to those comments.

Table 6.4-1.
U.S. Fish and Wildlife Service, Fish and Wildlife Coordination Act Report (September 2016)
Conservation Recommendations and USACE Responses

USFWS Category	ID No.	USFWS Recommendation	USACE Response
Alternative Evaluation	ALT1	Clarify the criteria required for an alternative to warrant full consideration	The USACE PAL response to USFWS in January 2015 described the alternative formulation process and noted that Phase I of that process evaluated the No Action Alternative (NAA) and six other Water Management Alternatives (WMA). One of those WMAs was the USFWS alternative (described in the USFWS July 2013 letter). USACE used an array of performance metrics to evaluate the ability of the various alternatives to meet the authorized project purposes and to rank the extent to which the alternatives met the objectives established for the WCM update. Phase 1 of the alternative formulation process identified the water management alternative (WMA 7) that would best balance all the authorized project purposes. WMA 7 features are included in the PAA. USACE appreciates extensive efforts of the USFWS to identify a system-wide operational plan for consideration during the WCM update process. USACE fully evaluated and considered the USFWS alternative.
Flow Regime	FR1	Develop an alternative or suite of alternatives that would maximize benefits to fish and wildlife resources in light of other project purposes.	USACE maintains that the alternative formulation process accomplishes this request. Full details of the iterative process used in the alternative selection methodology as well as all project impacts of each alternative are provided in the EIS (Sections 4 and 6 respectively).
	FR2	Conduct ecosystem flow analyses for the NAA and PAA using the methodology cited in the USFWS 2011 PAL addendum (analyses at four nodes, below the Buford, West Point, George, and Woodruff projects). Compare the results with the USFWS ecosystem flow guidelines. Evaluate provision of non-hydropower peaking “windows” during critical reproductive and rearing periods for a minimum of 4-6 weeks from March-May.	USACE agrees with this approach; the 2015 response to PAL provided a monthly flow statistics analysis of the simulated NAA and PAA depicting this information at numerous locations throughout the basin. Non-hydropower peaking “windows” were considered and determined to not be prudent based on equipment limitations, safety concerns, and serious impacts to other authorized project purposes. The needs of both the hydropower and fish and wildlife conservation purposes can be managed cooperatively to achieve benefits for both. USACE operations, including hydropower production, result in a mix of beneficial and adverse effects to aquatic fauna. To the extent that restoration of some of the natural flow regime components can be accomplished in balance with other project purposes, the PAA adequately strikes this balance.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
	FR3	Evaluate the potential for reducing the magnitude of the autumn drawdown, changing the order of refill, and/or beginning the spring refill earlier in order to provide fish access to and inundation of the floodplain.	This recommendation would have serious implications for flood risk management. One of the eight screening criteria that USACE developed to guide the WCM update process requires that USACE maintain at least the current level of flood risk management, as Congress intended when authorizing the system and projects. The alternatives considered in the EIS do not include any proposed changes to water management practices that exceed existing congressional authority.
	FR4	Evaluate methods to provide operational flexibility necessary for floodplain inundation, to include: 1) protecting structures and/or 2) purchasing and removing structures built in the historic floodplain.	Purchasing structures in the floodplain could potentially provide more flexibility regarding floodplain inundation. However, these actions are not currently authorized, nor are they appropriate as part of a WCM update. These types of actions require separate study authority.
	FR5	Evaluate the operational feasibility, constraints, and tradeoffs to providing different component(s) of environmental flow measures captured in our guidelines.	In the 2011 response to USFWS PAL, USACE provided information on the physical, safety, and logistical limitations to possible operational changes to specifically mimic a natural flow regime. Operating to mimic the natural flow regime is not possible at these multipurpose federal projects since they were designed and built to alter the natural flow regime to achieve specific project purposes and benefits. Operations that would not meet all the authorized purposes, including hydropower and flood risk management, are outside the scope of the WCM update.
	FR6	Work with USFWS and others to develop appropriate hydrological and meteorological criteria needed to classify the coming month as dry, average, or wet.	USACE currently utilizes the NIDIS Low Flow Information System to alert other water management operators and basin stakeholders of low flow conditions. USACE will continue to evaluate forecasting tools that will help improve water management practices and will coordinate these efforts with USFWS as well as other agencies and stakeholders.
	FR7	There are no minimum flow provisions downstream of the W. F. George project. Spillway gates are opened when low dissolved oxygen values are observed below the dam until the dissolved oxygen readings return to an acceptable level. USACE should evaluate modifying W. F. George project operations to provide a continuous minimum flow release instead of a “reactive response.”	The Walter F. George Lock and Dam project is a hydropower facility designed to meet peak demand that typically occurs during the weekday. During periods of normal flow, Walter F. George Lock and Dam may not release water on the weekends if the Jim Woodruff flow provisions can be met without support from upstream reservoirs. There is no authorized minimum flow requirement from Walter F. George Lock and Dam. Upstream projects (Buford and West Point) have small hydropower house units designed to meet the authorized continuous minimum flow requirement. Walter F. George Lock and Dam does not have a small hydropower house unit to provide a continuous minimum flow. Installation of siphons and occasional spillway releases assist with raising the dissolved oxygen level downstream of the project when needed. However, structural modification of the Walter F. George Lock and Dam is outside the scope of this WCM update.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
	FR8	Consider other options for operational flexibility that do not include changing the drought zone trigger from Zone 3 to Zone 2, and postponing the reinstatement of normal operations until Zone 1 is reached. These changes likely result in an increased frequency and duration of low flows in the Apalachicola River.	Drought operations under the PAA are triggered when the composite conservation storage drops into Zone 3 (not Zone 2 as indicated in the FWCAR). The Phase I alternative formulation process discussed in detail in Section 4 of the EIS considered alternative drought operation triggers to the one represented in the PAA.
Floodplain Inundation Assessment	FP1	Use LIDAR and stage-discharge relationships to calculate area (acres) of aquatic habitat connected to the main channel of the non-tidal Apalachicola River to compare the magnitude, duration, timing, frequency, and rate of change of Apalachicola River floodplain inundation in the NAA, PAA, and pre-Buford period.	LIDAR data for the entire Apalachicola River floodplain has not been made available to USACE, and USACE is not aware that models or software that correlate LIDAR data to specific discharges from Jim Woodruff Lock and Dam currently exists. Accordingly, USACE has used the best available information consistent with the guidance provided in the USFWS PALs. In the draft FWCAR, USFWS stated the following: “Given that the NAA and PAA exceedance curves are nearly the same, we do not expect that using LIDAR data would lend additional insights. Chattahoochee River floodplain connectivity would be expected to be nearly the same between the NAA and PAA.”
Water Quality	WQ1	Ensure that releases from all ACF dams meet or exceed water quality standards, to include: monitoring upstream and downstream of USACE reservoirs, testing operational and/or structural modifications to improve water quality; and post-modification monitoring to ensure that levels have been improved to state water quality standards.	The impoundment and release of river water through USACE ACF dams does not involve the discharge of any pollutant, and is not subject to specific Clean Water Act effluent limitations. USACE is not responsible for enforcing State water quality standards or regulating effluent discharges by others, and USACE cannot ensure that water quality standards are met. USACE monitors water quality in the tailrace of some ACF dams, and several federal and state agencies, including USGS, Alabama DEM, Florida DEP, and GAEPD, monitor surface water quality within, upstream and downstream of USACE reservoirs, and throughout the basin. Using this and other information, USACE has given careful consideration to water quality standards and has evaluated the effects of each alternative on water quality, including releases to ensure minimum flows where feasible and authorized. Substantial operational and/or structural modifications to improve dissolved oxygen or other water quality parameters to meet or exceed state water quality standards downstream of USACE dams would require separate authority and are beyond the scope of this WCM update.
	WQ2	Evaluate the effectiveness of the upgraded venting capabilities at Buford turbines.	This type of study is beyond the scope of the WCM update. Alternative authorization and appropriation, such as USACE restoration authorities, may be necessary to fulfill this conservation recommendation. USACE is willing to explore these opportunities with USFWS.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
	WQ3	Monitor water temperature upstream and downstream of USACE ACF reservoirs; test operational and/or structural modifications to improve temperature levels, as needed; and conduct post-modification monitoring to ensure that temperatures have been improved.	The Corps makes releases to improve water temperature and DO downstream of its projects when feasible. Structural modifications to improve temperature levels downstream of USACE dams would require separate study authority and is beyond the scope of this WCM update.
Fish Reservoir and Riverine Fishes / Fish Management	FM1	Provisions for fish passage should be incorporated into operations at the Woodruff, Andrews and W.F. George projects, while maintaining operational flexibility.	USACE has adopted fish passage operations at Jim Woodruff Lock and Dam into the WCM. Fish passage studies at the Jim Woodruff project indicate that few fish passing into Lake Seminole move up the Chattahoochee River arm of the basin. Recent genetic studies demonstrate that about 98 percent of the Alabama shad's natal waters are in the Flint River. Thus, fish passage operations at George W. Andrews Lock and Dam and Walter F. George Lock and Dam would most likely produce limited benefits. If future information dictates greater potential for fish passage benefits at these projects, the manuals can be further updated. Additionally, the absence of specific language in the project WCMs does not preclude routine lock operations at the Andrews or George projects that may benefit anadromous fish species.
	FM2	Review recent fisheries literature for new information on detrimental impacts to riverine fish spawning due to a 4-6 week stable or rising reservoir window, per the USACE draft SOP for "Lake Regulations and Coordination For Fish Management Purposes."	Lake regulation and coordination for fish management purposes is required by South Atlantic Division Regulation PDS-O-1 (31 May 2010). The Mobile District draft fish spawn SOP (2005) defines District operations for implementing this regulation and requires an annual meeting with state and federal fish and wildlife resource agencies. The annual meeting provides opportunity to: evaluate the success or failures of executing the fish spawn operations during the previous year; share data, including recent scientific investigations that support, modify, or reject the fish spawn operations; and identify potential refinements.
	FM3	Investigate modifying the fish spawn SOPs to occasionally emphasize river spawning over reservoir spawning and define circumstances where this could occur without unreasonably compromising other project purposes.	The existing language in the SOPs provides for this flexibility and specifically enables "operational adjustments recommended by the interagency team to minimize impacts and/or enhance system-wide benefits." As described in the paragraph above, modifications to the SOP can be proposed and mutually agreed upon or rejected as part of the annual coordination meeting with USFWS.
	FM4	Identify fish and wildlife recreation facilities that need infrastructure improvements to operate at a wider range of flows and/or reservoir elevations.	Infrastructure improvements require additional authority and are outside the scope of the WCM update. As a separate action from the WCM update, USACE can work with the USFWS and potential local cost-sharing partners to identify and develop fish and wildlife recreation facilities under other available USACE authorities.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
	FM5	Effects to Gulf sturgeon should be included in the development and evaluation of alternatives, as specified in our previous PALs. USFWS developed the Sturgeon Spawning Habitat Performance Measure (SSHPM) to facilitate the USACE analysis, but this information was not included in the analysis provided to USFWS.	USACE utilized the SSHPM Excel workbook developed by the USFWS, and the USACE response to the USFWS PAL (Section 2.7.1) noted that there were no differences between the NAA and PAA. USACE provided the USFWS with the workbook supporting this determination in March 2015.
	FM6	The impacts of the PAA to species in the ACF Basin currently petitioned for Federal listing under the ESA should also be described and quantified. USACE should update surveys and quantify effects of proposed future actions to these species.	USACE worked closely with the USFWS during the ESA section 7 consultation to ensure that the appropriate species were addressed. USACE utilized existing information for the species currently petitioned for listing and worked with USFWS to identify opportunities to improve the understanding and future evaluation of project impacts on these species. The final Biological Opinion (BO) for the PAA (September 2016) also discusses additional opportunities to further address these issues in response to a conservation recommendation to pursue a potential ESA section 7(a)(1) agreement with USFWS.
Climate Change	CC1	In addition to considering sea level rise, include multiple future climate scenarios into modeled discharge scenarios and USACE alternatives and create flow provisions for dry, average, and wet years in order to account for current climate variability.	The EIS includes climate change and sea level rise analyses consistent with USACE regulations. USACE engaged the Institute for Water Resources (IWR) to develop a numerical model (correlated with the HEC-ResSim and HEC-5Q models for the ACF system) to evaluate the resilience and limitations of the PAA in response to potential climate change conditions. Simulating the IWR climate change projections in HEC-ResSim and HEC-5Q provided an indication of potential climate change effects on hydrology and water quality in the basin for both the NAA and the PAA. The analysis is provided in the EIS (section 6.8 and appendix N).
Navigation	NV1	Evaluate the effects of channel maintenance activities required for navigation support by including an analysis of dredging needs, dredging impacts on fish and wildlife, and a cost-benefit analysis.	Navigation is an authorized project purpose. The PAA includes provisions for releases to support a January through May “navigation season” as long as sufficient water is available in the system. The navigation season operations assume no channel maintenance activities would occur on the Apalachicola River based on constraints discussed in detail in the EIS. If channel maintenance activities are re-instated for the Apalachicola River portion of the navigation project in the future, USACE would pursue the evaluations requested by the USFWS.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
Apalachicola Bay	AB1	Incorporate an updated Apalachicola Bay salinity model in the WCM update process to predict effects to oyster mortality and growth.	USFWS contracted with Dr. Peter Sheng to update the previously conducted hydrodynamic bay salinity modeling with simulated flow data from the HEC-ResSim modeling conducted for the WCM update. The preliminary report (available November 5, 2015 during review of the draft EIS) indicated little difference in expected salinity conditions in the estuary between the NAA and PAA. The PAA changed somewhat in response to comments on the draft EIS, but the revisions did not represent a radical departure from the PAA presented in the draft EIS. The salinity modeling report was not further updated by the USFWS to reflect the revised PAA, but the results would not be expected to differ appreciably from those presented in the draft report. USFWS's September 2016 Biological Opinion stated that they anticipate only minor changes in salinity regimes or estuarine habitat due to the WCMs (USFWS 2016b).
	AB2	Coordinate with the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute to complete analyses of the relationship of freshwater inflow to the benthic communities of Apalachicola Bay and changes in fish and shellfish abundance.	Based upon substantial information provided in response to the draft FWCAR, USACE disagrees with the relevancy of the impacts identified by the Florida Fish and Wildlife Conservation Commission's analysis of the pre-dam and post-West Point periods of record. The appropriate "without project condition" for the purpose of the WCM update is current operations, not a pre-dam condition. Congress previously authorized the construction and operation of the federal reservoirs to serve as multipurpose projects. USFWS stated in their 2016 Biological Opinion, "The magnitude of reduction in benthic invertebrates (i.e., sturgeon food) that results from a reduction in floodplain inundation in the Apalachicola River is unknown, and the WCM may have slightly beneficial effects by increasing the number of pulses and increasing the number of consecutive days/year > 16,200 cfs in the winter months. Until better data is available, we could conclude that this effect on estuarine invertebrate production is insignificant. Therefore, we anticipate only minor changes in salinity regimes or estuarine habitat due to the WCM." USFWS and USACE will be evaluating this concern in more detail in accordance with RPM 2016-3 in the recently issued BO for the PAA (USFWS 2016b).

USFWS Category	ID No.	USFWS Recommendation	USACE Response
Decision Support Model to Evaluate Operational Changes	DS1	Incorporate a decision support model into the WCM update process to evaluate the effects of management strategies on the riverine ecosystem, recreation, navigation, hydropower, and other uses of federal dams.	Considering the purpose and need for the EIS, USACE developed eight screening criteria to guide information gathering, identify solutions, and formulate alternatives. These screening criteria are described in section 1.4.4 of the EIS. The EIS includes a detailed description of the alternative development and evaluation process for the WCM update in sections 4 and 5. As described in those sections, Phase 1 and Phase 2 alternative formulation and evaluation processes used a wide array of performance metrics for all project purposes, which were considered equally. This approach provided the most effective decision support methodology for selecting a plan that best balances all authorized project purposes.
Adaptive Management	AMP1	Develop an adaptive management program, consistent with the authorized purposes of the ACF reservoirs, for achieving specific ecological and social goals for the management of the ACF system including specific releases for Woodruff Lock and Dam.	The WCM guidance, fish spawn SOP, ESA compliance annual reports, and monthly coordination with the USFWS regarding Apalachicola River flows generally achieve the goal of the formal adaptive management program that the USFWS recommends. The WCM guidance provides for operational flexibility to balance all project purposes over a wide variety of conditions. USFWS and USACE will evaluate this issue further in accordance with RPM 2016-1 of the recently issued BO for the PAA (September 2016).
Increasing Consumptive Demands	CD1	Recognize and consider the impacts of increasing consumptive (municipal, industrial, and agricultural) water demands in the basin and incorporate it into analysis of operational alternatives along with climate-driven hydrologic variability. Quantify the relationship between increasing consumptive demands in the ACF Basin and effects on various project purposes. Include metrics regarding water supply withdrawals, including potential increases, in the alternatives analysis.	Section 4.1 and the introduction to section 6 of the EIS describe the water supply withdrawal assumptions in the HEC-ResSim model. The model assumes consumptive demands for the NAA across the basin to be based upon the year of highest net withdrawal to date (2007). These levels of consumptive demand were selected by USACE because they represent the most severe consumptive demands experienced to date. For the PAA and other alternatives evaluated in detail, various level of increased withdrawals from Lake Lanier and from the Chattahoochee River in Metro Atlanta (up to and including the projected 2060 demand) were modeled as a result of the state of Georgia's water supply request (last updated in December 2015). For the PAA and other alternatives, 2007 net withdrawals were assumed for the other areas of the basin.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
Evaluation of Alternative Models	AM1	Investigate the use of alternative models to develop better unimpaired flow and alternative flow datasets. Compared to the USGS gage data, the unimpaired flow dataset does not accurately represent the magnitude, duration, timing, and rate of change of flow extremes (i.e., minimum and maximum flows). Flow extremes play important roles in reservoir operational decisions and in riverine, estuarine, and floodplain ecology.	USACE will continue to work with the states to improve the unimpaired flow development methodology and update the dataset accordingly. The unimpaired flow dataset has recently been updated and has been included as appendix O to the final EIS. The WCM update process used "HEC-ResSim Version 3.2, Build 3.2.1.19". HEC-ResSim is a generalized reservoir operations modeling package. Per USACE guidance, HEC-ResSim falls under the category of "engineering models used in planning studies", leaving certification to the Science & Engineering Technology initiative associated with the USACE Technical Excellence Network. The USACE Hydrologic Engineering Center developed this software which is the standard for USACE reservoir operations modeling. As of January 2010, the USACE Technical Excellence Network guidance listed HEC-ResSim as "Community of Practice Preferred" for the purpose of reservoir system analysis. Any alternative model selected would require the same level of review and endorsement.
	AM2	If the USGS Precipitation-Runoff Modeling System is developed specifically for the ACF in a timeframe useful for the ACF WCM update process, use it as an additional evaluation tool.	The Precipitation-Runoff Modeling System is not available for use at this time.
	AM3	Coordinate with USGS and Georgia Water Resources Institute regarding new models to explicitly address climate-based operational flexibility during the development and evaluation of flow alternatives, the WCM update, and the EIS analyses.	USACE is familiar with the Georgia Water Resources Institute models and maintains that HEC-ResSim is the best available tool for evaluating alternative system wide operations.
	AM4	Consider alternative water quality assessment methods to accurately evaluate effects of flow alternatives on water quality. Because the HEC-5Q water quality model outputs are not expected to accurately predict either the values or the range of values that are likely to occur in response to hourly discharge changes, consider using existing alternative models or develop regression models to accurately predict water quality parameters.	The HEC-5Q water quality model is appropriate for the WCM update. The HEC-5Q Water Quality Modeling Report included in the final EIS (appendix K) provides a detailed description of the "Demonstration of Model Performance" conducted by the water quality modeling team. The demonstration included extensive comparison of modeled and observed time series (streams) and profiles (reservoirs) as well as a model sensitivity analysis.
CRNRA (National Park Service)	NPS1	The impacts of the PAA on the CRNRA should be described and quantified. Information and recommendations provided separately by the NPS on Lake Lanier releases should be considered.	The EIS specifically addresses the effects of the PAA on natural resource and recreational considerations within the CRNRA in several areas within section 6.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
Ecosystem Services Impacts	ES1	The impacts of the PAA on ecosystem services should be described and quantified. Ecosystem services are benefits that humans derive from ecosystems. Riverine ecosystem services include water filtration by aquatic invertebrates, carbon sequestration by floodplain connectivity, recreation opportunities, and numerous others.	USACE currently does not have specific guidance on the valuation of ecosystem services in conjunction with USACE studies and impact assessments. Nonetheless, the EIS generally addresses effects to a wide variety of ecosystem functions and services throughout section 6, and those effects were considered in the selection of the PAA.
Mitigation Measures	MIT1	In the USACE NEPA documentation, the impacts of the PAA on fish and wildlife resources should not only be described and quantified, but USACE should also outline an approach to mitigation. Mitigation measures should be based upon more accurate projections of future projected resource conditions with and without the project.	As potential water management measures were identified and alternatives were developed, potential actions to offset adverse effects also were identified, analyzed and considered in the planning process. Compared to the NAA, the overall effects of the PAA and other alternatives on significant resources were determined to be minor, and specific compensatory mitigation measures by USACE were not required or considered necessary.
	MIT2	Development of mitigation measures should be scientifically formulated, and based on the future with and future without the project scenarios, and a determination of the net change between the two. Habitat-based evaluation techniques should be used wherever possible.	As indicated in the response to MIT1, the incremental effects to significant resources between the NAA and PAA were determined to be minor and would not require specific compensatory mitigation measures by USACE.
	MIT3	Impacts to the estuary that result from lower inflow and higher salinities have been quantified using empirical relationships and models. Mitigation for these impacts should be determined and implemented. We recommend that USACE consult with the State of Florida and USFWS Panama City Field Office.	As described in the information provided during coordination with the USFWS and presented in the EIS, the PAA would result in negligible impacts to the Apalachicola Bay estuary compared to the NAA. Therefore, no specific mitigation measures were determined to be necessary.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
Other	1	With other stakeholders, develop a basin-wide adaptive management strategy that has differential objectives that can accommodate prolonged dry periods, normal periods, and wet periods. Adjustable objectives will require additional metrics to evaluate successful basin-wide operations that are in concert with other stakeholder operations. In partnership, adjustable objectives can be appropriately prioritized depending on current and forecasted basin-wide meteorological conditions.	The PAA resulting from the WCM update process is flexible enough to adapt to a wide range of hydrologic conditions, ranging from extreme floods to extreme drought conditions, while providing a balance across all authorized project purposes under that range of conditions. The PAA even includes a contingency plan that establishes release priorities in the event of a drought so severe that all conservation storage is exhausted. There are numerous established metrics by which to measures the effectiveness of the PAA. In addition, water management inherently involves adapting to unforeseen conditions. Because adverse effects of the Master Manual update might occur in the future due to unforeseen conditions, actions would be taken within applicable authority and policies, and in coordination with other interests, to address such conditions when they occur through the implementation of temporary deviations to the water control plan, such as interim operation plans.
	2	With other state and federal agencies, conduct a full evaluation of water quality concerns that may be associated with USACE operations, considering risks and identifying adaptive measures that could eliminate or minimize consequences.	The impoundment and release of river water through USACE ACF dams does not involve the discharge of any pollutant, and is not subject to specific Clean Water Act effluent limitations. USACE is not responsible for enforcing State water quality standards or regulating effluent discharges by others, and USACE cannot ensure that water quality standards are met. USACE monitors water quality in the tailrace of some ACF dams, and several federal and state agencies, including USGS, Alabama DEM, Florida DEP, and GAEPD, monitor surface water quality within, upstream and downstream of USACE reservoirs, and throughout the basin. Using this and other information, USACE has given careful consideration to water quality standards and has evaluated the effects of each alternative on water quality, including releases to ensure minimum flows where feasible and authorized. Substantial operational and/or structural modifications to improve dissolved oxygen or other water quality parameters to meet or exceed state water quality standards downstream of USACE dams would require separate authority and are beyond the scope of this WCM update.
	3	Recommend a more comprehensive evaluation of the consequences of USACE operations relative to the purposes and authorizations of other federal and state agencies, including how USACE operations will impact the mission objectives and the associated consequences and costs.	Effects of the PAA (compared to the NAA) on public lands and waters are considered in section 6 of the EIS. This specific concern and recommendation specifically focuses on the actual or perceived effects of current and proposed operations on the CRNRA operated by the National Park Service. Refer to the response to NPS1 above.

USFWS Category	ID No.	USFWS Recommendation	USACE Response
	4	A broader range of fish and wildlife conservation metrics are needed. These metrics should be used to evaluate potential changes resulting from USACE operations. They should be indicative of impacts resulting from USACE operations, representative of targeted conservation conditions, and fully consider impacts to At-Risk species, including, but not limited to those recently petitioned.	USACE will work with USFWS to further develop and refine the fish and wildlife conservation metrics for the ACF Basin as a basis to more effectively evaluate the effects of USACE operations. The conservation recommendation in the recently issued BO for the PAA (September 2016) to enter into an ESA section 7(a)(1) agreement with the USFWS would be an appropriate vehicle to address this recommendation.

6.4.2 Vegetation and Wildlife Resources

As discussed in sections 2.5.1 and 2.5.2, vegetation and wildlife resources include the terrestrial vegetation communities, freshwater and estuarine wetland communities, and terrestrial wildlife resources including birds, mammals, and insects and other invertebrates in the ACF Basin, with an emphasis on those species known, or likely, to occur in riparian or terrestrial areas. (Fish and aquatic resources, including reptiles and amphibians, are discussed in subsequent sections). Under normal climatic and water quantity conditions, water management operations in the ACF Basin have little to no discernible effect on terrestrial vegetative communities and wildlife. It is the intensity and duration of drought conditions that affects those resources; in the ACF Basin, water management operations have no discernable effect. Under flood conditions and depending on how they are implemented, however, water management operations in the ACF Basin could have the potential to affect terrestrial vegetative communities and wildlife beneficially or adversely.

A summary of effects on vegetation and wildlife resources is provided in Table 6.4-2.

Table 6.4-2.
Summary of the Effects of Alternatives on Vegetation and Wildlife Resources

River	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Chattahoochee River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Flint River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.4.2.1 No Action Alternative

6.4.2.1.1 Chattahoochee River

Implementing the NAA would have negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. As stated above, under normal climatic and drought conditions, water management operations in the ACF Basin have little to no effect on terrestrial vegetative communities and wildlife. Flood risk management operations under the NAA would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing the NAA.

6.4.2.1.2 Flint River

Implementing the NAA would have negligible effect on terrestrial vegetation or wildlife along the Flint River. No aspect of the NAA has any effect on flow conditions along the river.

6.4.2.1.3 Apalachicola River

Implementing the NAA would have negligible effect on terrestrial vegetation or wildlife along the Apalachicola River and Bay. Flows from the Jim Woodruff Lock and Dam and the amount and extent of floodplain inundation along the Apalachicola River and in Apalachicola Bay would not change under the NAA. The current drought plan specifies a minimum release of 5,000 cfs from the Jim Woodruff Lock and Dam unless the composite conservation storage falls below the Drought Zone, in which case the minimum release from the Jim Woodruff Lock and Dam is 4,500 cfs. That plan would continue to be implemented under the NAA.

6.4.2.2 Alternative 1L

6.4.2.2.1 Chattahoochee River

Implementing Alt1L would have negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt1L would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt1L.

6.4.2.2.2 Flint River

Implementing Alt1L would have negligible effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.2.3 Apalachicola River

Alt1L would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). Thus, implementing Alt1L would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.3 Alternative 7A

6.4.2.3.1 Chattahoochee River

Implementing Alt7A would have the same effects on terrestrial vegetative communities and wildlife along the Chattahoochee River as the NAA.

6.4.2.3.2 Flint River

Implementing Alt7A would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.3.3 Apalachicola River

Alt7A would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). When flow in the river drops below 5,000 cfs during Drought Zone operations under Alt7A, vegetation and wildlife along the Apalachicola River would be expected to experience short-term slightly

adverse conditions. Drought Zone operations would occur infrequently and would generally be of relatively short duration (i.e., a few weeks or less). The vegetation and wildlife along the Apalachicola River would be able to endure drought conditions with no measureable changes to vegetative community composition or wildlife populations. Thus, implementing Alt7A would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.4 Alternative 7B

6.4.2.4.1 Chattahoochee River

Implementing Alt7B would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt7B would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt7B.

6.4.2.4.2 Flint River

Implementing Alt7B would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.4.3 Apalachicola River

Alt7B would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). Thus, implementing Alt7B would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.5 Alternative 7H

6.4.2.5.1 Chattahoochee River

Implementing Alt7H would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt7H would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt7H.

6.4.2.5.2 Flint River

Implementing Alt7H would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.5.3 Apalachicola River

Alt7H would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). When flow in the river drops below 5,000 cfs during Drought Zone operations under Alt7H, vegetation and wildlife along the Apalachicola River would be expected to experience short-term slightly

adverse conditions. Drought Zone operations would occur infrequently and would generally be of relatively short duration (i.e., a few weeks or less). The vegetation and wildlife along the Apalachicola River would be able to endure the conditions with no measureable changes to vegetative community composition or wildlife populations.

6.4.2.6 Alternative 7I

6.4.2.6.1 Chattahoochee River

Implementing Alt7I would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt7I would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt7I.

6.4.2.6.2 Flint River

Implementing Alt7I would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.6.3 Apalachicola River

Alt7I would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). When flow in the river drops below 5,000 cfs during Drought Zone operations under Alt7I, vegetation and wildlife along the Apalachicola River would be expected to experience short-term slightly adverse conditions. Drought Zone operations would occur infrequently and generally be of relatively short duration (i.e., a few weeks or less). The vegetation and wildlife along the Apalachicola River would be able to endure the conditions with no measureable changes to vegetative community composition or wildlife populations. Thus, implementing Alt7I would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.7 Alternative 7J

6.4.2.7.1 Chattahoochee River

Implementing Alt7J would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt7J would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt7J.

6.4.2.7.2 Flint River

Implementing Alt7J would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.7.3 Apalachicola River

Alt7J would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). Thus, implementing Alt7J would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.8 Alternative 7K (PAA)

6.4.2.8.1 Chattahoochee River

Implementing the PAA would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under the PAA would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing the PAA.

6.4.2.8.2 Flint River

Implementing the PAA would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.8.3 Apalachicola River

The PAA would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). When flow in the river drops below 5,000 cfs during Drought Zone operations under the PAA, vegetation and wildlife along the Apalachicola River would be expected to experience short-term slightly adverse conditions. Drought Zone operations would occur infrequently and would generally be of relatively short duration (i.e., a few weeks or less). The vegetation and wildlife along the Apalachicola River would be able to endure the conditions with no measureable changes to vegetative community composition or wildlife populations. Thus, implementing the PAA would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.9 Alternative 7L

6.4.2.9.1 Chattahoochee River

Implementing Alt7L would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt7L would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt7L.

6.4.2.9.2 Flint River

Implementing Alt7L would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.9.3 Apalachicola River

Alt7L would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). When flow in the river drops below 5,000 cfs during Drought Zone operations under Alt7L, vegetation and wildlife along the Apalachicola River would be expected to experience short-term slightly adverse conditions. Drought Zone operations would occur infrequently and would generally be of relatively short duration (i.e., a few weeks or less). The vegetation and wildlife along the Apalachicola River would be able to endure the conditions with no measureable changes to vegetative community composition or wildlife populations. Thus, implementing Alt7L would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.2.10 Alternative 7M

6.4.2.10.1 Chattahoochee River

Implementing Alt7M would have a negligible effect on terrestrial vegetation or wildlife along the Chattahoochee River. Under normal climatic and drought conditions, water management operations in the ACF Basin have little to no influence on those resources. Flood risk management operations under Alt7M would continue as they have since 1989. The Lake Lanier and West Point Dam and Lake projects would store flood water, which would be released from the reservoirs so flows would not exceed the bankfull discharges. Terrestrial vegetation and wildlife along the Chattahoochee River, therefore, would not be affected by implementing Alt7M.

6.4.2.10.2 Flint River

Implementing Alt7M would have no effect on terrestrial vegetation or wildlife along the Flint River.

6.4.2.10.3 Apalachicola River

Alt7M would not appreciably alter flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam and continuing to Apalachicola Bay compared to the NAA (see section 6.1.1.2.5). When flow in the river drops below 5,000 cfs during Drought Zone operations under Alt7M, vegetation and wildlife along the Apalachicola River would be expected to experience short-term slightly adverse conditions. Drought Zone operations would occur infrequently and would generally be of relatively short duration (i.e., a few weeks or less). The vegetation and wildlife along the Apalachicola River would be able to endure the conditions with no measureable changes to vegetative community composition or wildlife populations. Thus, implementing Alt7M would be expected to have the same effects on terrestrial vegetative communities and wildlife along the Apalachicola River as the NAA.

6.4.3 Fish and Aquatic Resources

6.4.3.1 Rivers

Fish and aquatic resources in the ACF Basin between Buford Dam and Apalachicola Bay could be affected somewhat differently under the alternatives, depending on the extent of changes in streamflow and water quality conditions compared to the NAA.

The nine alternatives, each of which incorporates a different water supply option, include either Water Management Alternative 1 or Water Management Alternative 7 from Table 4.2-1. Both include fish and wildlife conservation measures, including current fish spawn standard operating procedures and fish passage lockages at Jim Woodruff Lock and Dam. The alternatives evaluated also call for similar federally listed

threatened and endangered species operations, including the current ramping rate with suspension of the ramping rate during drought conditions and current seasonal flow targets.

The ranges used to define water quality effects were determined based on conditions that would protect fish and aquatic resources. Therefore, those definitions can be used to assess the effects of various management alternatives on these communities. Water quality parameters that relate to fish and aquatic resources include water temperature and levels of DO, TP, TN, and chlorophyll *a*. Fish are sensitive to DO concentrations, and thus, mortality can result when fish are exposed to very low concentrations of DO; fish kills are high profile and very visible to the public. Seasonal considerations are important in evaluating DO and, because cooler water has a greater capacity for maintaining oxygen in a dissolved state, higher and lower levels are expected, respectively, in winter and summer months. Nutrients such as TN and TP can disrupt aquatic ecosystems in elevated concentrations, which effectively serve as fertilizers for enhanced growth of aquatic plants, including algae. High nutrient levels, thus, indirectly lead to increases in turbidity, decreases in DO, and other associated effects. Chlorophyll *a* concentration is an indicator of algal biomass. Higher levels of chlorophyll *a* can be considered as additional evidence of stream degradation and are unfavorable for fish and aquatic resources. However, according to GAEPD, there may be positive benefits to a reservoir fishery from increases in phosphorus and chlorophyll *a* (USFWS 2016 response to comments final EIS provided in appendix J). If not at critical levels, an increase in nutrient loading could lead to increased biomass and improved fishing within Lake Lanier, Walter F. George Lake, and West Point Lake. Other water quality factors that can be harmful to fish and aquatic resources include toxic contaminants such as pesticides, herbicides, metals, and acidity/alkalinity (low or high pH).

Decision criteria for establishing thresholds for water quality parameters are presented in sections 6.1.2.1 (water temperature), 6.1.2.2 (DO), 6.1.2.3 (TP), 6.1.2.4 (TN), and 6.1.2.5 (chlorophyll *a*).

The relative importance of the different water quality parameters and their associated effects on fish and wildlife varies depending on the specific location within the river system, season of the year, and other factors. While all relevant parameters were considered equally from a systemwide perspective, the analysis of specific reaches of the river system might have given greater focus to one or more parameters that would tend to have a more dominant influence in those particular reaches. For example, DO would generally receive more focus downstream of dams in the late summer and fall for reservoirs from which releases occur in the lower regions. Water temperature might receive greater focus if a coldwater fishery is involved (e.g., immediately downstream of Buford Dam). In the headwaters and main bodies of reservoirs, nutrient-related parameters might receive greater scrutiny, specifically during the growing season.

The Chattahoochee River is essentially disconnected from its floodplain, so floodplain connectivity would not be influenced by the different alternatives. In addition, changes in streamflow on the Chattahoochee River between Buford Dam and Lake Seminole are minor under the various alternatives and are not expected to have direct effects on fish and aquatic resources. Streamflow conditions for the Chattahoochee River are described in detail in section 6.1.1.2 for each alternative relative to the NAA. Figure 6.1-19 through Figure 6.1-30 present model outputs for Buford Dam and the Chattahoochee River at Peachtree Creek and Atlanta over the modeled period of hydrologic record. The figures present results for magnitude of flow conditions at Buford Dam and at Atlanta, and percent of days exceeded for flows at the Chattahoochee River (Peachtree Creek, Atlanta). Figure 6.1-31 through Figure 6.1-46 present model outputs for the Chattahoochee River at Whitesburg and for West Point Dam, including the magnitude of flow conditions at West Point Dam and at Columbus. Figure 6.1-47 through Figure 6.1-52 present the magnitude of flow conditions at George W. Andrews Lock and Dam. The figures show that there is little difference between alternatives.

The Apalachicola River has a wide and relatively flat floodplain and is highly connected to vast overbank areas with backwater sloughs and interconnecting channels. The Apalachicola River floodplain is highly sensitive to appreciable changes in flow conditions downstream of Woodruff Lock and Dam, floodplain connectivity, and fall rates in the river.

For the NAA, flows in the Apalachicola River would be governed by the current RIOP, as described in section 2.1.1.2.4.4. Adjustments would be made in operations under Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M to protect threatened and endangered species, as outlined in section 5.4.6.

The criteria used to define water quantity effects on fish and aquatic resources in the Apalachicola River downstream of Jim Woodruff Lock and Dam include discharge rates and area of floodplain habitat. These criteria are appropriate for assessing overall effects on the wide variety of aquatic organisms—including aquatic vegetation, riverine and estuarine fish, amphibians, reptiles, mollusks, and other invertebrates—that inhabit the Apalachicola River and the adjacent floodplain.

A summary of effects on aquatic resources is provided in Table 6.4-3. For this summary, effects on aquatic resources in segments of the Chattahoochee River caused by changes in water quality from the NAA are based on median changes in water quality parameters, as indicated in Table 6.1-17 (water temperature), Table 6.1-18 (DO), Table 6.1-21 (TP), Table 6.1-22 (TN), and Table 6.1-23 (chlorophyll *a*). Effects at the 5th and 95th percent occurrence and during the growing season of a dry year are discussed in the following sections, where applicable, but represent rare conditions and were not used to determine the overall effect. Effects of water quantity changes on fish and aquatic resources in the Apalachicola River are detailed in section 6.4.3.1.4. The most extreme effect of each criterion evaluated for a stream segment was used to determine the overall effect. For example, if the effect of an alternative is slightly adverse for DO and negligible for other water quality parameters, the effect on fish and aquatic resources was determined to be slightly adverse.

Table 6.4-3.
Summary of the Effects of Alternatives on Riverine Fish and Aquatic Resources

Reach	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Buford Dam to Atlanta	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Atlanta to West Point Lake	Baseline	Slightly adverse	Negligible/ No change	Slightly adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Adverse	Substant-ially adverse
West Point Dam to Walter F. George Lake	Baseline	Substant-ially adverse	Negligible/ No change	Negligible/ No change	Slightly adverse	Slightly adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse	Substant-ially adverse
Walter F. George Lock and Dam to Lake Seminole	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Slightly adverse	Negligible/ No change	Slightly adverse
Apalachicola River	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.

Adverse—Any adverse impact is clearly detectable and would have an appreciable effect.

Substantially adverse—Any adverse impact would result in a highly noticeable effect.

6.4.3.1.1 Chattahoochee River Downstream of Buford Dam

6.4.3.1.1.1 No Action Alternative

Streamflow and water quality conditions in the Chattahoochee River downstream of Buford Dam would not change under the NAA. Section 6.1.1.2.2 describes flows along that reach of the Chattahoochee River. Operations to support fish spawning in rivers, consistent with other project purposes, would continue as currently practiced. Aquatic communities in the Chattahoochee River below Buford Dam are heavily influenced by water control operations at the dam, particularly because of the effect on water temperature and DO. Therefore, water quality conditions for the NAA are used as the baseline against which the other alternatives are compared.

The cool water released from the reservoir supports a trout fishery below the dam, which would not otherwise be possible in this part of Georgia. Water temperature increases going downstream of the dam. During the growing season, the median daily water temperature is more than 15 °C warmer at the downstream end of the reach than it is just below Buford Dam.

The portion of the Chattahoochee River from Buford Dam to Atlanta experiences the lowest DO concentrations just downstream of the dam. Modeled DO differences are more pronounced during the growing season of a dry year, causing DO concentrations to drop below the water quality standard of 6 mg/L. The area affected by low DO during dry conditions is limited to a small reach just below the dam, from which fish can move downstream into conditions that are more favorable.

Nutrient levels are high from Atlanta to West Point Lake. The highest concentrations occur in low-flow years. In dry-weather conditions along this reach of the Chattahoochee River, concentrations of TN are near 3.5 mg/L. Downstream of Whitesburg, very high median chlorophyll *a* concentrations close to 10 µg/L occur during the growing season. High nutrient and chlorophyll *a* concentrations are indicators of degraded stream conditions, directly and indirectly affecting DO concentrations and generally not supporting a healthy aquatic community.

6.4.3.1.1.2 Alternative 1L

Overall, implementing Alt1L would be expected to have a slightly adverse effect on fish and aquatic resources. Over the modeled period, DO would be slightly adverse at the reach from Atlanta to West Point Lake. Slightly adverse conditions would be expected from Atlanta into West Point Lake because median TP and TN concentrations over the modeled period would be expected to increase. Under Alt1L, there would be little to no change in water temperature or the concentration of chlorophyll *a*. Alt1L would be expected to have a slightly adverse effect on aquatic resources in Buford Dam to Atlanta, Atlanta to West Point Lake, and West Point Lake as the result of an increase in nutrients and a decrease in DO.

6.4.3.1.1.3 Alternative 7A

Overall, implementing Alt7A would be expected to have a negligible effect on fish and aquatic resources. Under Alt7A, there would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a*.

6.4.3.1.1.4 Alternative 7B

Overall, implementing Alt7B would be expected to have a negligible effect on fish and aquatic resources. Median DO over the modeled period in Lake Lanier would benefit slightly from limiting water withdrawals and returns to relocation amounts in this alternative. Slightly beneficial effects would be expected in Lake Lanier from reducing water withdrawals and returns from current conditions in the

NAA to relocation contracted amounts. Those benefits also would be expected to slightly reduce the lowest and highest TN concentrations (5th and 95th percent occurrences) from Atlanta to West Point Lake during the growing season of a representative dry weather year. Under Alt7B, there would be little to no change in water temperature or the concentration of TP or chlorophyll *a*. Alt7B would be expected to have a slightly beneficial effect on aquatic resources in Lake Lanier and slightly adverse effects from Atlanta to West Point Lake.

6.4.3.1.1.5 Alternative 7H

Overall, implementing Alt7H would be expected to have a slightly adverse effect on fish and aquatic resources. Water temperature would be expected to increase slightly from Buford Dam to Atlanta and decrease slightly from Atlanta to West Point Lake. The DO level would be expected to decrease slightly. Concentrations of TP would increase slightly from Buford Dam to Atlanta and increase more from Atlanta to West Point Lake, although the modeled TP concentration would be less than water quality standards allow at the West Point Lake headwaters. The level of TN would increase slightly, and there would be little to no change in the concentration of chlorophyll *a*. Alt7H would be expected to have a slightly adverse effect on aquatic resources from Buford Dam to Atlanta and a substantially adverse effect from Atlanta to West Point Lake as the result of an increase in nutrients and a decrease in DO. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP and TN loads in the river, which under limited circumstances could result in substantial adverse changes to water quality.

6.4.3.1.1.6 Alternative 7I

Overall, implementing Alt7I would be expected to have a slightly adverse effect on fish and aquatic resources. The DO level would be expected to decrease by 0.3 mg/L in the reach from Atlanta to West Point Lake. Concentrations of TP would expected to increase downstream of Buford Dam because allowable phosphorus loads would be expected to be exceeded when the NAA meets water quality standards. The TN concentrations also would be expected to increase in the reaches from Lake Lanier. Under Alt7I, there would be little to no change in water temperature or the concentration of chlorophyll *a*. Alt7I would be expected to have a slightly adverse effect on aquatic resources from Buford Dam to Atlanta and a substantially adverse effect from Atlanta to West Point Lake as the result of an increase in nutrients and a decrease in DO.

6.4.3.1.1.7 Alternative 7J

Overall, implementing Alt7J would be expected to have an adverse effect on fish and aquatic resources. The DO level would be expected to increase in Lake Lanier, where slight benefits might be realized, and to decrease in the reach from Atlanta to West Point Lake, where median DO would be slightly adverse. The TP loads would be expected to exceed standards when the NAA meets the allowable load for TP in the reach from Atlanta to West Point Lake. Under Alt7J, there would be little to no change in water temperature or the concentration of chlorophyll *a*. Alt7J would be expected to have a slightly beneficial effect on aquatic resources in Lake Lanier. Substanial adverse effects would be expected from Atlanta to West Point Lake as the result of an increase in nutrients and a decrease in DO.

6.4.3.1.1.8 Alternative 7K (PAA)

Overall, implementing the PAA would be expected to have an adverse effect on fish and aquatic resources. Conditions would be slightly adverse in Lake Lanier and in the reach from Atlanta to West Point Lake, where DO would decrease. The TP level would increase from Atlanta to West Point Lake.

Adverse effects would be expected from Atlanta into West Point Lake as the result of an increase in TN. Under the PAA, there would be little to no change in water temperature or the concentration of chlorophyll *a*. The PAA would be expected to have slightly adverse effects from Buford Dam to Atlanta as the result of an increase in nutrients and substanial adverse effects from Atlanta to West Point Lake caused by an increase in nutrients and a decrease in DO. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP and TN loads in the river, which under limited circumstances could result in substantial adverse changes to water quality.

6.4.3.1.1.9 Alternative 7L

Overall, implementing Alt7L would be expected to have a slightly adverse effect on fish and aquatic resources. The DO level over the modeled period would be slightly adverse in the reach from Atlanta to West Point Lake. Concentrations of TP and TN would increase slightly, and there would be little to no change in water temperature or the concentration of chlorophyll *a*. Alt7L would be expected to have slightly adverse effects from Buford Dam to Atlanta and adverse effects Atlanta to West Point Lake caused by an increase in nutrients and a decrease in DO.

6.4.3.1.1.10 Alternative 7M

Overall, implementing Alt7M would be expected to have an adverse effect on fish and aquatic resources. The DO level would be expected to decrease in the reach from Atlanta to West Point Lake. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reaches from Atlanta to West Point Lake. Concentrations of TN would increase slightly, and there would be little to no change in water temperature or the concentration of chlorophyll *a*. Alt7M would be expected to have slightly adverse effects from Buford Dam to Atlanta as the result of an increase in nutrients and substantial adverse effects from Atlanta to West Point Lake caused by an increase in nutrients and a decrease in DO.

6.4.3.1.2 Chattahoochee River Downstream of West Point Dam

6.4.3.1.2.1 No Action Alternative

Implementing the NAA would have a negligible effect on fish and aquatic resources in the Chattahoochee River downstream of the West Point Dam. Water quality conditions under the NAA are used as the baseline against which the other alternatives are compared.

Median water temperature drops suddenly from 22 °C to 19 °C at the tailrace of the West Point Dam as the result of water being released from the bottom layer of the water column. Temperature increases going downstream of the dam. Median DO concentrations are above 6.5 mg/L. The median TP concentration in the reach from West Point Dam to Walter F. George Lake is 0.04–0.08 mg/L. The level of TN decreases downstream of the West Point Dam, except near Columbus, where it increases, most likely the result of nutrient-rich wastewater discharges. Chlorophyll *a* concentrations are elevated downstream of the West Point Dam during the growing season.

6.4.3.1.2.2 Alternative 1L

Overall, implementing Alt1L would be expected to have a slightly adverse effect on fish and aquatic resources. Under Alt1L, there would be little to no change in water temperature or the concentration of DO or chlorophyll *a* downstream of West Point Dam. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reach from West Point Dam to Walter F.

George Lake because allowable phosphorus loads would be expected to be exceeded when the NAA meets water quality standards. The TN level would be expected to increase by at least 0.1 mg/L from the NAA downstream of West Point Dam. The effect of Alt1L on aquatic resources downstream of West Point Dam would be substantially adverse because of an increase in nutrients. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP and TN loads in the river, which under limited circumstances could result in substantial adverse changes to water quality.

6.4.3.1.2.3 Alternative 7A

Overall, implementing Alt7A would be expected to have a negligible effect on fish and aquatic resources. Under Alt7A, there would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* downstream of the West Point Dam.

6.4.3.1.2.4 Alternative 7B

Overall, implementing Alt7B would be expected to have a negligible effect on fish and aquatic resources. Under Alt7B, there would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* downstream of the West Point Dam.

6.4.3.1.2.5 Alternative 7H

Overall, implementing Alt7H would be expected to have a slightly adverse effect on fish and aquatic resources. There would be negligible change expected in water temperature and DO. Concentrations of TP and TN would be elevated, and the median change in growing season concentrations of chlorophyll *a* during the dry year would be expected to be higher by 1 µg/L. The effect of Alt7H on aquatic resources downstream of West Point Dam would be slightly adverse because of an increase in nutrients.

6.4.3.1.2.6 Alternative 7I

Overall, implementing Alt7I would be expected to have a slightly adverse effect on fish and aquatic resources. The TP levels in the reaches from West Point Dam to Walter F. George Lake would be expected to increase because allowable phosphorus loads would be expected to be exceeded when the NAA meets water quality standards. TN would slightly increase, and there would be little to no change in water temperature or the concentration of DO or chlorophyll *a.* The effect of Alt7I on aquatic resources downstream of West Point Dam would be slightly adverse because of an increase in nutrients.

6.4.3.1.2.7 Alternative 7J

Overall, implementing Alt7J would be expected to have a slightly adverse effect on fish and aquatic resources. There would be negligible change expected in water temperature or the concentration of DO or chlorophyll *a*. The TP loads would be expected to exceed standards when the NAA meets the allowable load, and TN concentrations would be elevated. The effect of Alt7H on aquatic resources downstream of West Point Dam would be substantially adverse because of an increase in nutrients.

6.4.3.1.2.8 Alternative 7K (PAA)

Overall, implementing the PAA would be expected to have an adverse effect on fish and aquatic resources. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reach from West Point Dam to Walter F. George Lake because allowable phosphorus loads

would be expected to be exceeded when the NAA meets water quality standards. Concentrations of TN would be elevated, and negligible change would be expected in water temperature or the concentration of DO or chlorophyll *a*. The effect of the PAA on aquatic resources downstream of West Point Dam would be substantially adverse because of an increase in nutrients. As a part of Georgia's water withdrawal increase, Georgia would return more treated wastewater to the Chattahoochee River between the Buford and West Point dams. As the withdrawal increases, the wastewater return loads would subsequently increase the TP and TN loads in the river, which under limited circumstances could result in substantial adverse changes to water quality.

6.4.3.1.2.9 Alternative 7L

Overall, implementing Alt7L would be expected to have a slightly adverse effect on fish and aquatic resources. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reach from West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when the NAA meets water quality standards. The TN concentrations would be elevated, and negligible change would be expected in water temperature or the concentration of DO or chlorophyll *a*. The effect of Alt7L on aquatic resources downstream of West Point Dam would be substantially adverse because of an increase in nutrients.

6.4.3.1.2.10 Alternative 7M

Overall, implementing Alt7M would be expected to have an adverse effect on fish and aquatic resources. Increased returns downstream of Buford Dam would be expected to be substantially adverse on TP in the reach from West Point Dam to Walter F. George Lake because allowable phosphorus loads would be expected to be exceeded when the NAA meets water quality standards. The TN concentrations would be elevated, and negligible change would be expected in water temperature or the concentration of DO or chlorophyll *a*. The effect of Alt7M on aquatic resources downstream of West Point Dam would be substantially adverse because of an increase in nutrients.

6.4.3.1.3 Chattahoochee River Downstream of Walter F. George Dam

6.4.3.1.3.1 No Action Alternative

Implementing the NAA would result in negligible change in the effects on fish and aquatic resources. Slower moving waters caused by the George W. Andrews Lock and Dam increase the median temperatures in the tailrace of Walter F. George Lock and Dam by 2 °C from the preceding reach of West Point Dam to Walter F. George Lake.

The concentration of DO below the Walter F. George Lock and Dam is similar to or slightly higher than it is below West Point Dam. During the growing season of a dry year, median DO concentrations downstream of Walter F. George Lock and Dam increase quickly from 4.5 mg/L to above 6.0 mg/L and then continue to rise from 6.0 to 8.0 mg/L to Lake Seminole.

The median TP concentration downstream of Walter F. George Lock and Dam to Lake Seminole is around 0.089 mg/L. The TN level decreases from Walter F. George Lock and Dam to Lake Seminole.

6.4.3.1.3.2 Alternative 1L

Implementing Alt1L would be expected to have negligible effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* under Alt1L.

6.4.3.1.3.3 Alternative 7A

Implementing Alt7A would be expected to have negligible effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* under Alt7A.

6.4.3.1.3.4 Alternative 7B

Implementing Alt7B would be expected to have negligible effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* under Alt7B.

6.4.3.1.3.5 Alternative 7H

Implementing Alt7H would be expected to have negligible effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be a slight increase in TP, and the median growing season chlorophyll *a* concentration during a dry year would be expected to be about 1 µg/L higher, creating slightly adverse conditions for aquatic life. There would be little to no change in water temperature or the concentration of DO or TN.

6.4.3.1.3.6 Alternative 7I

Implementing Alt7I would be expected to have slightly adverse effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be a slight increase in TN and little to no change in water temperature or the concentration of DO or TP.

6.4.3.1.3.7 Alternative 7J

Implementing Alt7J would be expected to have negligible effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* under Alt7J.

6.4.3.1.3.8 Alternative 7K (PAA)

Implementing the PAA would be expected to have a slightly adverse effect on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be a slight increase in TN and little to no change in water temperature or the concentration of DO or TP.

6.4.3.1.3.9 Alternative 7L

Implementing Alt7L would be expected to have negligible effects on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be little to no change in water temperature or the concentration of DO, TP, TN, or chlorophyll *a* under Alt7L.

6.4.3.1.3.10 Alternative 7M

Implementing Alt7M would be expected to have a slightly adverse effect on fish and aquatic resources downstream of Walter F. George Lock and Dam. There would be a slight increase in TN and little to no change in water temperature or the concentration of DO or TP.

6.4.3.1.4 Apalachicola River

In the Apalachicola River, fish and aquatic resources—including aquatic vegetation, riverine and estuarine fish, amphibians, reptiles, mollusks, and other invertebrates—could be affected by changes in discharge rates and area of floodplain habitat on the Apalachicola River. The river level (dependent on discharge from the Jim Woodruff Dam) largely dictates available floodplain habitat.

Discharge rates on the Apalachicola River are similar across alternatives. Flow conditions downstream of Jim Woodruff Lock and Dam for the proposed alternatives would not be appreciably different from flow conditions under the NAA. As described in detail in section 6.1.1.2.5 and summarized in Table 6.1-2, flow conditions under each alternative were essentially characterized as "negligible" or "no change" from the NAA.

Floodplain habitat connectivity on the Apalachicola River also is similar across alternatives. The maximum 30-day growing season floodplain habitat connectivity for each alternative was calculated as the maximum amount of floodplain spawning habitat available for at least 30 consecutive days during the months of April–October. This criterion was based on the life history requirements of many riverine fishes, including species specific to the Apalachicola River. This criterion also is an appropriate standard for assessing habitat for the wide range of other aquatic organisms that inhabit the Apalachicola River and its floodplain. USFWS developed the Floodplain Spawning Habitat Performance Measure (FSHPM) to assist in this evaluation. Interpretation of the model results as presented in Figure 6.4-1 and Figure 6.4-2 and the tabulated information in Table 6.4-4 shows the area of floodplain habitat for each alternative. All alternatives are less than 2 percent different from the NAA.

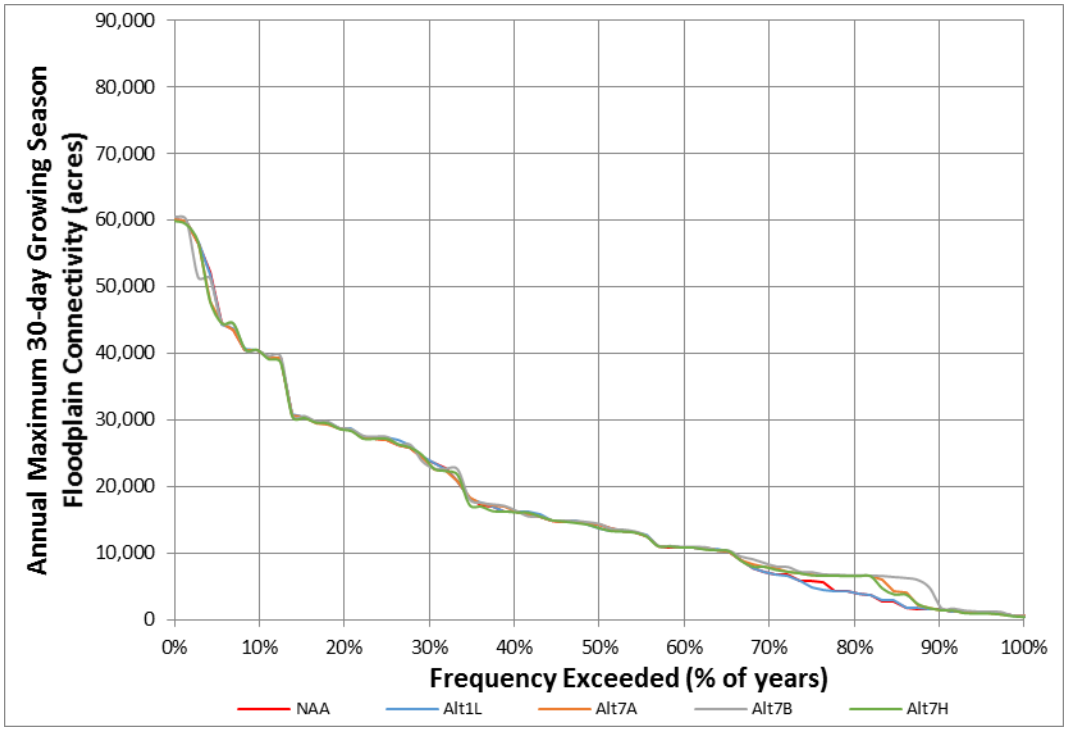


Figure 6.4-1. Frequency of Maximum Amount of Floodplain Spawning Habitat Available for at Least 30 Consecutive Days during Apr–Oct over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

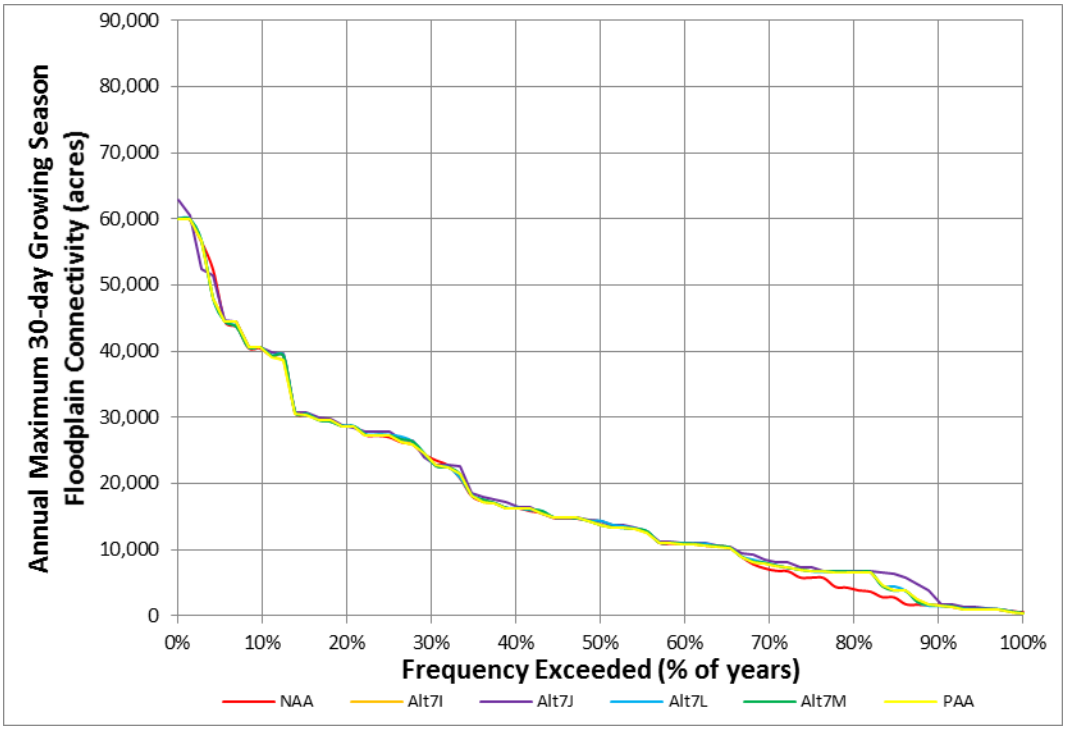


Figure 6.4-2. Frequency of Maximum Amount of Floodplain Spawning Habitat Available for at Least 30 Consecutive Days during Apr–Oct over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

Table 6.4-4.
Floodplain Habitat Connectivity on the Apalachicola River

	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Annual Maximum 30-day Growing Season Floodplain Connectivity (ac)	60046	60068	60046	60504	59906	59884	62927	59868	60068	59986

Note: ac = acres.

Discharge rates and area of floodplain habitat are the principal factors that could influence aquatic organisms and communities in the Apalachicola River and for each of these evaluation criteria, the differences are slight between each of the alternatives and the NAA. Given that wastewater return rates are unchanged along this reach and flows in the Apalachicola River are similar across alternatives, water quality in the Apalachicola River also would be relatively unchanged, as illustrated in Figure 6.1-65 through Figure 6.1-196. Therefore, each of the alternatives evaluated would be expected to have negligible effects on fish and aquatic resources in the Apalachicola River.

6.4.3.2 Reservoirs

This section describes the effects on reservoir fisheries and other aquatic resources associated with changes in USACE operations and various water supply options on Lake Lanier, West Point Lake, Walter F. George Lake, Lake George W. Andrews, and Lake Seminole.

Operational flow changes would affect habitat for reservoir fisheries and other aquatic resources mainly through changes in water levels, reservoir flushing rates (retention times Table 6.1-24), and associated changes in water quality parameters (e.g., nutrient loading and DO concentrations). Seasonal water-level

fluctuations can substantially change the area of shallow-water habitats and inundated shoreline vegetation in reservoirs and, in turn, influence the reproductive success of resident fish populations.

Substantial daily or weekly fluctuations in reservoir levels associated with hydroelectric power generation peaking operations could adversely affect reservoir fisheries by dewatering spawning and nursery habitats for littoral species, exposing nests and eggs deposited in shallow-water habitats, and reducing the availability of shoreline cover and its associated invertebrate food supply. Performance measures developed by USFWS were used in this evaluation, specifically to assess reservoir fisheries habitat with the assumption that a greater departure of reservoir levels from optimum (e.g., littoral spawning, rearing) results in a greater effect on habitats, including loss. USFWS recommended the Reservoir Fisheries Performance Measure (RFPM) because it specifically characterizes the spatial extent of the reservoir most likely to support successful fish survival and reproduction as a direct function of containing suitable habitat features.

The effect of the alternatives on reservoir fisheries was determined using the area (in acres [ac]) of productive zone inundated for more than 30 days during the spawning season, as calculated using the RFPM. The inundated productive zone was defined for each reservoir and is presented in subsequent sections. The inundated productive zone over the modeled period for each alternative was compared to the NAA and determined to have the following impacts:

Lake Lanier

- Negligible impact if the productive zone inundation was between 7,050 and 7,350 ac
- A slightly adverse impact if the productive zone inundation was between 6,800 and 7,000 ac
- An adverse impact if the productive zone inundation was between 6,500 and 6,800 ac
- A substantial adverse impact if the productive zone inundation was <6,400 ac
- A slightly beneficial impact if the productive zone inundation was between 7,400 and 7,600 ac

West Point Lake

- Negligible impact if the productive zone inundation was between 3,640 and 3,740 ac
- A slightly adverse impact if the productive zone inundation was between 3,550 and 3,640 ac
- An adverse impact if the productive zone inundation was between 3,300 and 3,550 ac
- A substantial adverse impact if the productive zone inundation was <3,300 ac
- A slightly beneficial impact if the productive zone inundation was between 3,740 and 3,850 ac

Walter F. George Lake

- Negligible impact if the productive zone inundation was between 11,400 and 11,700 ac
- A slightly adverse impact if the productive zone inundation was between 11,250 and 11,400 ac
- An adverse impact if the productive zone inundation was between 11,100 and 11,250 ac
- A substantial adverse impact if the productive zone inundation was <11,000 ac
- A slightly beneficial impact if the productive zone inundation was between 11,700 and 11,850 ac

Interpretation of the model results as presented in Figure 6.4-3 through Figure 6.4-8 and the tabulated information in Table 6.4-5 summarizes the overall effect of alternatives on reservoir fish and aquatic resources.

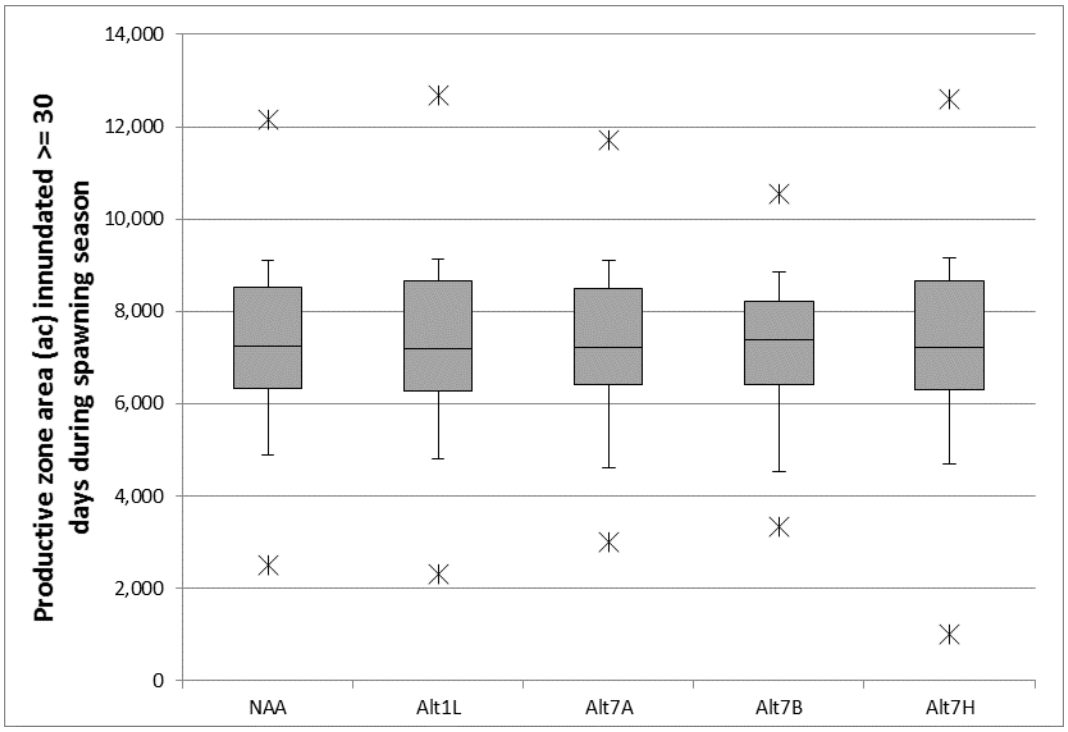


Figure 6.4-3. Lake Lanier Productive Zone Area Inundated for More than 30 Days during Spawning Season (Apr 1–Jun 1) over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

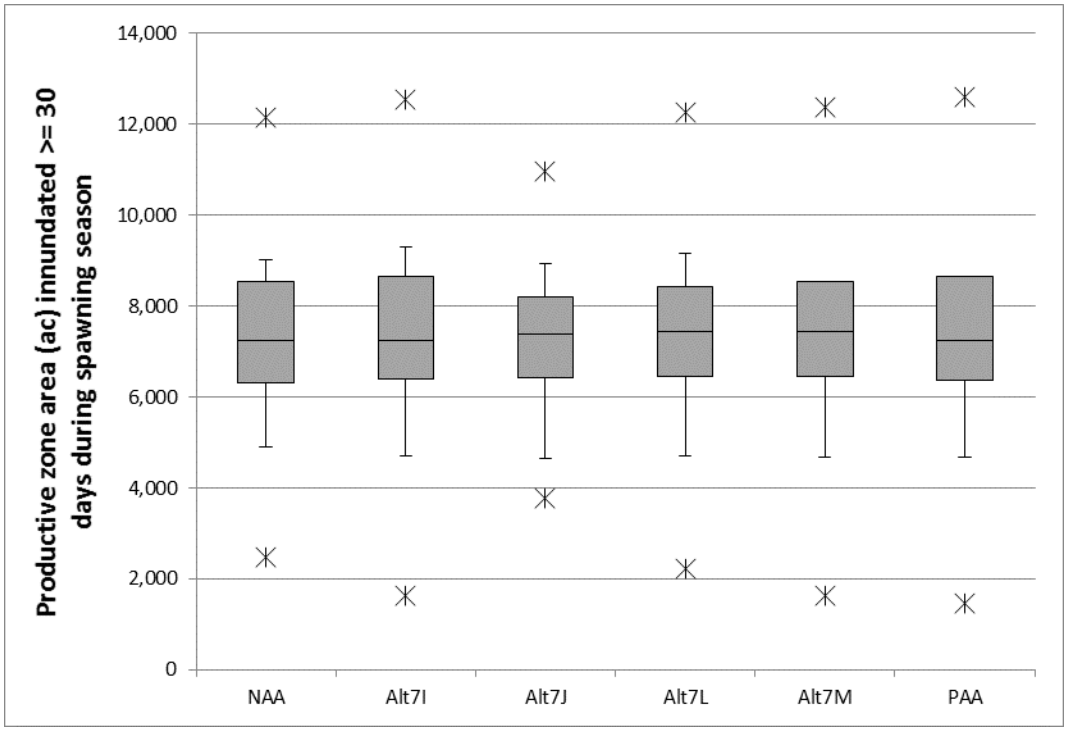


Figure 6.4-4. Lake Lanier Productive Zone Area Inundated for More than 30 Days during Spawning Season (Apr 1–Jun 1) over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

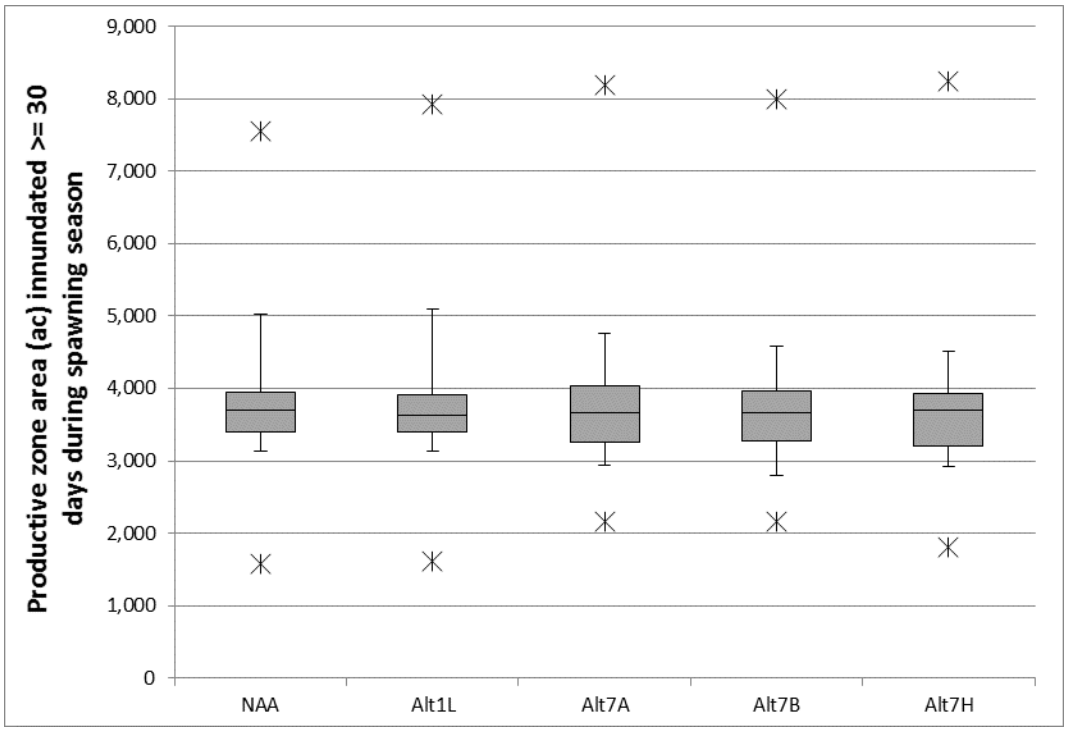


Figure 6.4-5. West Point Lake Productive Zone Area Inundated for More than 30 Days during Spawning Season (Apr 1–Jun 1) over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

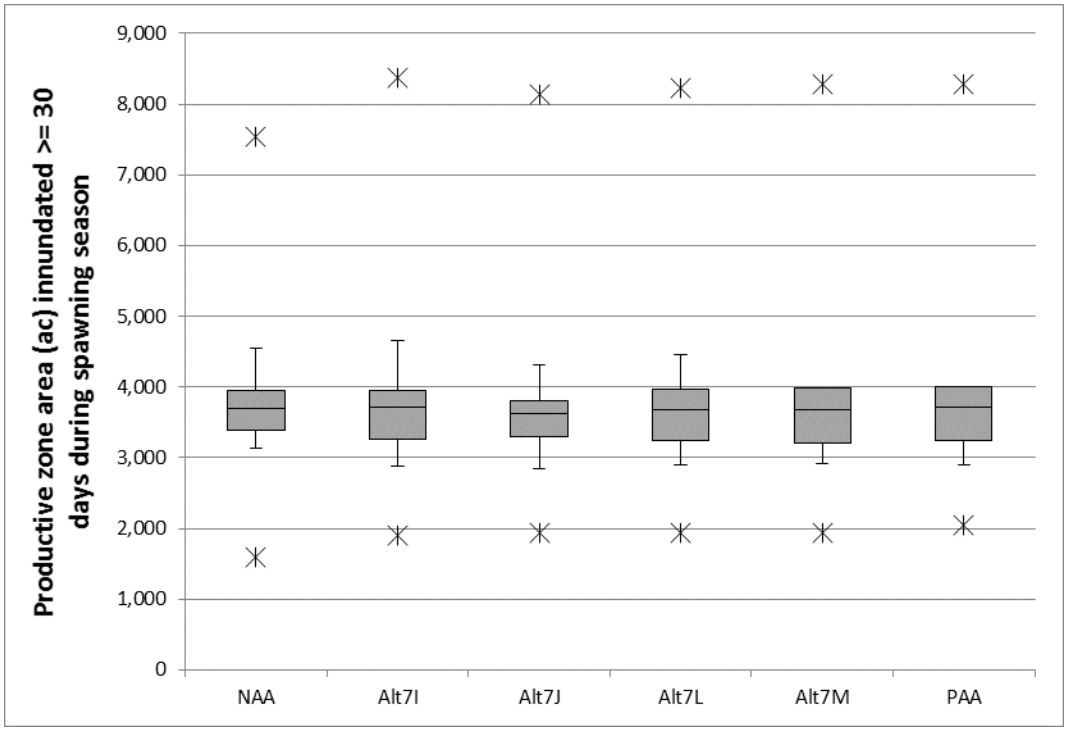


Figure 6.4-6. West Point Lake Productive Zone Area Inundated for More than 30 Days during Spawning Season (Apr 1–Jun 1) over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

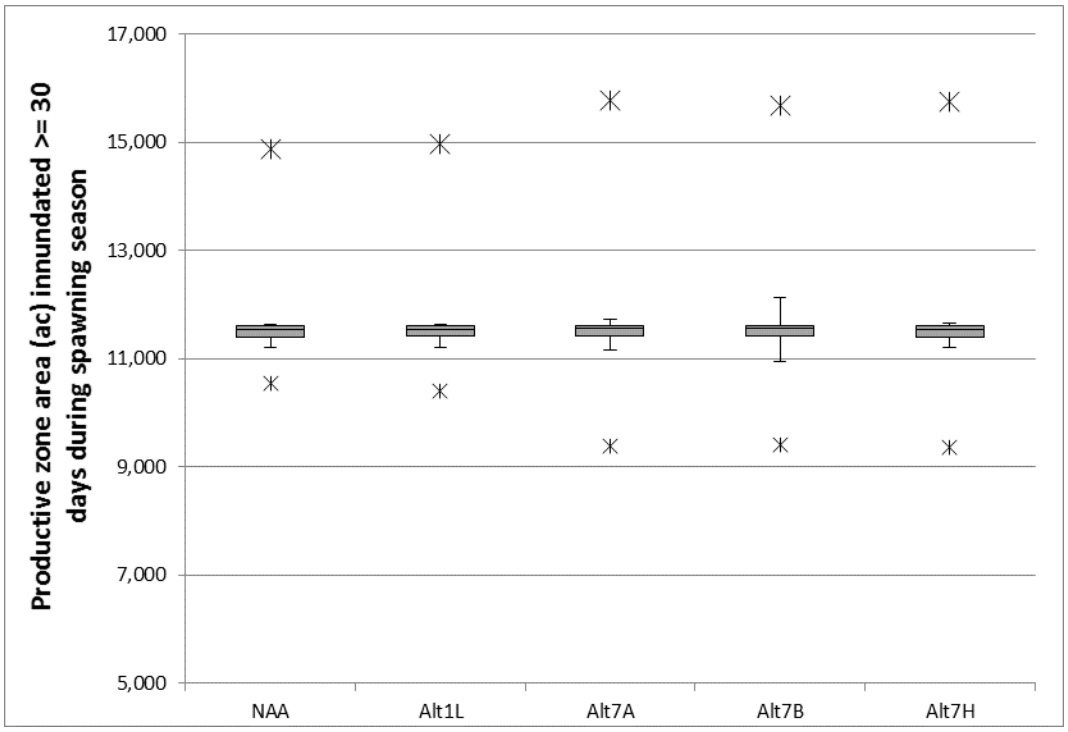


Figure 6.4-7. Walter F. George Lake Productive Zone Area Inundated for More than 30 Days during Spawning Season (Mar 15–May 15) over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

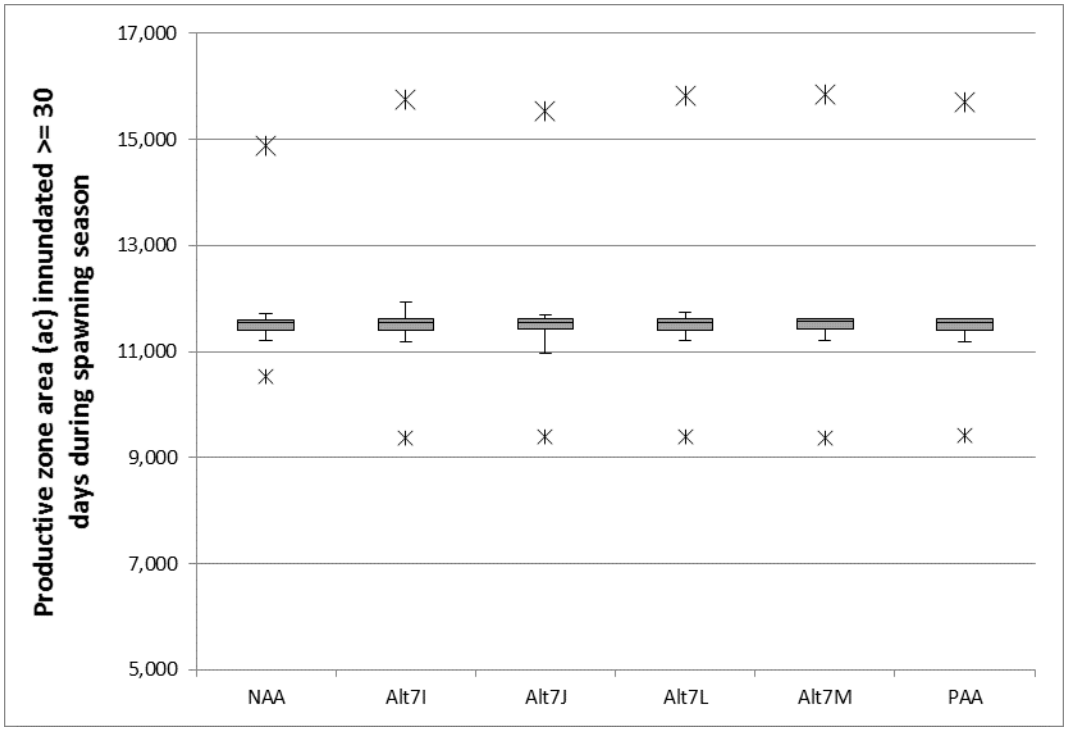


Figure 6.4-8. Walter F. George Lake Productive Zone Area Inundated for More than 30 Days during Spawning Season (Mar 15–May 15) over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

Table 6.4-5.
Summary of the Effects of Alternatives on Reservoir Fish and Aquatic Resources

Reservoir	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly Beneficial	Slightly Beneficial
West Point Lake	Baseline	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly Adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change
Walter F. George Lake	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake George W. Andrews	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lake Seminole	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Nonfederal Reservoirs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Negligible/No change if the productive zone inundation was between 7,050 and 7,350 ac at Lake Lanier, between 3,640 and 3,740 ac at West Point Lake, between 11,400 and 11,700 ac at Walter F. George Lake, and no measurable change at Lake George W. Andrews, Lake Seminole, and nonfederal reservoirs.

Slightly adverse—Slightly adverse if if the productive zone inundation was between 6,800 and 7,000 ac at Lake Lanier, between 3,550 and 3,640 ac at West Point Lake, between 11,250 and 11,400 ac at Walter F. George Lake.

Slightly beneficial—Slightly beneficial if if the productive zone inundation was between 7,400 and 7,600 ac at Lake Lanier, between 3,740 and 3,850 ac at West Point Lake, between 11,700 and 11,850 ac at Walter F. George Lake.

6.4.3.2.1 Lake Lanier

This section describes the effects of operations under the alternatives considered and refers to Figure 6.1-1 through Figure 6.1-6 for daily water surface elevations over the period of record and Figure 6.4-3 and Figure 6.4-4 for the range of productive zone area innundated for more than 30 days during spawning season for Lake Lanier. Negligible effects on reservoir fisheries or other aquatic resources would be expected if the RFPM output acreage is within approximately 150 ac (plus or minus) of the median NAA model output. If the modeled productive zone inundated for more than 30 days during the spawning season is between 7,050 and 7,350 ac, negligible effects on reservoir fisheries and other aquatic resources would be expected. In general, increased acreage from 7,400 to 7,600 ac would be slightly beneficial, decreased acreage from 6,800 to 7,000 ac would be slightly adverse, decreased acreage from 6,500 to 6,800 ac would be adverse, and acreage less than 6,400 ac would be substantially adverse. In general, increased acreage is beneficial while decreased acreage is adverse. The advantage of acreage increases diminishes as inundation reaches extreme expanses.

6.4.3.2.1.1 No Action Alternative

No effects on reservoir fisheries or other aquatic resources would result from implementing the NAA. Median daily water surface elevations, shown in Figure 6.1-1, would be expected, representing a continuation of current conditions at Lake Lanier. RFPM model results predict a median productive zone of approximately 7,236 ac inundated for more than 30 days, with a range from approximately 2,494 to 12,154 ac. These values serve as the baseline for comparing the potential effects of the other alternatives.

6.4.3.2.1.2 Alternative 1L

Implementing Alt1L would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,187 ac, with a range of from approximately 2,304 to 12,673 ac.

6.4.3.2.1.3 Alternative 7A

Implementing Alt7A would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,222 ac, with a range of from approximately 2,995 to 11,717 ac.

6.4.3.2.1.4 Alternative 7B

Implementing Alt7B would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,394 ac, with a range of from approximately 3,347 to 10,534 ac.

6.4.3.2.1.5 Alternative 7H

Implementing Alt7H would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,230 ac, with a range of from approximately 1,005 to 12,602 ac.

6.4.3.2.1.6 Alternative 7I

Implementing Alt7I would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,255 ac, with a range of from approximately 1,627 to 12,543 ac.

6.4.3.2.1.7 Alternative 7J

Implementing Alt7J would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,385 ac, with a range of from approximately 3,764 to 10,968 ac.

6.4.3.2.1.8 Alternative 7K (PAA)

Implementing the PAA would be expected to have negligible effects on reservoir fisheries or other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,238 ac, with a range of from approximately 1,467 to 12,594 ac.

6.4.3.2.1.9 Alternative 7L

Implementing Alt7L would be expected to have slightly beneficial effects on reservoir fisheries and other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,439 ac, with a range of from approximately 2,219 to 12,255 ac.

6.4.3.2.1.10 Alternative 7M

Implementing Alt7M would be expected to have slightly beneficial on reservoir fisheries and other aquatic resources on Lake Lanier. The median inundated productive zone for more than 30 days would be expected to be 7,449 ac, with a range of from approximately 1,623 to 12,381 ac.

6.4.3.2.2 West Point Lake

West Point Lake has a surface area of 25,864 ac. Water surface elevations for West Point Lake under the modeled conditions and different alternatives are discussed in section 6.1.1.1.1.10. This section describes the effects of operations under the alternatives considered and refers to Figure 6.1-7 through Figure 6.1-12 for daily water surface elevations over the period of record and Figure 6.4-5 and Figure 6.4-6 for the range of productive zone area innundated for more than 30 days during spawning season for West Point Lake. Decision criteria for environmental effects are based on the RFPM for West Point Lake. Negligible effects on reservoir fisheries or other aquatic resources would be expected if the RFPM output acreage is within approximately 50 ac (plus or minus) of the median model output for the NAA (i.e., 3,691 ac), or between 3,640 and 3,740 ac. In general, increased acreage from 3,740 to 3,850 ac would be slightly beneficial, decreased acreage from 3,550 to 3,640 ac would be slightly adverse, decreased acreage from 3,300 to 3,550 ac would be adverse, and acreage less than 3,300 ac would be substantially adverse.

6.4.3.2.2.1 No Action Alternative

Implementing the NAA would be expected to have no effect on reservoir fisheries or other aquatic resources. The RFPM results predict a median inundated productive zone of 3,691 ac for more than 30 days at West Point Lake, with a range of 1,586–7,545 ac. These results serve as the baseline against which to compare potential effects of other alternatives.

6.4.3.2.2.2 Alternative 1L

Implementing Alt1L would be expected to have slightly adverse effects on reservoir fisheries and other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,635 ac, with a range of approximately 1,621–7,920 ac.

6.4.3.2.2.3 Alternative 7A

Implementing Alt7A would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,672 ac, with a range of approximately 2,156–8,182 ac.

6.4.3.2.2.4 Alternative 7B

Implementing Alt7B would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,663 ac, with a range of approximately 2,156–7,997 ac.

6.4.3.2.2.5 Alternative 7H

Implementing Alt7H would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,695 ac, with a range of approximately 1,806–8,242 ac.

6.4.3.2.2.6 Alternative 7I

Implementing Alt7I would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,714 ac, with a range of approximately 1,897–8,379 ac.

6.4.3.2.2.7 Alternative 7J

Implementing Alt7J would be expected to have slightly adverse effects on reservoir fisheries and other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,633 ac, with a range of approximately 1,942–8,139 ac.

6.4.3.2.2.8 Alternative 7K (PAA)

Implementing the PAA would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,715 ac, with a range of approximately 2,045–8,277 ac.

6.4.3.2.2.9 Alternative 7L

Implementing Alt7L would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,678 ac, with a range of approximately 1,932–8,227 ac.

6.4.3.2.2.10 Alternative 7M

Implementing Alt7M would be expected to have negligible effects on reservoir fisheries or other aquatic resources on West Point Lake. The median inundated productive zone for more than 30 days would be expected to be 3,678 ac, with a range of approximately 1,944–8,288 ac.

6.4.3.2.3 Walter F. George Lake

Walter F. George Lake (Lake Eufaula) has a surface area of approximately 45,180 ac. Figure 6.1-13 through Figure 6.1-18 present daily water surface elevations relative to Walter F. George Lake operations over the modeled period of record for the alternatives considered and Figure 6.4-7 and Figure 6.4-8 for the range of productive zone area innundated for more than 30 days during spawning season. Decision criteria for environmental effects were based on the RFPM for Walter F. George Lake. Negligible effects on reservoir fisheries or other aquatic resources on Walter F. George Lake would be expected if the RFPM output acreage is within approximately 150 ac (plus or minus) of 11,545 ac, the median model output for the NAA. Negligible effects on reservoir fisheries or other aquatic resources on Walter F. George Lake would be expected if the productive zone inundated for more than 30 days during the spawning season is between 11,400 and 11,700 ac. In general, increased acreage from 11,700 to 11,850 ac would be slightly beneficial, decreased acreage from 11,250 to 11,400 ac would be slightly adverse, decreased acreage from 11,100 to 11,250 ac would be adverse, and an inundated productive zone less than 11,000 ac would be substantially adverse.

6.4.3.2.3.1 No Action Alternative

Implementing the NAA would have negligible effects on reservoir fisheries or other aquatic resources on Walter F. George Lake. The RFPM results predict a median inundated productive zone of 11,551 ac for more than 30 days at Walter F. George Lake. The expected inundated area ranges from a minimum of

10,538 ac to a maximum of 14,890 ac. These results serve as the baseline against which to compare potential effects of the other alternatives.

6.4.3.2.3.2 Alternative 1L

Negligible change from the NAA would be expected under Alt1L. The RFPM results in a median productive zone of 11,536 ac inundated for more than 30 days with an approximate range of 10,405–14,979 ac.

6.4.3.2.3.3 Alternative 7A

Negligible change from the NAA would be expected under Alt7A. The RFPM results in a median productive zone of 11,566 ac inundated for more than 30 days with an approximate range of 9,388–15,787 ac.

6.4.3.2.3.4 Alternative 7B

Negligible change from the NAA would be expected under Alt7B. The RFPM results in a median productive zone of 11,557 ac inundated for more than 30 days with an approximate range of 9,402–15,676 ac.

6.4.3.2.3.5 Alternative 7H

Negligible change from the NAA would be expected under Alt7H. The RFPM results in a median productive zone of 11,546 ac inundated for more than 30 days with an approximate range of 9,365–15,751 ac.

6.4.3.2.3.6 Alternative 7I

Negligible change from the NAA would be expected under Alt7I. The RFPM results in a median productive zone of 11,548 ac inundated for more than 30 days with an approximate range of 9,369–15,744 ac.

6.4.3.2.3.7 Alternative 7J

Negligible change from the NAA would be expected under Alt7J. The RFPM results in a median productive zone of 11,555 ac inundated for more than 30 days with an approximate range of 9,400–15,526 ac.

6.4.3.2.3.8 Alternative 7K (PAA)

Negligible change from the NAA would be expected under the PAA. The RFPM results in a median productive zone of 11,553 ac inundated for more than 30 days with an approximate range of 9,424–15,711 ac.

6.4.3.2.3.9 Alternative 7L

Negligible change from the NAA would be expected under Alt7L. The RFPM results in a median productive zone of 11,553 ac inundated for more than 30 days with an approximate range of 9,390–15,822 ac.

6.4.3.2.3.10 Alternative 7M

Negligible change from the NAA would be expected under Alt7M. The RFPM results in a median productive zone of 11,563 ac inundated for more than 30 days with an approximate range of 9,381–15,861 ac.

6.4.3.2.4 Lake George W. Andrews

Lake George W. Andrews is a run-of-river project with little variation in water surface elevation between the NAA and various alternatives, as described in section 6.1.1.1.4. Therefore, RFPM was not applied to Lake George W. Andrews. Negligible change would be expected in productive zone inundation on Lake George W. Andrews under any of the alternatives.

6.4.3.2.5 Lake Seminole

Lake Seminole is also a run-of-river project with little variation in water surface elevation between the NAA and various alternatives, as described in section 6.1.1.1.5. Therefore, the RFPM also was not applied to Lake Seminole. Negligible changes in productive zone inundation would be expected under any of the alternatives on Lake Seminole.

6.4.3.2.6 Other Reservoirs and Impoundments

As described in section 6.1.1.1.6, negligible changes would occur to the structures and/or operations of nonfederal reservoirs under any of the alternatives considered. Consequently, negligible change would be expected in the spatial extent of the productive zones for reservoir fisheries habitat in nonfederal reservoirs.

6.4.3.3 Apalachicola Bay and Estuary

Functionally, estuaries exist at the junction of fresh and salt waters and are integrally linked to freshwater inputs. Principal consequences for the management of freshwater flow to estuaries are related to both the magnitude and timing of flows (Mann and Lazier 1991). Freshwater flows are integral not only to maintaining the delivery of material and energy critical to estuarine productivity but also to providing habitat conditions conducive to maintaining the diversity and abundance of the estuarine community. As mentioned in section 2.5.3.3, three regions in the Apalachicola Bay estuary are of interest with respect to salinity requirements for juvenile Gulf sturgeon, oyster habitat, white shrimp, and several species for which a fishery management plan exists that is consistent with their essential fish habitat (EFH) designation. Changes in salinity and other water quality parameters in Apalachicola Bay and Estuary are negligible, given little to no change in streamflows from the NAA in the Apalachicola River at Chattahoochee, Florida (as discussed in detail in section 6.1.1.2.5 and presented in Figure 6.1-55, Figure 6.1-56, Table 6.1-12, and Table 6.4-6). Therefore, negligible effects would be expected to the terrestrial vegetation communities, freshwater and estuarine wetland communities, and terrestrial wildlife resources including birds (migratory and coastal), mammals, and insects and other invertebrates.

In addition to this analysis, preliminary results of salinity modeling provided by USFWS to the USACE and conducted by Dr. Peter Sheng indicated similar salinity levels in Apalachicola Bay between the NAA and the PAA from the draft EIS (Alt7H) (Paramygin and Sheng 2015). It should be noted that the proposed action evaluated by Dr. Sheng is slightly different than the PAA (Alt7K) presented in this final EIS. However, the difference in the 2015 proposed action and the PAA is limited to water supply assumptions in Metro Atlanta. The PAA provides for less water supply in Metro Atlanta than the 2015 proposed action. It is expected that salinity modeling results for the PAA would be similar to those for the 2015 proposed action.

Table 6.4-6.
Summary of the Effects of Alternatives on Estuarine Fish and Aquatic Resources

	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Estuarine fish and aquatic resources	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

As stated in the 2015 draft FWCAR, USFWS could not locate additional analyses or new data sets to quantify potential impacts to juvenile Gulf sturgeon, eastern oysters, and white shrimp prior to drafting the PAL. (Those documents and USACE responses are included in appendix J of this final EIS). The 2016 USFWS Biological Opinion addresses juvenile Gulf sturgeon as discussed in section 6.4.4.3.1. Metrics to quantify potential impacts to eastern oysters, white shrimp, and other species have not been developed to date.

The NAA and the PAA both operate for federally listed threatened and endangered species downstream from Jim Woodruff Lock and Dam. They both include current ramping rates, suspension of ramping rates in drought, and current minimum flow provisions at the Chattahoochee, Florida, U.S. Geological Survey (USGS) gage on the Apalachicola River. Differences in the operation of Jim Woodruff Lock and Dam for downstream federally listed threatened and endangered species occurs only if the BI is less then 7,000 cfs for 30 days. As described in section 4.1.2.8.8.3, the ramping rate would be suspended in cases of prolonged low flow under the the PAA. Because neither the flows nor the quality of the water entering Apalachicola Bay from the river would change appreciably under any of the proposed alternatives, no EFH for commercial fisheries in Apalachicola Bay, designated under the Magnuson-Stevens Fishery Conservation and Management Act, would be adversely affected by implementing any of the alternatives.

During review of the draft EIS, the National Marine Fisheries Service provided comments by letter dated January 15, 2016, including the following recommendation to ensure the conservation of EFH and associated fishery resources:

> The Master Manual and project WCMs allow a minimum flow of 5,000 cfs at the Jim Woodruff Lock and Dam to minimize impacts resulting from reduced freshwater flows to the Apalachicola Bay and estuary.

The PAA is consistent with this conservation recommendation to the maximum extent practicable. Releases from Jim Woodruff Lock and Dam would be expected to equal or exceed 5,000 cfs about 99.7 percent of the days over the modeled period of record. The HEC-ResSim simulation indicated that there would be one occurrence over the modeled period of record when daily flows would likely decline to a level between 5,000 and 4,500 cfs for about 90 days under the most extreme drought conditions. Operations would not be expected to adversely affect EFH and associated fishery resources.

6.4.4 Protected Species

USACE is responsible for determining project-specific effects on protected species because the effects depend largely on where and how the actions occur. USACE also is responsible for pursuing consultation with USFWS in accordance with section 7 of the ESA regarding any expected effects on those species.

Endangered species consultation for conservation of protected species in the Apalachicola River below Jim Woodruff Lock and Dam, in accordance with section 7 of the ESA, was initiated in March 2006 and has been ongoing. In May 2012, the USFWS issued a Biological Opinion (BO) and Incidental Take

Statement for the Revised Interim Operations Plan (RIOP) (see section 2.1.1.2.4.4). On July 22, 2014 USACE requested to reinitiate ESA section 7 consultation with the USFWS to request additional incidental take of the threatened Chipola slabshell. By letter dated August 7, 2014, USFWS amended the 2012 BO and Incidental Take Statement for the RIOP to revise the Incidental Take Statement as requested by USACE.

On May 31, 2016, USACE requested the initiation of formal ESA section 7 consultation on the proposed update of the Master WCM for the ACF Basin and provided a biological assessment (BA) for the PAA. The BA described the features of the PAA (Alt7K) and evaluated the potential effects to the threatened Gulf sturgeon and designated critical habitat for the Gulf sturgeon as well as three listed species of mussels and their designated critical habitat. The BA was prepared in accordance with the criteria for analysis as defined in the ESA *Section 7 Consultation Handbook*. By letter dated June 10, 2016, the USFWS requested additional information from USACE in response to specific questions on the content of the BA. On June 30, 2016, USACE provided a revised BA. By way of follow-up meetings with USFWS staff and email transmissions, USACE staff members provided supplementary information for the BA during July 2016. By letter dated, July 29, 2016 the USFWS indicated all the necessary information had been provided.

In the BA, USACE determined that the PAA may adversely affect the fat threeridge *(Amblema neislerii)*, purple bankclimber *(Elliptoideus sloatianus)*, and Chipola slabshell *(Elliptio chipolaensis)*, but was not likely to adversely affect their designated critical habitat. Additionally, USACE determined that the proposed action may affect, but is not likely to adversely affect, the Gulf sturgeon *(Acipenser oxyrinchus desotoi)* and its designated critical habitat. The analyses used to inform these determinations were consistent with the previous consultations with the USFWS regarding Jim Woodruff Lock and Dam operations. During consultation, the USFWS concurred with the USACE effects determination for the listed mussel species and associated critical habitats but concluded that the PAA may adversely affect the Gulf sturgeon and its designated critical habitat as well as designated critical habitat for the three listed mussels. Although, the USACE disagreed with this determination, after extended discussions with the USFWS, the USACE acquiesced to formal consultation on the Gulf sturgeon. On September 14, 2016, the USFWS issued a BO for the PAA for the ACF WCM update addressing these listed species as a result of the consultation. In the BO the USFWS determined that the PAA: 1) will not jeopardize the continued existence of the Gulf sturgeon, the fat threeridge, purple bankclimber, and Chipola slabshell; and 2) will not destroy or adversely modify designated critical habitat for the fat threeridge, purple bankclimber, and Chipola slabshell (USFWS 2016b).

The BO considered that the WCM is reviewed every 5 years pursuant to USACE South Atlantic Division policy; therefore, it was issued with the understanding that the WCM may be revised or updated within 5 years and that this BO will be reviewed, or consultation reinitiated, at that time.

Incidental Take. The BO concluded that two forms of take are expected for Gulf sturgeon and two for the three mussel species.

Take of Gulf sturgeon eggs and larvae may occur due to rapid increases and decreases in stage and discharge associated with hydropeaking operations at Jim Woodruff Lock and Dam during the spawning season (March 1-May 31). The form of this take is injury or mortality of fertilized eggs and larvae caused by sudden alteration of water depth and velocity, which disrupts normal hatching and dispersal patterns and reduces food resources for larval sturgeon. The take may occur during and shortly after spawning and hatching, as spawning habitats potentially become temporarily unsuitable during the months of March, April, and May. The second form of take of Gulf sturgeon is caused by the proposed WCM operations potentially reducing the estuarine invertebrate production, which is critical to juvenile sturgeon growth and survival in the first winter of life. The take will occur in in the late summer and fall (July 15-November 24) as well as winter and spring periods (November 24-June1).

The USFWS anticipates the actual incidental taking of Gulf sturgeon associated with the proposed WCM operations will be difficult to detect. Therefore, USACE will monitor the extent of Gulf sturgeon take using 1) the aggregate number of days in which hydropeaking occurs (i.e., number of days with flows between 6,700 and 18,300 cfs between March 1 and May 31) not to exceed an average 32 days per spawning season or up to 160 days in the next five spawning seasons; and 2) the floodplain inundation will not be reduced below 655,000 ac-day per summer and fall period on average (or a reduction of up to 95,000 ac-days over the next five summer and fall periods) or below 135 days during the winter and spring period on average (or a reduction of up to 12 days over the next five winter and spring periods). These are surrogate measures that indicate the frequency of conditions created by WCM operations that cause the anticipated taking. Exceeding these surrogate measures of the levels of incidental take for Gulf sturgeon shall prompt a reinitiation of consultation.

Take of listed mussels due to the WCM may occur when conditions are such that USACE reduces the releases from Jim Woodruff Lock and Dam below 10,000 cfs. The form of this take is mortality that results from habitat modification leading to oxygen stress, temperature stress, and/or increased predation. These conditions may result in immediate or delayed mortality, and as such, mussels that are able to move and remain submerged may still be found dead in the water after the reduction in flows. The take may occur in microhabitats that become exposed or isolated from flowing water when releases from Jim Woodruff Lock and Dam are less than 10,000 cfs. In addition, take includes harm that occurs as a result of reduced growth and/or reproduction due to the high temperatures and low dissolved oxygen that has been shown to occur in these habitats. Take of fat threeridge and Chipola slabshell due to the WCM may also occur when conditions are such that USACE reduces the floodplain inundation to less than 30 consecutive days between March 1 and August 15. The form of this take is harm through reduction in host fish populations and mortality of glochidia. These conditions may result in reduced recruitment of fat threeridge and Chipola slabshell in the subsequent year.

USFWS analysis indicates a 3 to 8.1 percent chance of implementing a reduction in flows to less than 5,000 cfs, because the 1939-2012 simulations trigger the 4,500 minimum flow of the WCM three times. Therefore, incidental take of listed mussels attributable to the reduction in flow to 4,500 cfs could at most consist of one event in the next five years. Mussels could recolonize habitats greater than 5,000 cfs and be incidentally taken during subsequent low flows. USFWS model results indicate that incidental take of listed mussels attributable to the reduction of flows greater than 5,000 cfs occur with a 13.5 percent chance, and one event of this nature is likely to occur at flows above 5,000 cfs in the next five years.

USFWS analysis indicates that a maximum of 34,000 fat threeridge may be exposed in the Apalachicola River, Chipola Cutoff, and Chipola River downstream of the Chipola Cutoff when the minimum flow is reduced to 4,500 cfs (22,000 individuals) and when individuals recolonize habitats greater than 5,000 cfs followed by stranding during subsequent low flows (12,000 individuals). USFWS expects a maximum of 90 purple bankclimbers (60 if flows are reduced to 4,500 cfs; 30 in habitats greater than 5,000 cfs) may be exposed on the rock shoal near RM 105 and at a few locations elsewhere in the action area during each of these events. USFWS expects a maximum of 106 Chipola slabshell (53 if flows are reduced to 4,500 cfs; 53 in habitats greater than 5,000 cfs) may be exposed in the Chipola River downstream of the Chipola Cutoff and middle Apalachicola River during this event. USACE will monitor the extent of this form of take based on observed mortality. Additionally, fat threeridge and Chipola slabshell may experience harm through reduced recruitment. USACE will monitor the extent of this form of take using a surrogate measure that indicates the frequency of conditions created by WCM operations that cause the anticipated taking; a year with less than 30 consecutive days of at least 31,000 ac of floodplain inundation between March 1 and August 15 will not occur more than once in the next five years. Exceeding this level of incidental take for these three mussel species shall prompt a reinitiation of consultation (USFWS 2016b).

Reasonable and Prudent Measures (RPM). The BO included three RPMs as necessary and appropriate to minimize the impacts of incidental take of Gulf sturgeon, fat threeridge, purple bankclimber, and Chipola slabshell on the Apalachicola River. The RPMs summarized below supersede those described in previous BOs for water management activities in the ACF Basin (USFWS 2016b). USACE intends to comply with the terms and conditions of the RPMs. If USACE is unable to comply with any of the terms and conditions, it will reconsult with the USFWS.

RPM 2016-1, Adaptive Management. Identify ways to avoid and minimize take and implement alternative management strategies within the scope of the authorities of WCM as new information is collected.

Rationale: Additional information will be collected to address uncertainties about the listed species and their critical habitat primary constituent element (PCEs) in the action area, water use upstream, and climatic conditions. This information needs to be evaluated to determine if actions to avoid and minimize take associated with the USACE water management operations are effective or could be improved within the scope of the WCM. The USFWS BO identifies possible uncertainties about USACE actions and a preliminary assessment of actions to be assessed through adaptive management. Putting this information in the proper decision context of USACE operations is the fundamental basis for adaptive management according to both USACE and USFWS policy and guidance. Formalizing the adaptive management process will provide a framework for assessing management options that are within the authority of USACE Mobile District under the WCM as well as setting the appropriate decision context for future updates to the WCM as appropriate.

Terms and Conditions:

a) Develop an Adaptive Management Framework – The USACE and USFWS will develop an adaptive management framework for identifying ways to minimize take as new information is collected. Implementation of these adaptive management strategies will begin by March 14, 2017 or within 60 days of the Record of Decision being signed, whichever comes later. The framework will: 1) outline the adverse effects identified in the BO; 2) specify objectives to assess those effects and identify possible alternative actions to minimize those effects (BO provides examples of uncertainties and a preliminary assessment of actions that identified providing more floodplain inundation, reducing opportunities for hydropeaking, and reducing frequency of low flows as general outcomes of actions that would address the adverse effects.); 3) identify specific, measureable attributes to monitor progress toward the objectives, the sampling design(s) for measuring those attributes, and the period over which monitoring will be conducted; 4) describe the process for evaluating the adverse effects and developing, implementing, and assessing the recommended actions to further avoid and minimize take of listed species included in this consultation.
b) Establish an Adaptive Management Technical Team – In order to accomplish a), USACE will establish an informal, multi-agency technical team. This team will consist of technical staff from USACE and USFWS. Technical representatives from other federal agencies (e.g., National Marine Fisheries Service, USGS) may be asked to participate as mutually agreed upon by USACE and USFWS. This team will develop and implement the adaptive management framework. This adaptive management technical team will meet as needed, but at least annually during the next five years, or until a new BO is issued, to review and discuss the monitoring efforts established in the adaptive management plan. As appropriate and based on the data collected and analyses done pursuant to the management/work plans described in a), the technical advisory team will identify potential conservation measures, within the scope of the WCM, to further avoid and minimize take of listed species in the river reaches included as part of this consultation.

c) Minimize Foraging Effects on Juvenile Gulf Sturgeon – To minimize the negative effects of the WCM on food production for juvenile Gulf sturgeon and adverse modification to critical habitat, USACE will inundate the floodplain with a magnitude of at least 100,000 ac in pulses of at least 15 consecutive days in July 15-November 24 over 5 years (based on metrics GS4 and GS5 in section 5.2.1). Additional water will be added to the floodplain during the November 24-June 1 for an average of 12 days (based on GS1). USACE will monitor the biological effect of these proposed actions (e.g., starting by monitoring primary productivity in the Apalachicola River), and the details of how and when in these time periods the floodplain is inundated will be explored within the authority of the WCM through adaptive management. Through an incremental approach over 5 years, the result of adaptive management will be a set of management rules and targeted monitoring to meet these criteria. For example, if a 30-day pulse in July-August is provided, this may also benefit mussel host fish populations. The adaptive management technical team will begin analyzing food production in the lower Apalachicola River as measured at the Sumatra gage. Use of chlorophyll *a* and turbidity monitoring will be reviewed by the adaptive management technical team to determine if it would capture the effects of the action on the food production or to determine if another monitoring regime in the vicinity of the Sumatra gage is more efficient and effective than chlorophyll *a* and turbidity monitoring at the gage.
d) Implement Adaptive Management Recommendations – The USACE shall assume responsibility for implementing the monitoring actions that the adaptive management technical team recommends and that the USFWS agrees are reasonable and necessary to understand, avoid, and minimize take resulting from the actions taken under USACE WCM.
e) Review WCM Implementation – The USACE shall organize semi-annual meetings with USFWS to review implementation of the WCM and adaptive management framework including new data and results, information needs and methods to address those needs, evaluations and monitoring specified in the Incidental Take Statement, formulate actions that minimize take of listed species, and monitor the effectiveness of those actions.
f) Provide Annual Report – The USACE shall provide an annual report to USFWS on or before January 31 each year documenting (1) compliance with the terms and conditions of the Incidental Take Statement during the previous year, (2) any conservation measures implemented for listed species in the action area; and (3) recommendations for actions in the coming year to minimize take of listed species.
g) Provide Monthly Status Update – The USACE shall provide by email or other timely electronic means to USFWS on a monthly basis the status of WCM implementation including the hydrology of the system, composite system storage, and any data related to any other adopted criteria.

Costs: The costs to implement the provisions of RPM 2016-1 over the five-year period covered by the BO are estimated to be approximately $600,000 to $800,000, depending on the frequency of meetings, results of monitoring, and recommendations of the technical team. Costs are based upon fiscal year [FY] 2016 price levels.

RPM 2016-2, Water Quantity and Water Quality Stations. Develop and implement a monitoring program associated with USGS, NOAA or other similar monitoring stations within the ACF Basin for water quantity and water quality parameters.

Rationale: Gaging of water quantity and quality within the ACF Basin will be used to inform estimates of take and management options to be assessed through adaptive management (RPM 2016-1). Improved water quality information is also essential to understanding the influences of USACE management on key water quality parameters associated with PCEs for critical habitat of listed mussels and sturgeon.

Terms and Conditions:

a) Monitor Water Quantity and Water Quality – USACE and USFWS will work with USGS to develop and implement a monitoring program that supplements current monitoring stations within the ACF Basin. USACE, in collaboration with USGS, will begin implementation of additional gaging by March 14, 2017 or within 60 days of the Record of Decision being signed, whichever comes later. The supplemental information to be collected will include additional water quantity and/or water quality parameters related to PCEs for critical habitat of the listed species, including flow, water temperature, salinity, and dissolved oxygen. The USACE will be responsible for funding the annual maintenance costs associated with the supplemental data collected at these existing USGS gage locations for the duration of the BO to aid in monitoring abiotic conditions tied to the baseline and potential changes in take. Through the adaptive management approach, the USFWS and USACE will assess the need to increase, reduce, or change the monitoring locations set forth in these terms and conditions. Additional to the species monitoring described in RMP 2016-3, specific gages (identified in the BO) will be monitored for discharge, stage, water temperature, dissolved oxygen at a minimum, with other water quality parameters as needed (pH, conductivity, turbidity, salinity) to assess the status and possible adverse modification of PCEs for critical habitat and associated take for listed mussels and sturgeon. Each gage shall monitor river conditions at 15-minute or other appropriate intervals and seasons as agreed by USFWS with data transmitted via satellite to the USGS office, for display on the USGS web page in real-time, and available in regular reports. The Chattahoochee and Sumatra gages will be monitored at least monthly. If the latest measurement suggests that the Chattahoochee gage height is less than the current unshifted rating curve value that corresponds to a discharge of 5,000 cfs, do not reduce releases until the USGS verifies discharge via field measurement or until coordination with the USFWS and USGS indicates that a discharge measurement is unnecessary. All data will be shared with the USFWS at least annually in the report described for RPM 2016-1.
b) Establish New USGS Gage Stations – Additional USGS gages (identified within the BO) may be established if the scientific information obtained from monitoring leads the adaptive management technical team to determine additional gages downstream are necessary to capture the effect of the action on food production or foraging access for Gulf sturgeon.

Costs: The costs to implement the provisions of RPM 2016-2 over the five-year period covered by the BO are estimated to be approximately $400,000 to $500,000, depending on specific parameters monitored and the frequency of required maintenance. Costs are based upon FY 2016 price levels.

RPM 2016-3, Species Monitoring. Monitor the level of take associated with the WCM and evaluate ways to avoid and minimize take by monitoring the distribution and abundance of the listed species in the action area.

Rationale: Monitoring populations and relevant habitat conditions associated with take of listed species within the ACF Basin will serve the USACE's information needs for future consultations on updates to the WCM and associated activities. Further, as habitat conditions change, it is necessary to monitor the numbers and spatial distribution of the populations to determine the accuracy of the take estimates. Monitoring will inform the adaptive management framework developed for RPM 2016-1.

Terms and Conditions: In consultation with the USFWS, the USACE shall plan and implement the following monitoring efforts relative to the endangered and threatened species, their habitats, designated critical habitat that will develop information necessary to understand the impact of incidental take and to ensure that the anticipated levels of incidental take are not exceeded.

a) Monitoring and Reporting Take:
    1) USACE will, in coordination with USFWS and the adaptive management technical team, develop and implement monitoring programs to establish baselines and track changes in abundance, density, and frequency of occurrence of fat threeridge, Chipola slabshell and purple bankclimber within the aquatic habitats downstream of Jim Woodruff Lock and Dam. This species monitoring is additional to and complements the water quality monitoring as part of RPM 2016-2. Reports and data will be provided to the USFWS at least annually and will be shared with the adaptive management technical team as needed. These monitoring plans will be completed and implemented by March 14, 2017 or within 60 days of the Record of Decision being signed, whichever comes later.
    2) In coordination and collaboration with USFWS and the adaptive management technical team, USACE will develop and implement a plan to create opportunities within existing operations to monitor the outcome of actions to minimize potential effects of hydropeaking at Jim Woodruff Lock and Dam and reduction in floodplain inundation on Gulf sturgeon. This species monitoring is additional to and complements the water quality monitoring as part of RPM 2016-2. USACE will submit a draft plan for USFWS review and approval by January 1, 2017 or 60 days before the first Gulf sturgeon spawning season after the Record of Decision is signed, whichever comes later. Reports and data will be provided to the USFWS at least annually. Monitoring objectives and design will be linked to assessment of take and to assessment of the success of the adaptive management actions (i.e., targeted monitoring for adaptive management).
b) Adapt Monitoring – Coordinate monitoring results with the adaptive management technical team and, if needed, adapt the monitoring according to the adaptive management technical team recommendations and the formal adaptive management framework developed for RPM 2016-1.

Costs: The costs to implement the provisions of RPM 2016-3 over the five-year period covered by the BO are estimated to be approximately $2,400,000 to $2,750,000, depending on the design of the monitoring program, frequency of required monitoring, and adaptive changes to the monitoring program. Costs are based upon FY 2016 price levels.

Conservation Recommendations. USFWS provided conservation recommendations for ACF Basin water management operations per Section 7(a)(1) of the ESA, which directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations for ACF Basin water management operations are discretionary activities that USACE may undertake within its authorities to minimize or avoid the adverse effects of a proposed action, help implement recovery plans, or develop information useful for the conservation of listed species. USFWS offered the following conservation measures in the BO:

a) Work with the USFWS to formalize a 7(a)(1) agreement that works towards recovery of listed, candidate, and at risk species in the basin. The species in the ACF Basin are recoverable, but cannot be recovered without key partners. USACE controls water operations in the system and this has implications for the aquatic species. Effort spent on conservation actions now should result in a greater return on conservation investment and allow for more operational flexibility in the future. In addition, an appropriately designed 7(a)(1) program will promote recovery and facilitate future interagency 7(a)(2) interactions.
b) In collaboration with the USFWS, implement Gulf sturgeon monitoring with emphasis on WCM operations whose effect to Gulf sturgeon is highly uncertain. Specific recommended monitoring activities are outlined in the BO.

c) In collaboration with the USFWS, continue to develop and assess potential adjustments to water management decisions under the WCM in response to increased knowledge of listed species effects and develop additional conservation measures and management options for the ACF Basin to promote recovery of listed species.
d) In collaboration with the USFWS, improve measures of success in reaching explicit objectives for both fish and wildlife resources and other project purposes prior to the next update of the WCM.
e) Develop a report using the best available science that describes how predicted changes in climate could affect WCM operations. The USFWS suggests that the report be updated once every five years.
f) Implement Gulf sturgeon and freshwater mussel recovery actions, including but not limited to, developing habitat suitability indices, conducting life history and population studies, restoring reaches to provide suitable habitat, and assessing sediment quality.
g) Improve the public understanding of water management of the ACF system, the related conservation needs of listed species, and the management of the multiple purposes of the federal reservoirs.
h) Identify and implement water conservation measures in the basin to avoid impacts to fish and wildlife resources by working with municipal, agricultural, and industrial water users to reduce consumptive uses to develop additional drought response strategies.
i) Assist stakeholders to plan future water management to minimize water consumption thus minimizing detrimental effects to species.
j) Update, as soon as practicable, tools for assessing the effects of ongoing and future system operations, including estimates of basin inflow and consumptive demands. The tools should assist in identifying flows that provide sufficient magnitude, duration, frequency, and rate of change to support the survival and recovery of the listed species in the ACF Basin.

In order for the USFWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the USFWS requested notification of the implementation of any conservation recommendations in the annual report required by the BO. The PAA does not currently implement any of the discretionary conservation recommendations. However, USACE will seek opportunities to implement pertinent conservation recommendations and, if so, will notify the USFWS accordingly.

Detailed documentation of the ESA section 7 consultation process for the ACF WCM update process is provided in appendix J.

Reservoir operations may influence two types of direct and/or indirect changes that could potentially affect the habitats of the federally-protected species listed in Table 2.5-5:

- Alteration of flow regimes in reservoirs and downstream of dams
- Water quality degradation

A general overview of these potential effects from the existing literature is provided below.

6.4.4.1 Alteration of Flow Regimes in Reservoirs and Downstream of Dams

Little information is available on the linkages between flow regime characteristics and the life histories of protected species occurring in the ACF Basin. Previous efforts at riverine ecosystem restoration have demonstrated that it is impossible to simultaneously optimize conditions for all species (Sparks 1992, 1995; Toth 1995). However, overall biological diversity and ecosystem function benefit from interannual variations in species success (Tilman et al. 1994). Consistent with authorized project purposes, the ecology and biodiversity of the basin, including its protected species, can be sustained when natural patterns of variability of flow regimes can be maintained or restored. USACE has been working with

USFWS through ESA section 7 consultation and the provisions of the FWCA to establish flow regimes throughout the basin that meet the project purposes of federal reservoirs for peaking operations and ensure adequate flows downstream of dams, particularly during the spawning season. As discussed in section 4.1.3.5.3, operations to allow small pulses were found to inherently and adversely affect hydroelectric power, flood risk management, and navigation through the use of potentially significant amounts of storage, and those water management measures were eliminated from detailed evaluation. Current operations in the basin for fish spawning, fish passage, and provisions of minimum flows at the USGS gage in the Apalachicola River at Chattahoochee, Florida, have been protective of listed species and were included in this WCM update as described in section 4.2.

6.4.4.2 Water Quality Degradation

Riverine communities generally require clean water with sufficiently high DO concentrations and appropriate temperatures. Although controls on point source discharges under the Water Pollution Act of 1972, as amended, have improved water quality in the ACF Basin since the 1970s, problems related largely to nonpoint source sedimentation and other contaminants continue in many river reaches. For example, urban runoff is the major source of water quality degradation for the Chattahoochee River in the reach between Atlanta and Whitesburg, Georgia (Stamer et al. 1979). Biological conditions in the ACF Basin are most severely degraded in its urbanized reaches (Frick et al. 1998). Water quality degradation is a frequently cited concern for the riverine-dependent species included in the Comprehensive Study's Protected Species Report (Ziewitz et al. 1997). It is quite likely that water quality is a limiting factor for several of the species, including the six federally listed mussels. Any actions that could alter water quality must address effects on the protected species.

6.4.4.3 Impacts of Modeled Alternatives

Federal- and state-protected species occurring in or near water systems of the ACF Basin are presented in Table 2.5-5. Based on habitat preference and federal status, a subset of those species has been identified as having a high potential to be affected by the proposed changes in flow regime (USFWS 2010). The following sections present the results of the HEC-ResSim modeling used to evaluate the potential effect of various alternatives on federally listed Gulf sturgeon and mussels in the Apalachicola River.

An evaluation of Chattahoochee River shoal bass (*Micropterus cataratae*) based on recommendations from USFWS also is included in the discussion (USFWS 2013). Although the shoal bass is not currently listed by USFWS, it is a species of concern and is a state-listed species in Georgia (threatened) and Alabama (protected). USFWS recommended the performance metrics used for shoal bass in section 6.4.4.3.3.

The following sections provide a general assessment of the potential effects of the PAA and other alternatives on Gulf sturgeon and its designated critical habitat, three listed species of mussels in the Apalachicola River and their critical habitats, and shoal bass. Note that the USFWS BO in appendix J resulting from the 2016 ESA section 7 consultation contains more detailed information on the effects of the PAA on federally-listed species, including reasonable and prudent measures to avoid jeopardy and conservation recommendations.

6.4.4.3.1 Gulf Sturgeon

USFWS developed the Sturgeon Spawning Habitat Performance Measure (SSHPM) to evaluate effects on Gulf sturgeon habitats in the Apalachicola River. USACE used several metrics from the SSHPM to evaluate the effects of the alternatives on Gulf sturgeon in the Apalachicola River from exposure during varying conditions. Gulf sturgeon spawning habitat was quantified at three locations known to support the species. The maximum amount of habitat available during inundation at 8.5–17.8-ft depths from March

through May as well as over 30 consecutive days to support the timing of three life stages (i.e., spawning, egg incubation, and early larval development) of Gulf sturgeon were evaluated. Collectively, these stages have been estimated to occur over approximately 30 days in the ACF Basin (USFWS 2008a; Pine et al. 2006). The following subsections define the effects of alternatives on Gulf Sturgeon based on six specific metrics defined by the USFWS (2013):

- The change in median annual Gulf sturgeon spawning habitat from the NAA (18.17 ac)
- Frequency (% of days) of Gulf sturgeon spawning habitat availability (ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft) on each day March 1–May 31 at the two sites that support spawning
- Frequency (% of years) of Gulf sturgeon spawning habitat availability (maximum ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft for at least 30 consecutive days each year) March 1–May 31 at the two sites that support spawning
- Daily fall rates with respect to exposure of Gulf sturgeon eggs and larvae
- Maximum number of consecutive days per year < 16,000 cfs
- Departures from average water temperatures between March 1 to May 31

Interpretation of the model results as presented in Figure 6.4-9 through Figure 6.4-21 and the tabulated information in Table 6.4-7 provides the basis for the description of effects on Gulf sturgeon in the ACF Basin.

Young-of-the-year (YOY) Gulf sturgeon spend 6–10 months feeding in the river as they migrate downstream. They appear in the estuaries in December–February. Juveniles (< 6 years ; except YOY) are believed to overwinter in the estuary, but telemetry studies and mark-recapture efforts are not available to confirm that belief. Juvenile Gulf sturgeon (304–890 millimeter [mm]) fork length stay in the river for about the first 2–3 years and then move to the estuary, where they forage until they reach subadult size (891–1,250 mm fork length, or 3–4 ft). Then they move to the barrier islands to forage, generally between December and March. It appears that juveniles have, as do adults, a spatial distribution largely dictated by prey availability. Since the sturgeon is a benthic feeder, an area within the Apalachicola River system that supports a prey base of benthic organisms is a potential feeding ground and, therefore, considered critical habitat. Sulak and Clusston (1999) found that juvenile Gulf sturgeon are found primarily over bare sandy substrate, devoid of structural barriers such as submerged vegetation. Since little or no difference in flow conditions downstream of Jim Woodruff Lock and Dam is expected for any of the alternatives when compared to the NAA, neither would any change in foraging habitat for Gulf sturgeon be expected.

The daily fall rates for each alternative will have no additional effects with respect to exposure of Gulf Sturgeon eggs and larvae compared to the NAA. Because Gulf sturgeon spawning most often occurs at depths between 8 and 18 ft, a rapid fall in river stage could result in exposure or stranding of eggs and larvae. A depth of 8 ft over the highest known Gulf sturgeon spawning habitat on the Apalachicola River corresponds to a flow of approximately 40,000 cfs. Under the USACE ACF project water control operations, impacts to Gulf Sturgeon spawning habitat are not expected. The Jim Woodruff Dam water management operations have mechanisms in place to ensure that, when flows are less than 40,000 cfs, a decline of more than 8 ft in less than 14 days during the months of March, April, and May does not occur. Analysis of the simulated flows verifies that this potential take event does not occur. The Jim Woodruff Lock and Dam water management operations also include a fall rate schedule when discharges are within the capacity of the powerhouse that facilitates movement of mussels and host fish as river stages decline.

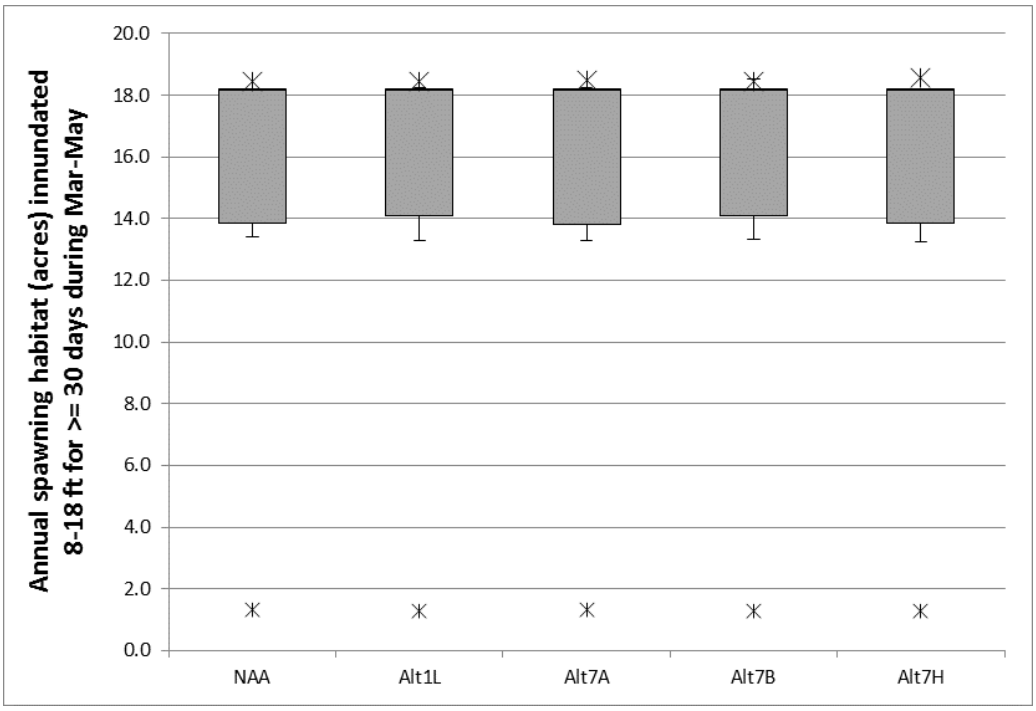


Figure 6.4-9. Change in Median Annual Gulf Sturgeon Spawning Habitat over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

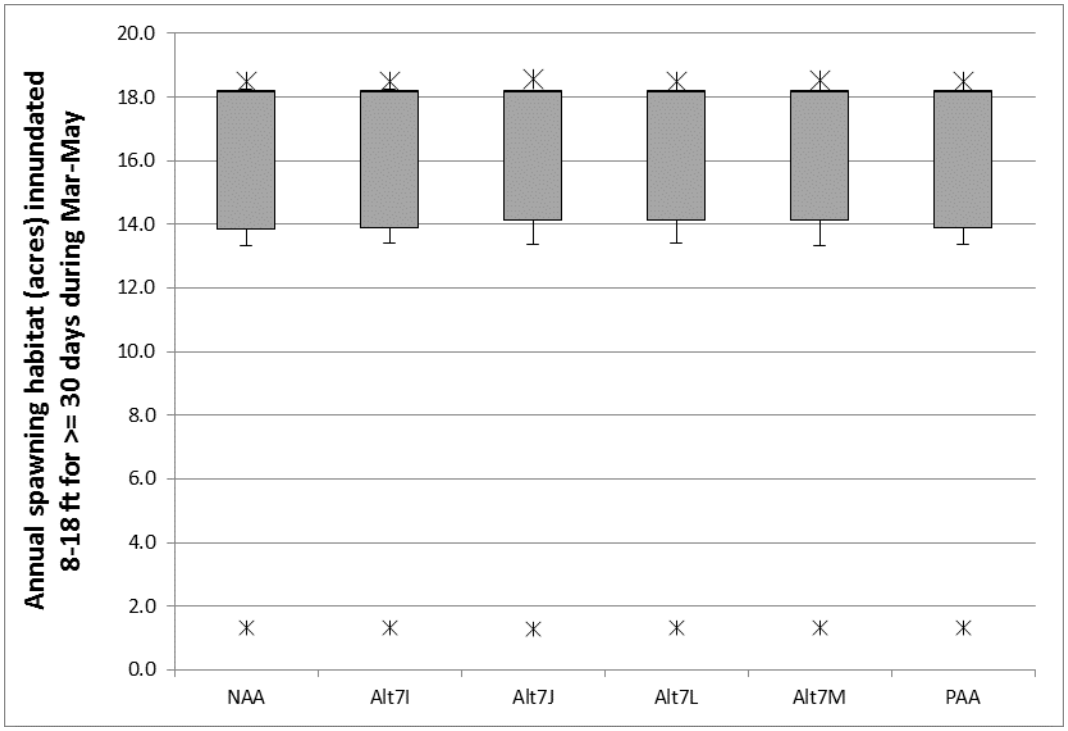


Figure 6.4-10. Change in Median Annual Gulf Sturgeon Spawning Habitat over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and PAA.

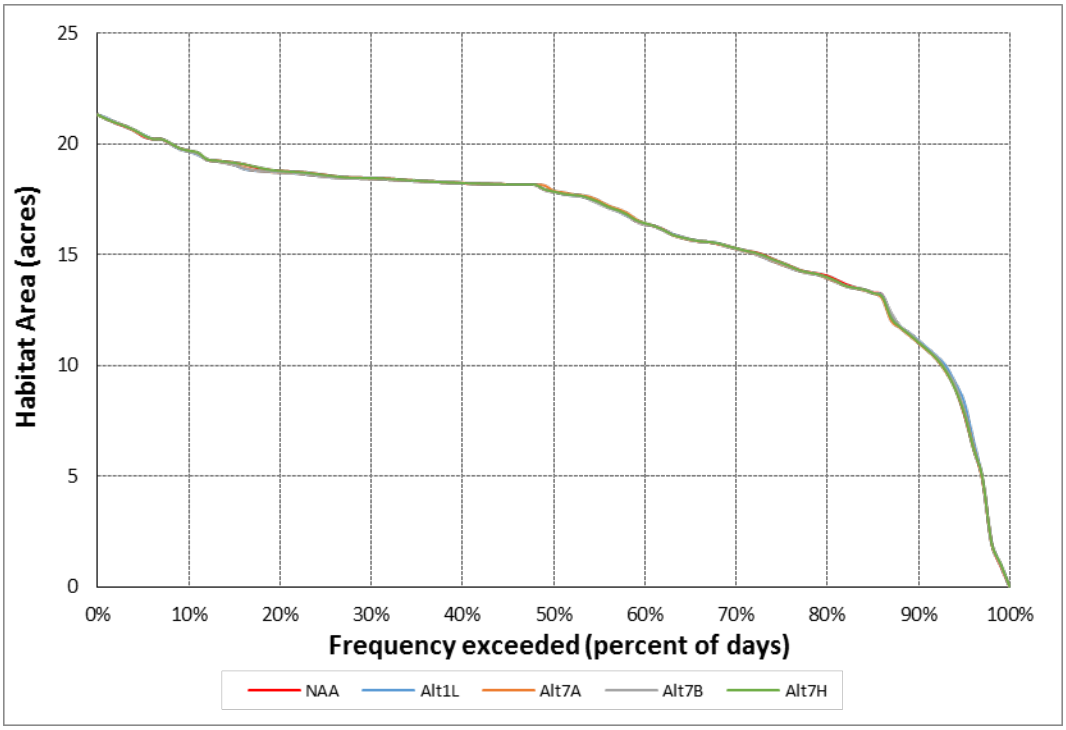


Figure 6.4-11. Frequency (% of days) of Gulf Sturgeon Spawning Habitat Availability (ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft) on Each Day Mar 1–May 31 at the Two Sites that Support Spawning over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

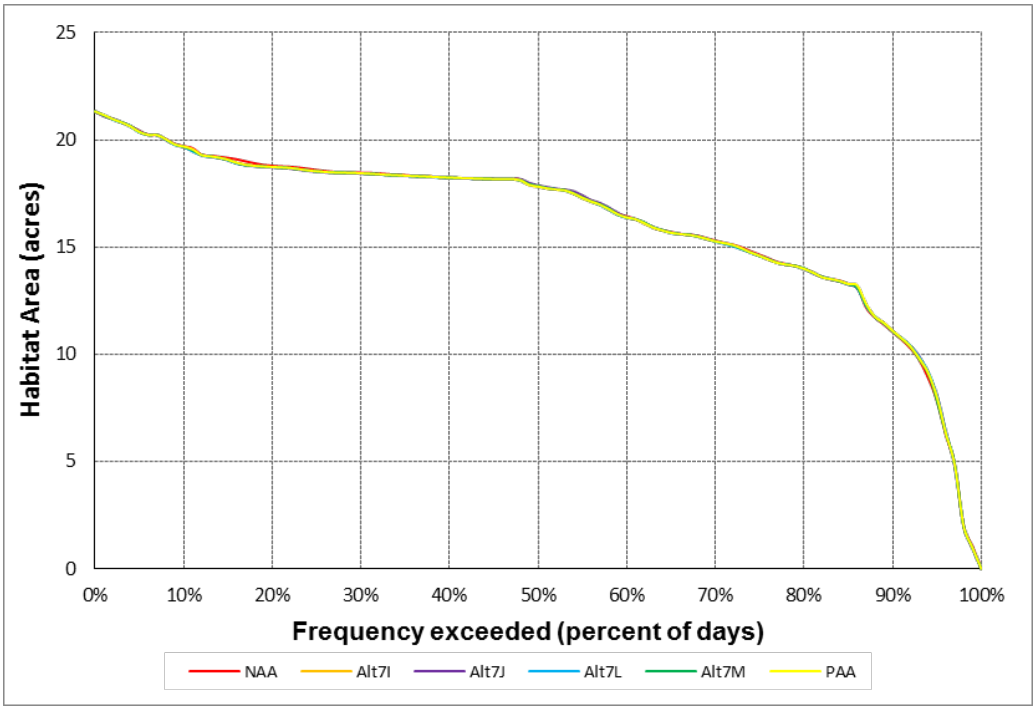


Figure 6.4-12. Frequency (% of days) of Gulf Sturgeon Spawning Habitat Availability (ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft) on Each Day Mar 1–May 31 at the Two Sites that Support Spawning over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

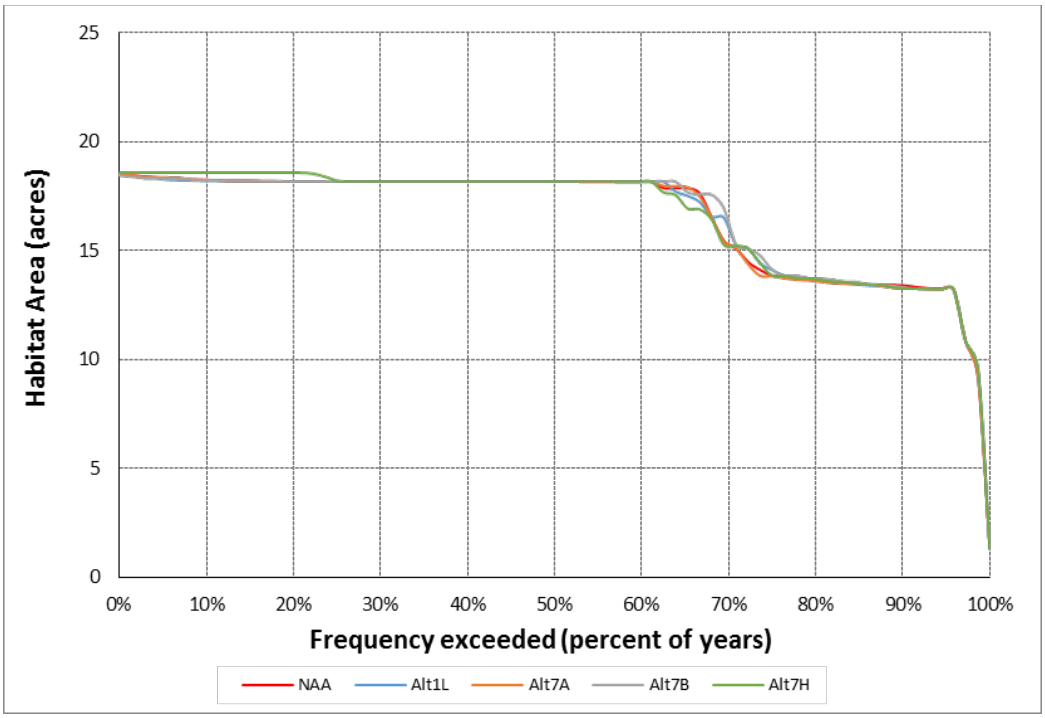


Figure 6.4-13. Frequency (% of years [yrs]) of Gulf Sturgeon Spawning Habitat Availability (max ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft for at least 30 consecutive days each yr) Mar 1–May 31 at the Two Sites that Support Spawning over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

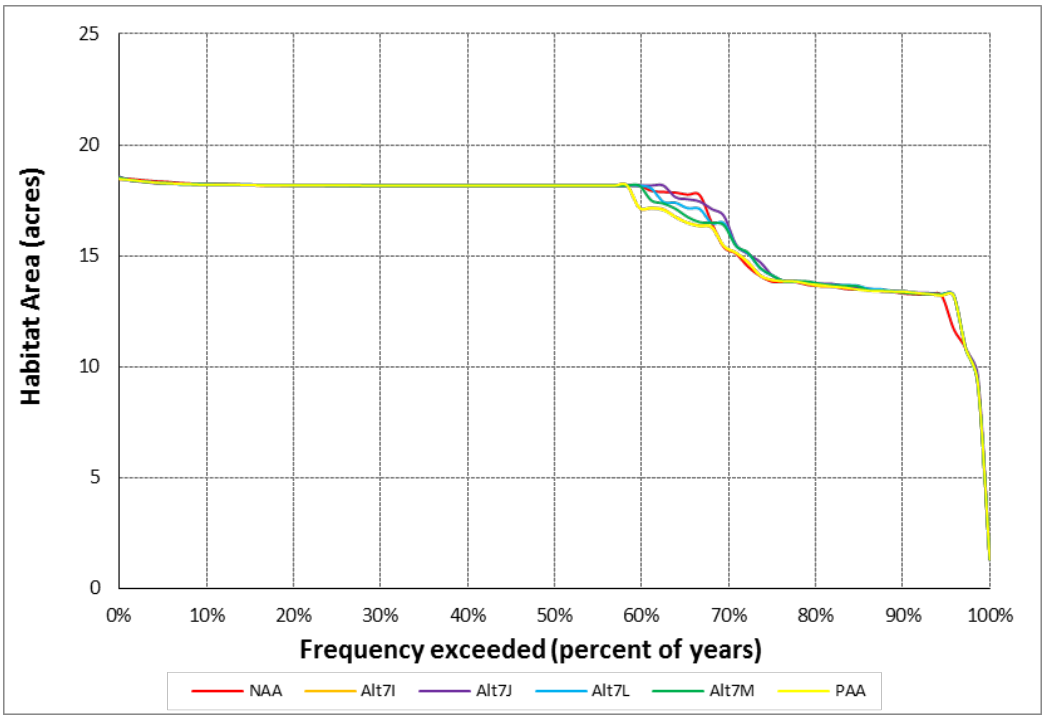


Figure 6.4-14. Frequency (% of yrs) of Gulf Sturgeon Spawning Habitat Availability (max ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft for at least 30 consecutive days each yr) Mar 1–May 31 at the Two Sites that Support Spawning over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

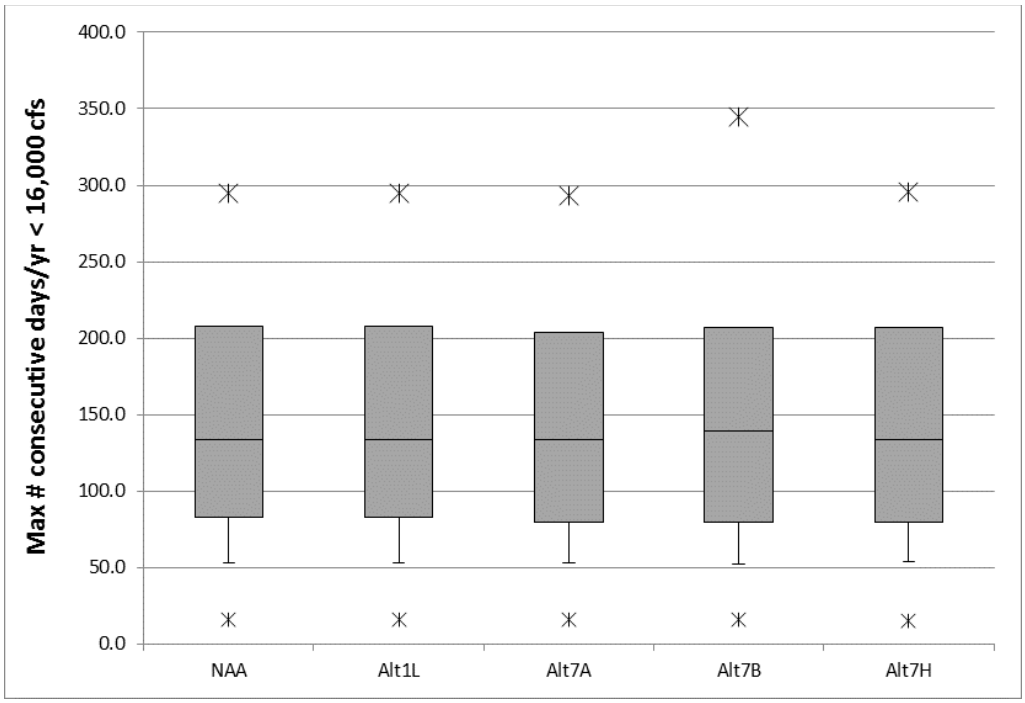


Figure 6.4-15. Maximum Number of Consecutive Days per Yr < 16,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

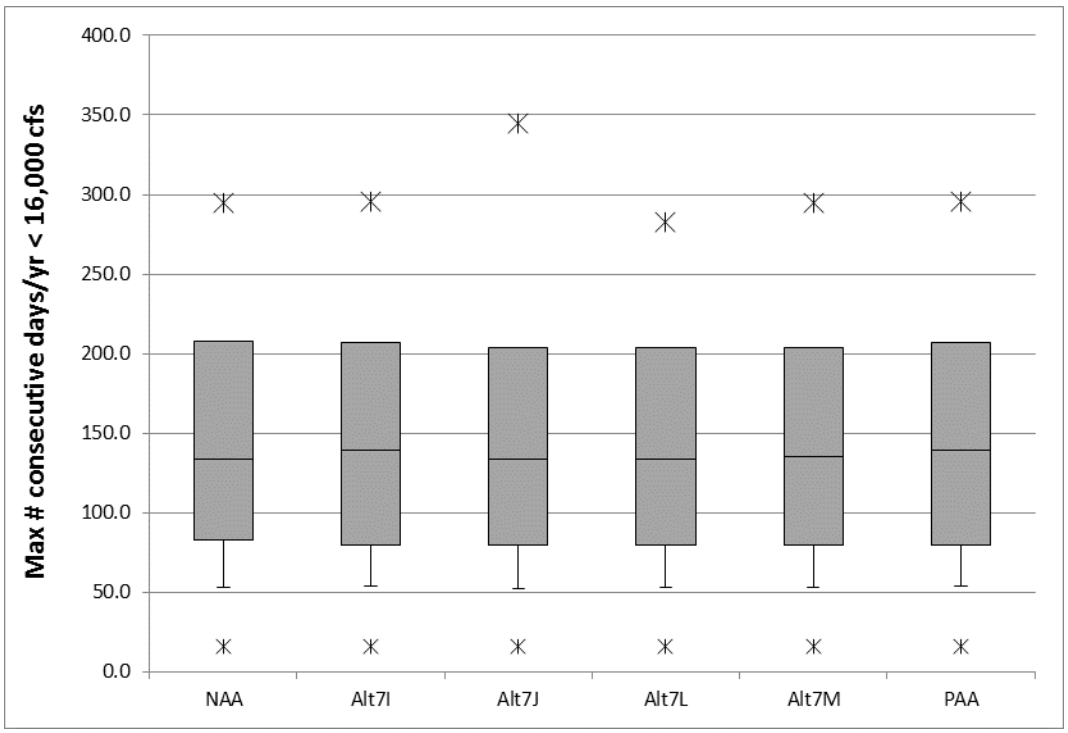


Figure 6.4-16. Maximum Number of Consecutive Days per Yr < 16,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

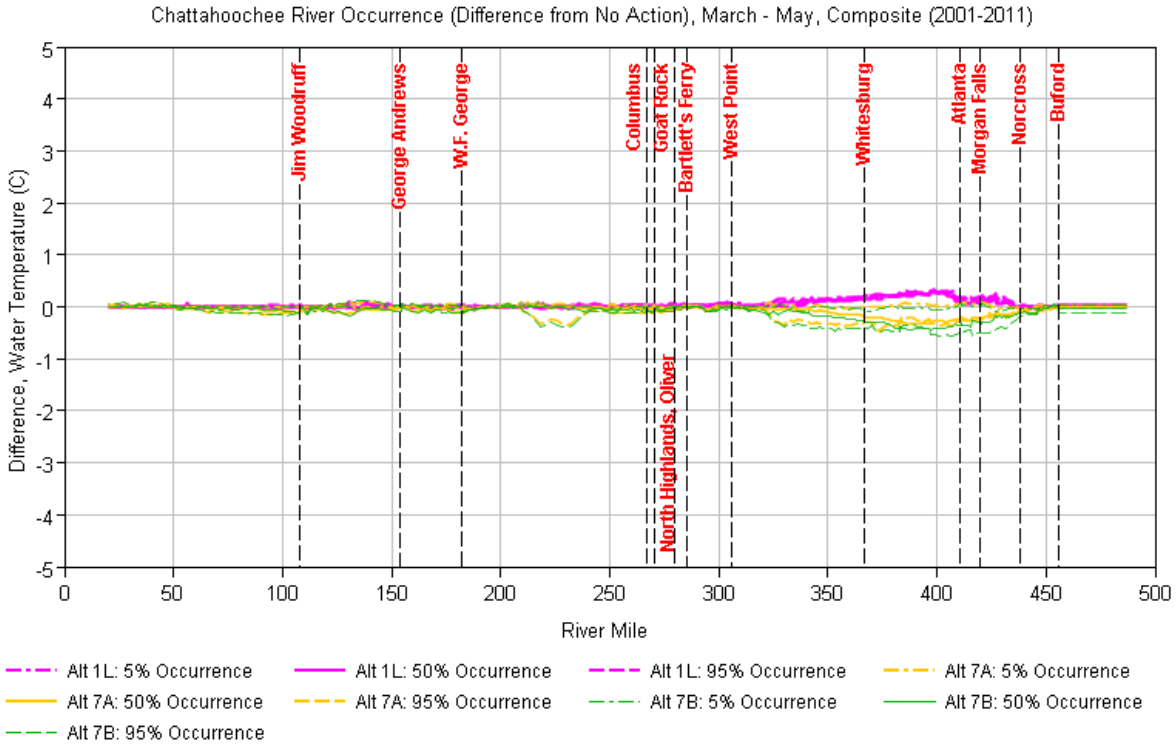


Figure 6.4-17. Departures from the NAA Average Water Temperatures Mar 1–May 31 over the Modeled Period of Record (2001–2011) for the NAA and Alt1L, Alt7A, and Alt7B.

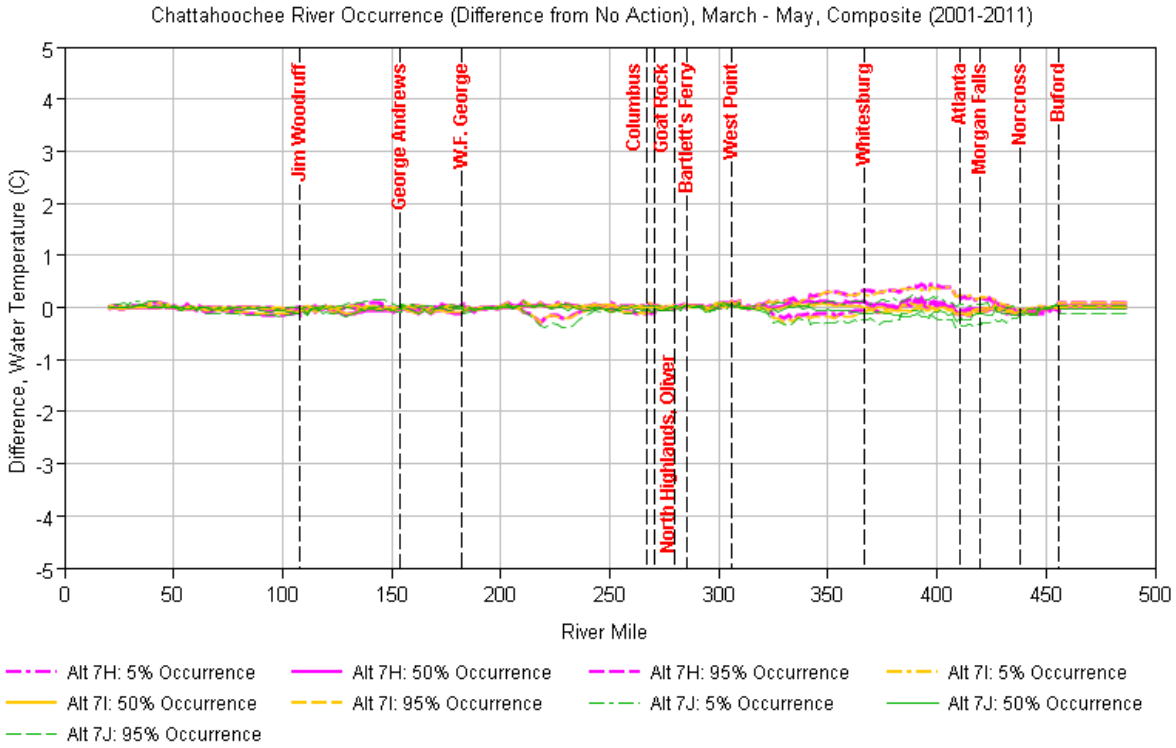


Figure 6.4-18. Departures from the NAA Average Water Temperatures Mar 1–May 31 over the Modeled Period of Record (2001–2011) for Alt7H, Alt7I, and Alt7J.

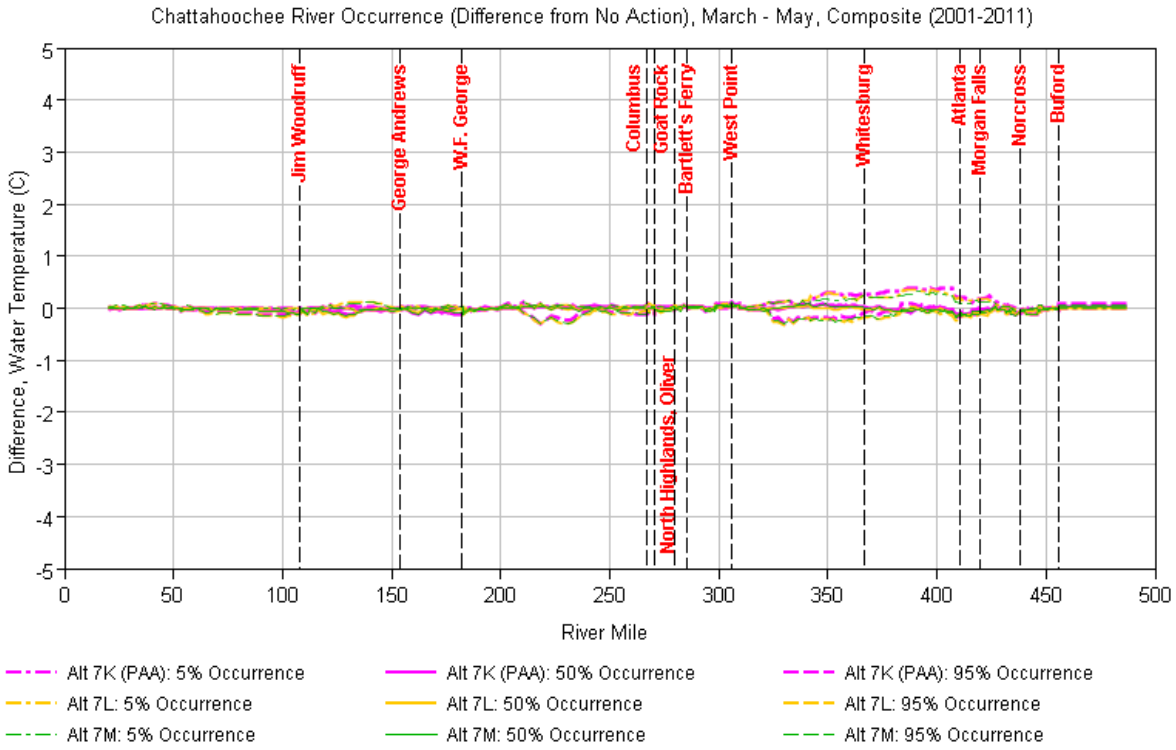


Figure 6.4-19. Departures from the NAA Average Water Temperatures Mar 1–May 31 over the Modeled Period of Record (2001–2011) for the PAA, Alt7L, and Alt7M.

Table 6.4-7.
Summary of the Effects of Alternatives on Gulf Sturgeon

	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Change in median annual Gulf sturgeon spawning habitat from that available under the NAA (18.17 ac)	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Frequency (% of days) of Gulf sturgeon spawning habitat availability (ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft) on each day Mar 1–May 31 at the two sites that support spawning	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Frequency (% of yrs) of Gulf sturgeon spawning habitat availability (max ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft for at least 30 consecutive days each yr) Mar 1–May 31 at the two sites that support spawning	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Daily fall rates with respect to exposure of Gulf sturgeon eggs and larvae	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Max # of consecutive days per yr < 16,000 cfs	Baseline	Negligible/ No change	Negligible/ No change	Slightly beneficial	Negligible/ No change	Slightly beneficial	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change
Departures from average water temperatures Mar 1–May 31	Baseline	Negligible/ No change	Negligible/ No change	Slightly adverse	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.

Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

6.4.4.3.1.1 No Action Alternative

The median annual Gulf sturgeon spawning habitat available under the NAA is 18.17 ac. The frequency (percent of days) of Gulf sturgeon spawning habitat availability (ac of potentially suitable spawning substrate inundated to depths of 8.5–17.8 ft) on each day March 1–May 31 at the two sites that support spawning is similar between the NAA and the alternatives, with a median acreage of 17.86. The frequency (percent of years) of Gulf sturgeon spawning habitat availability on each day March 1–May 31 at the two sites that support spawning is similar between the NAA and the alternatives. The habitat area does not begin to decline until a 60-percent frequency. The maximum number of consecutive days on which flows would be less than 16,000 cfs is 134. The average water temperature between March 1 and May 31 is similar between alternatives. Negligible changes are expected to occur when departures from average water temperatures Mar 1–May 31 are less than 0.5°C and slightly adverse effects would be expected if departures from the average temperature is greather than 0.5°C. These data serve as the baseline for comparing the potential effects of the other alternatives.

6.4.4.3.1.2 Alternative 1L

Overall, implementing Alt1L would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt1L as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be the same for Alt1L as for the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs is the same for Alt1L as for the NAA. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.1.3 Alternative 7A

Overall, implementing Alt7A would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7A as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31, at the two sites that support spawning would be less than 2-percent difference between Alt7A and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be 1 day more than under the NAA. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.1.4 Alternative 7B

Overall, implementing Alt7B, overall, would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7B as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between Alt7A and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be 139, four days more than under the NAA, and slightly beneficial effects would be expected. The departure from the average water temperature between March 1 and May 31 would be slightly greater than 0.5 °C, and adverse effects would be expected.

6.4.4.3.1.5 Alternative 7H

Overall, implementing Alt7H would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7H as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between Alt7H and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be the same as under the NAA. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.1.6 Alternative 7I

Overall, implementing Alt7I, would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7I as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between Alt7A and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be 139, four days more than the NAA, and slightly beneficial effects would be expected. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.1.7 Alternative 7J

Overall, implementing Alt7J would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7J as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between Alt7H and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be the same as under the NAA. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.1.8 Alternative 7K (PAA)

In the BA for ESA section 7 consultation with USFWS, USACE determined that implementing the PAA may affect, but would not be likely to adversely affect, the Gulf sturgeon or its critical habitat. The median annual Gulf sturgeon spawning habitat available would be the same for the PAA as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between the PAA and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be 139, four days more than under the NAA, and slightly beneficial effects would be expected. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

In its September 2016 BO, USFWS determined that the PAA would be likely to adversely affect the Gulf sturgeon and its designated critical habitat, requiring an Incidental Take Statement, Reasonable and Prudent Measures (RPMs) to avoid and minimize incidental take, and Terms and Conditions for implementing the RPMs. These provisions in the BO are summarized in section 6.4.4 above, and the BO in its entirety is included in appendix J. Compliance with the RPMs and Terms and Conditions will assure that incidental take is limited to the extent possible.

6.4.4.3.1.9 Alternative 7L

Overall, implementing Alt7L would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7L as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between Alt7L and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be the same as the NAA. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.1.10 Alternative 7M

Overall, implementing Alt7M would be expected to have negligible incremental effects on Gulf sturgeon compared to the NAA. The median annual Gulf sturgeon spawning habitat available would be the same for Alt7M as for the NAA. Additionally, the frequencies (percent of days and percent of years) of Gulf sturgeon spawning habitat on each day March 1–May 31 at the two sites that support spawning would be less than a 2-percent difference between Alt7M and the NAA. The maximum number of consecutive days on which flows would be less than 16,000 cfs would be the same as under the NAA. The departure from the average water temperature between March 1 and May 31 is less than 0.5 °C, and negligible effects would be expected.

6.4.4.3.2 Mussels

Mussel species—including the federally protected fat threeridge, Chipola slabshell, and purple bankclimber—all have federally designated critical habitat in the ACF Basin. USFWS developed the Apalachicola River Mussel Performance Measure (ARMPM) to evaluate the effects on shallow water mussel habitats in the Apalachicola River. USACE used several metrics from the ARMPM to evaluate the effects of the alternatives on mussel species in the Apalachicola River from exposure during low-flow conditions. Interpretation of the model results as presented in Table 6.4-8 through Table 6.4-10, Figure 6.4-20 through Figure 6.4-33, and the tabulated information in Table 6.4-11 provides the basis for the description of effects on mussels in the ACF Basin. Table 6.4-8 provides a qualitative assessment of the expected effects of the alternatives on mussels in the Apalachicola River. River water levels (dependent on the discharge of Jim Woodruff Dam) largely dictate available habitat for Apalachicola River mussels, and fluctuations in those levels have the potential to strand mussels. Water management operations affecting river water level fall rates in the Apalachicola River are described in section 4.1.2.8.

Table 6.4-8.
Minimum Flow from Each Modeled Year (cfs)

Year	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
1939	9444	9440	9396	9391	9442	9443	9440	9443	9440	9441
1940	7288	7292	6899	6783	6196	6263	6803	6263	6713	6262
1941	5010	5048	5191	5192	5188	5189	5189	5189	5188	5189
1942	9619	9619	9619	9619	9619	9619	9619	9619	9619	9619
1943	7835	7828	7832	7828	7827	7828	7822	7828	7826	7827
1944	9163	9162	9163	9166	9163	9162	9167	9162	9162	9162
1945	9035	9220	9534	9696	9402	9359	9734	9368	9561	9525
1946	10401	10440	10097	10387	10317	10309	10422	10309	10308	10308
1947	9887	9878	9889	9883	9884	9886	9900	9887	9878	9881
1948	11906	11905	11906	11906	11905	11905	11905	11905	11905	11905
1949	13453	13470	13463	13458	13471	13464	13449	13463	13467	13470
1950	7766	7766	7726	7861	7701	7696	7900	7690	7767	7735
1951	5353	5351	5050	5050	5050	5050	5050	5050	5050	5050
1952	7182	7196	6855	7099	7115	7036	7086	7036	7087	7088
1953	8852	8852	8852	8895	8852	8852	8932	8852	8852	8852
1954	5406	5490	5050	5050	5050	5050	5050	5050	5050	5050
1955	5009	5022	5115	5050	5050	5050	5050	5050	5114	5050
1956	5338	5050	5050	5050	5050	5050	5050	5050	5050	5050
1957	5622	5492	5620	5537	5601	5589	5488	5583	5477	5614
1958	8258	8256	8258	8256	8254	8255	8255	8255	8255	8255
1959	8456	8454	8478	8457	8489	8492	8444	8493	8469	8481
1960	8806	8830	8807	8936	8775	8770	8969	8764	8839	8808
1961	7873	7871	7873	7873	7869	7870	7870	7870	7870	7870
1962	7419	7389	7479	7404	7374	7375	7414	7391	7389	7382
1963	5678	5737	5712	5805	5693	5669	5856	5669	5729	5699
1964	12695	12683	12692	12693	12673	12674	12674	12674	12674	12674
1965	9406	9390	9395	9423	9399	9410	9757	9409	9381	9395
1966	8453	8453	8453	8453	8453	8453	8453	8453	8453	8453
1967	7550	7559	7551	7678	7551	7537	7711	7531	7560	7554
1968	5634	5893	5253	5196	5278	5246	5231	5238	5174	5284
1969	6067	5990	6188	6019	5951	5954	6094	5948	6015	5984
1970	6996	6996	6996	6996	6996	6996	6996	6996	6996	6996
1971	9823	9834	9823	9822	9862	9834	9833	9834	9834	9834
1972	6797	6791	6795	6796	6787	6789	6790	6789	6789	6789
1973	8531	8636	8531	8721	8636	8636	8863	8636	8636	8636
1974	8505	8543	8406	8476	8490	8459	8454	8451	8541	8504
1975	14254	14323	14248	14240	14355	14324	14314	14324	14320	14320
1976	8157	8379	8157	8157	8262	8168	8157	8169	8159	8163
1977	6344	6358	6230	6063	6197	6192	6090	6167	6271	6228
1978	6918	6918	6367	6622	6203	6203	6676	6203	6302	6058
1979	6694	6731	6672	6774	6676	6658	6681	6652	6722	6698
1980	6449	6446	6446	6439	6441	6444	6438	6444	6444	6444

Year	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
1981	5020	5042	5049	5049	5049	5049	5049	5049	5049	5049
1982	8368	8367	8367	8387	8576	8354	8380	8353	8484	8558
1983	8324	8506	8323	8323	8504	8504	8504	8504	8504	8504
1984	8292	8292	8292	8292	8292	8292	8292	8292	8292	8292
1985	5858	5943	6196	5675	6184	6165	5675	6159	6213	6196
1986	5049	5049	5049	5049	5049	5049	5049	5049	5049	5049
1987	6277	6303	6058	6288	6087	6081	6307	6081	6057	6086
1988	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
1989	8242	5050	6311	8203	6311	6311	7662	6317	6317	6311
1990	6017	6103	5988	6004	5964	5835	5867	5971	5637	5634
1991	9001	9004	9004	9059	9005	9004	9059	9004	9061	9005
1992	8374	8387	7727	7136	7280	7299	7907	7299	7766	7722
1993	5610	6126	5581	5564	5603	5838	5563	5838	5530	5599
1994	9027	8822	10588	10681	10644	10553	10705	10635	10641	10629
1995	7120	7189	7018	7081	7007	6980	7002	6972	7066	7041
1996	7637	7645	7641	7674	7645	7654	7690	7642	7646	7642
1997	6027	5711	5761	5764	5781	5808	5764	5810	5792	5799
1998	8296	8296	7768	7851	7748	7724	7865	7717	7805	7769
1999	5050	5084	5050	5050	5050	5050	5050	5050	5050	5050
2000	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
2001	5288	5296	5050	5318	5300	5300	5385	5301	5290	5264
2002	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
2003	8907	8976	8937	9065	8977	8980	9116	8975	9020	9015
2004	7006	7044	5798	5841	5844	5803	5788	5457	5505	5793
2005	9131	9152	9129	9129	9123	9124	9124	9124	9124	9124
2006	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
2007	5050	5050	4550	5050	4550	4550	5050	4550	4550	4550
2008	5050	5050	5050	5050	5050	5050	5050	5050	5050	5050
2009	7306	7143	7047	7011	7463	6984	7011	7451	7002	7002
2010	5723	5722	5681	5674	5702	5643	5622	5712	5733	5732
2011	5050	5025	5050	5050	5050	5050	5050	5050	5050	5050

Table 6.4-9.
Median Fall Rate when Flows are < 10,000 cfs over the Modeled Period of Record (1939–2011)

NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

Table 6.4-10.
Maximum Fall Rate when Flows are < 10,000 cfs over the Modeled Period of Record (1939–2011)

NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08

The following subsections define the effects of alternatives on mussels based on 10 specific metrics defined by USFWS (2013):

- Interannual frequency of flow rates < 5,000–10,000 cfs
- Median number of days flows per year are less than the thresholds of 5,000–10,000 cfs
- Median number of consecutive days per year flows are < 5,000–10,000 cfs
- Maximum number of days flows per year are < 5,000–10,000 cfs
- Maximum number of consecutive days per year flows are < 5,000–10,000 cfs
- Lowest daily flow for each year
- Frequency (number of days) of daily stage changes foot per day (ft/day)
- Frequency (percent of days) of daily stage changes (ft/day) when releases at Woodruff Dam are < 10,000 cfs.
- Median fall rate when flows are < 10,000 cfs
- Maximum fall rate when flows are < 10,000 cfs

As described in section 4.1.2.8, USACE considered fall rates in the Apalachicola River and the ramping of releases from Jim Woodruff Dam in the development of the alternatives considered for evaluation.

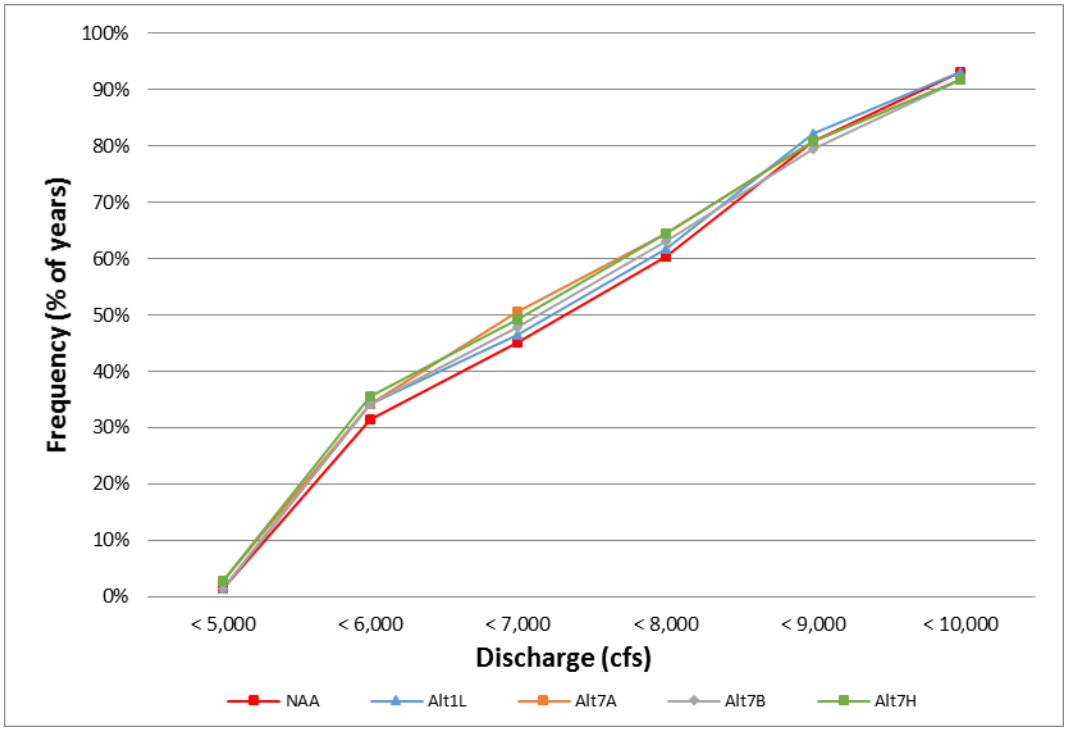


Figure 6.4-20. Interannual Frequency of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

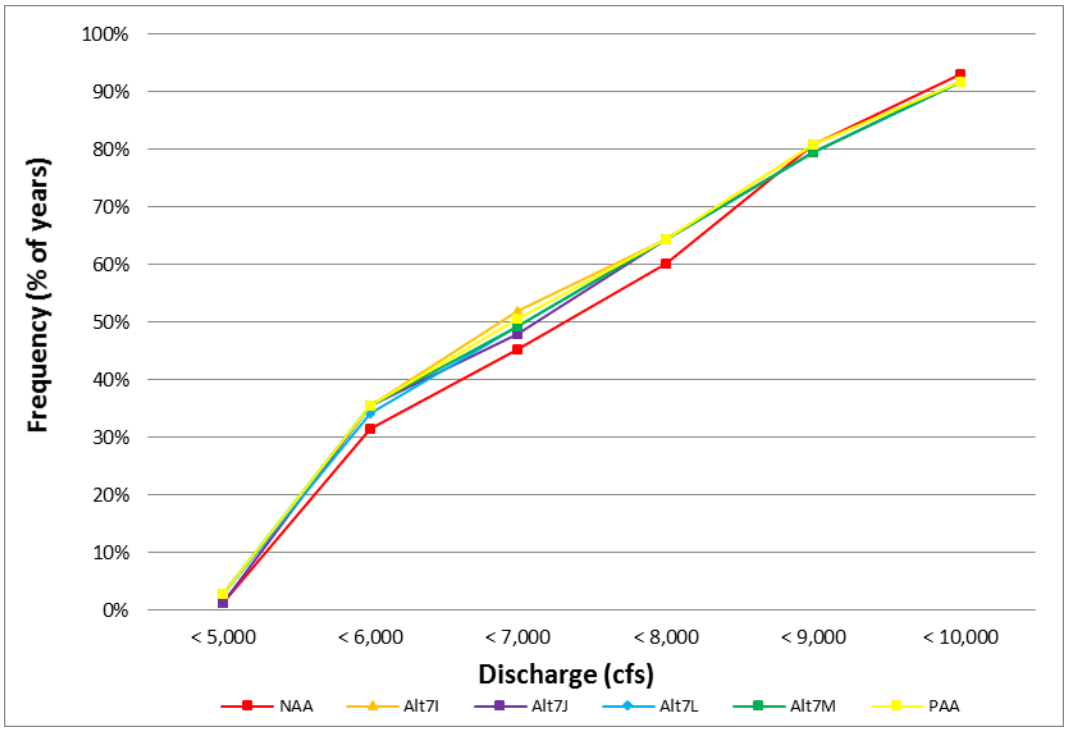


Figure 6.4-21. Interannual Frequency of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

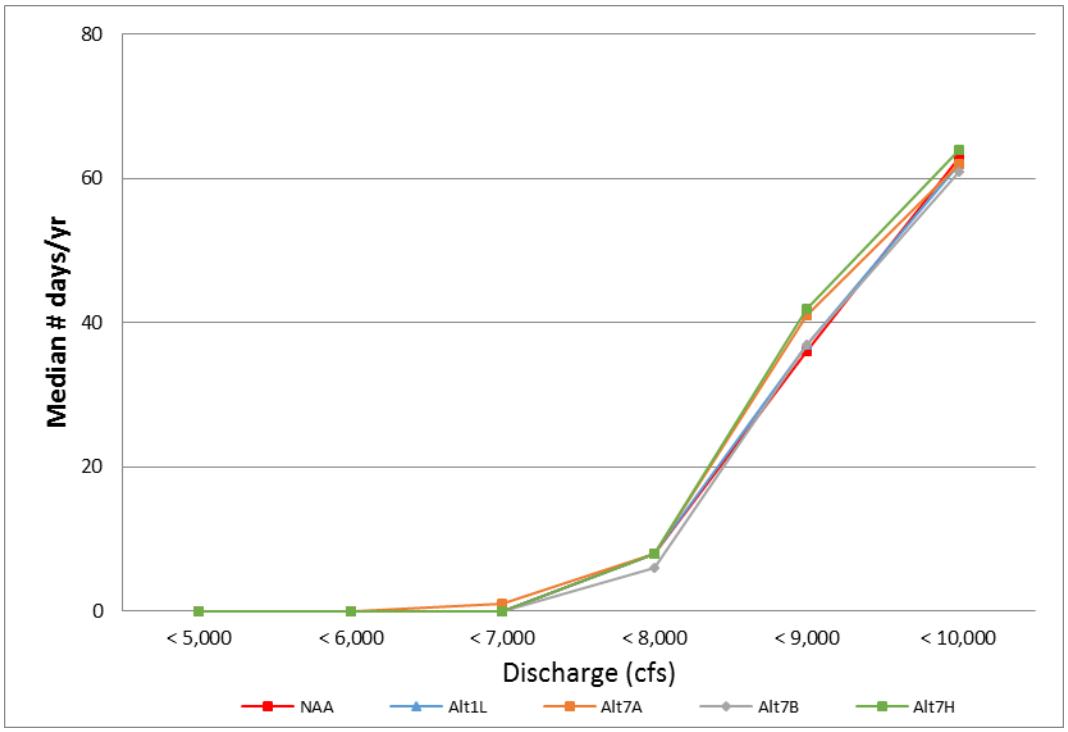


Figure 6.4-22. Median Number of Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

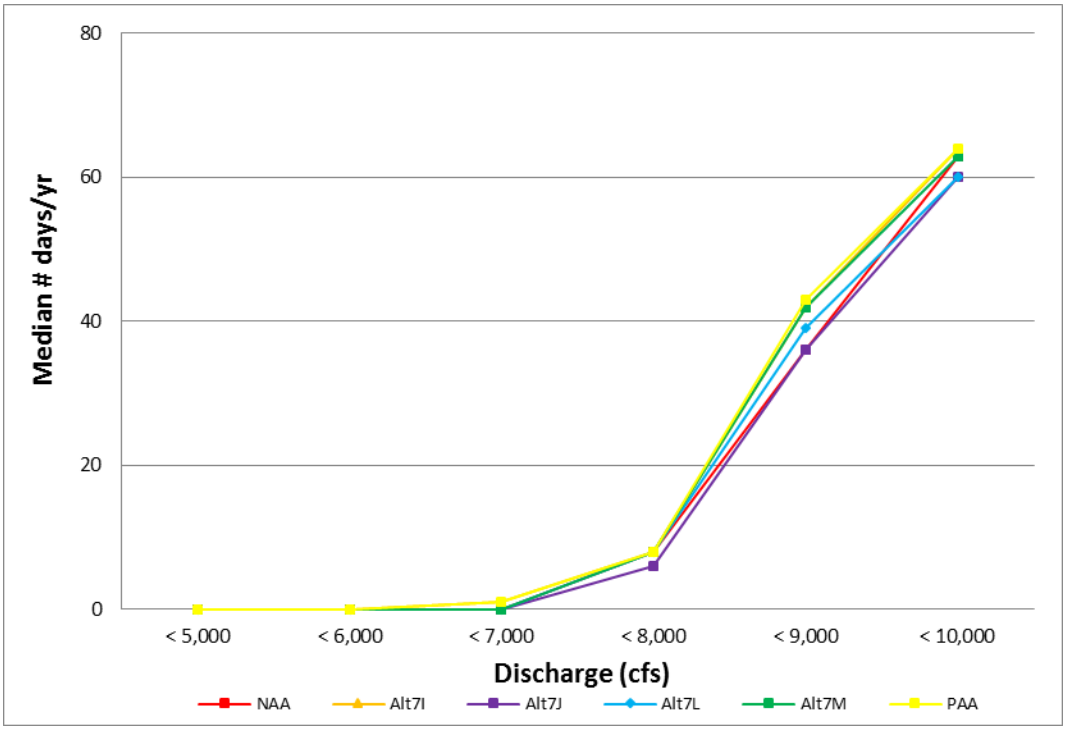


Figure 6.4-23. Median Number of Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

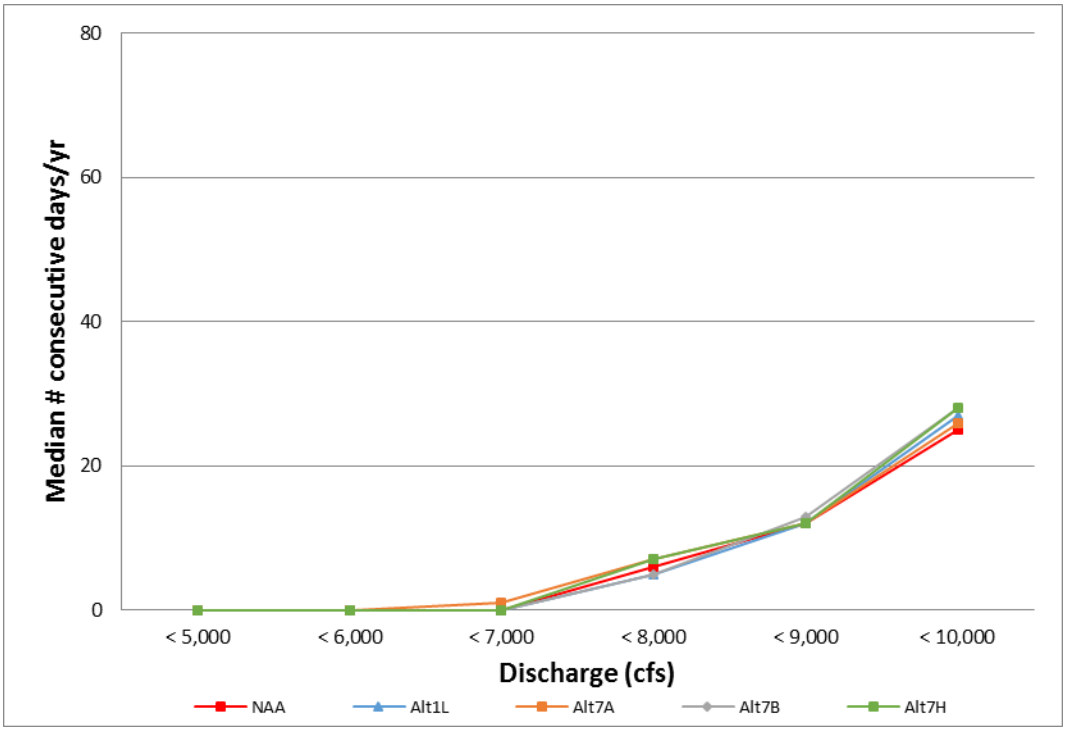


Figure 6.4-24. Median Number of Consecutive Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

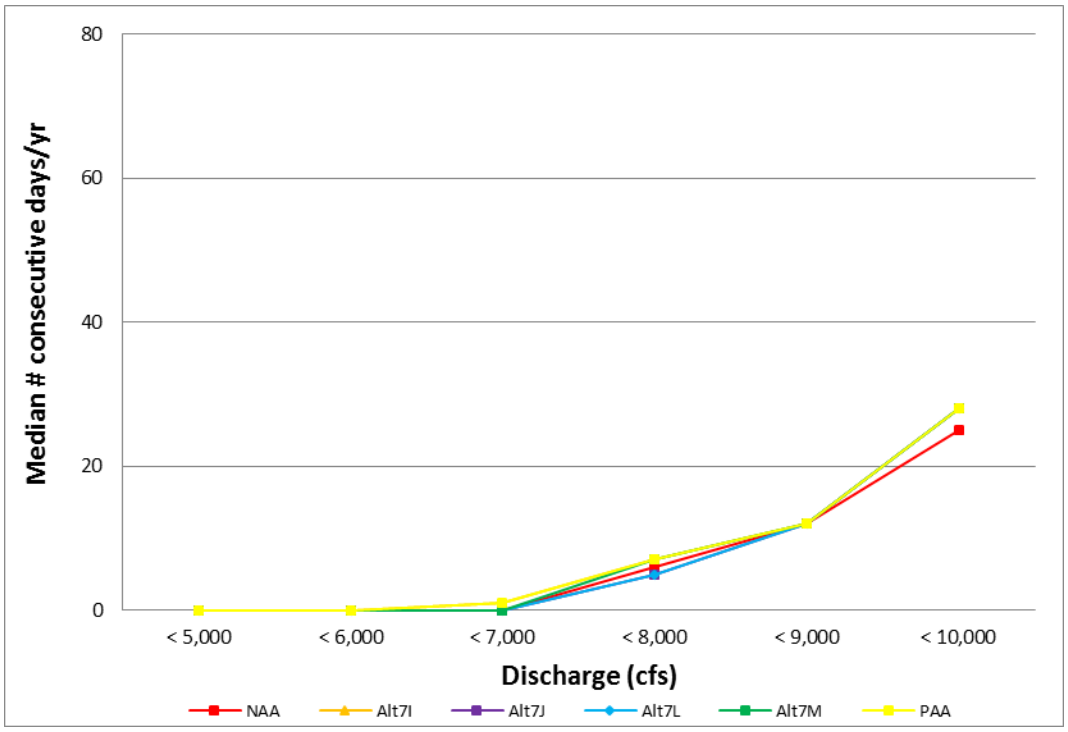


Figure 6.4-25. Median Number of Consecutive Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

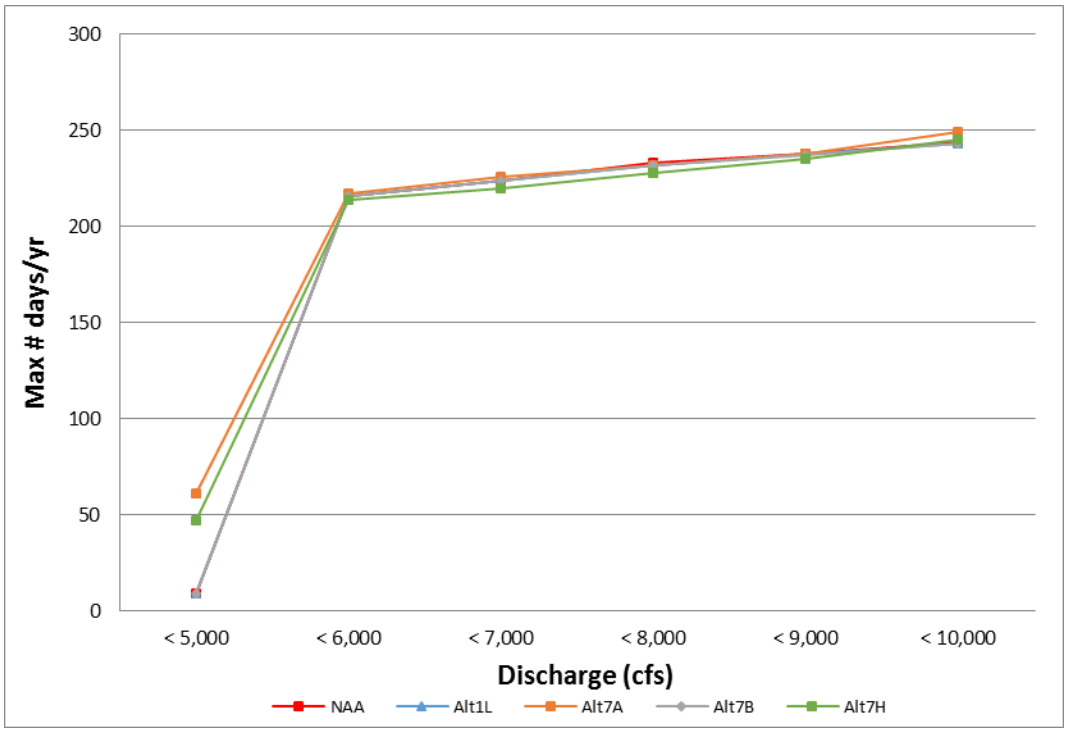


Figure 6.4-26. Maximum Number of Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

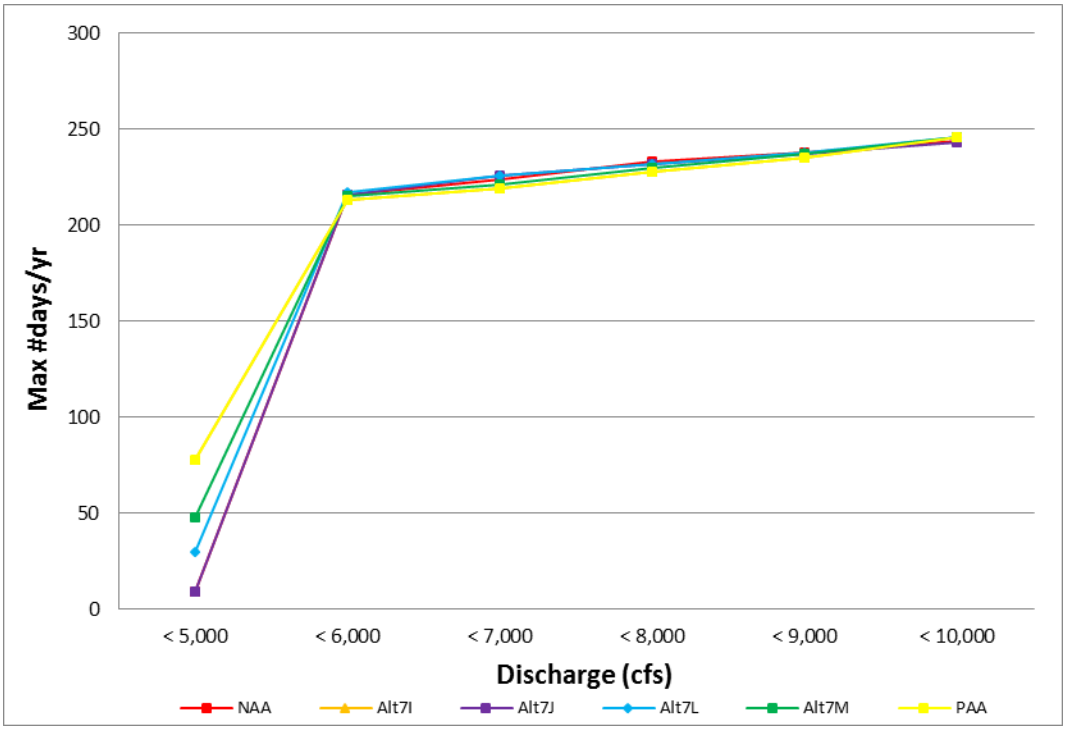


Figure 6.4-27. Maximum Number of Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

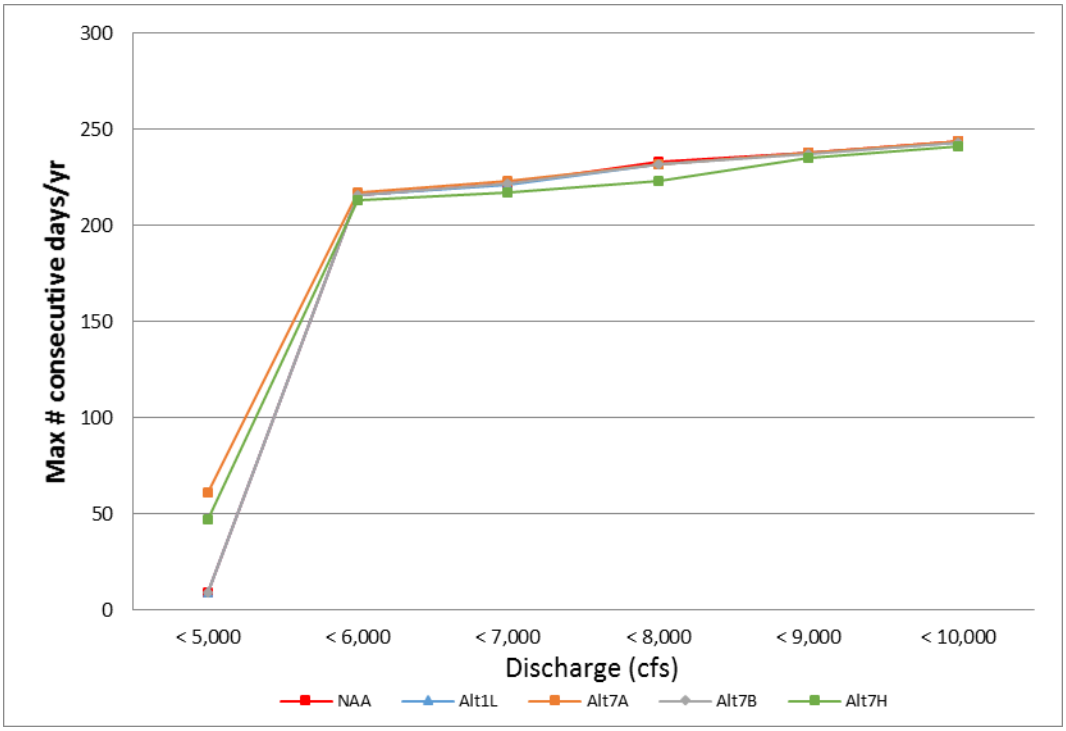


Figure 6.4-28. Maximum Number of Consecutive Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

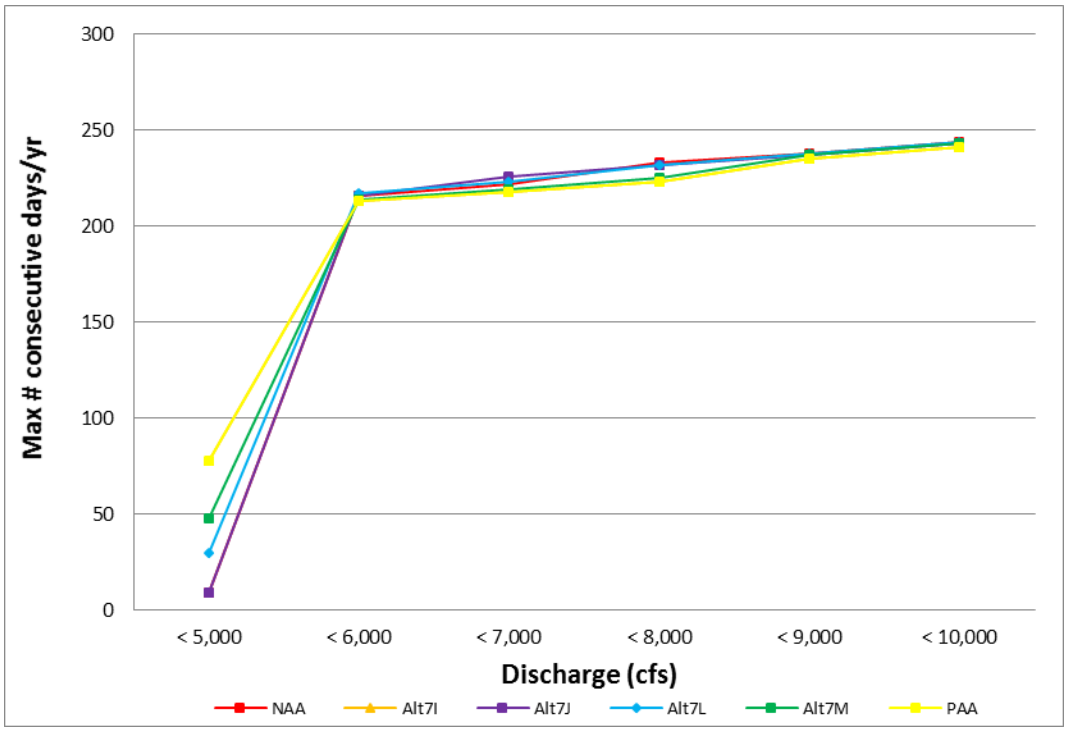


Figure 6.4-29. Maximum Number of Consecutive Days of Flows of < 5,000–10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

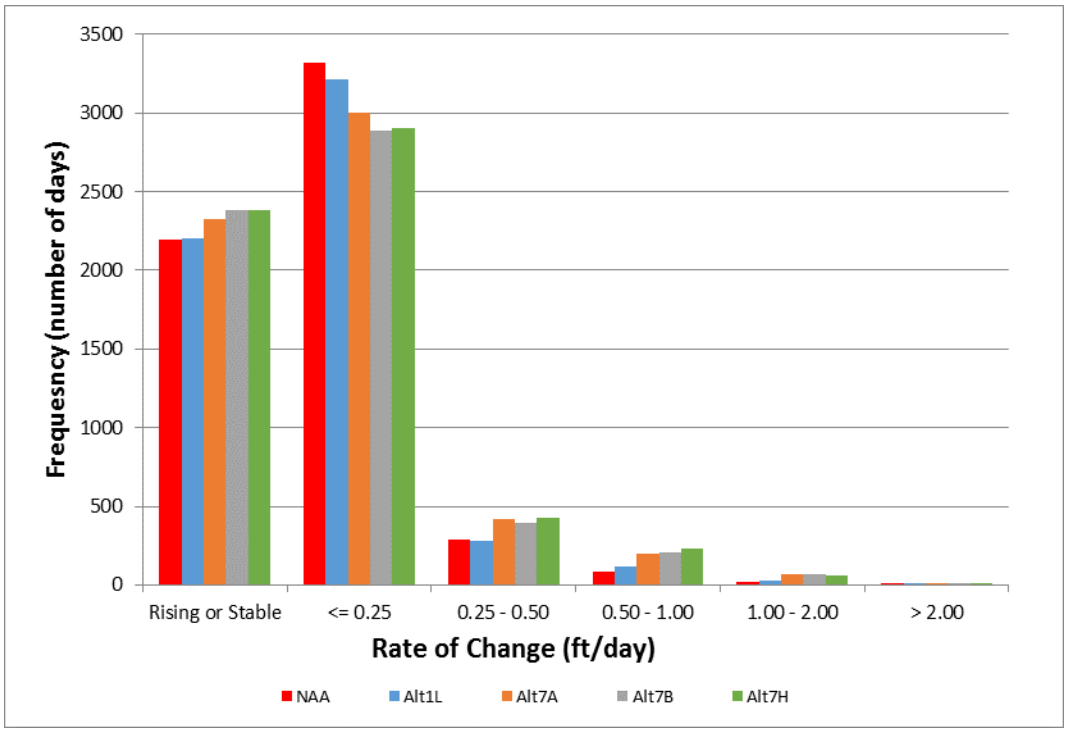


Figure 6.4-30. Frequency (# of days) of Daily Stage Changes (ft/day) over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

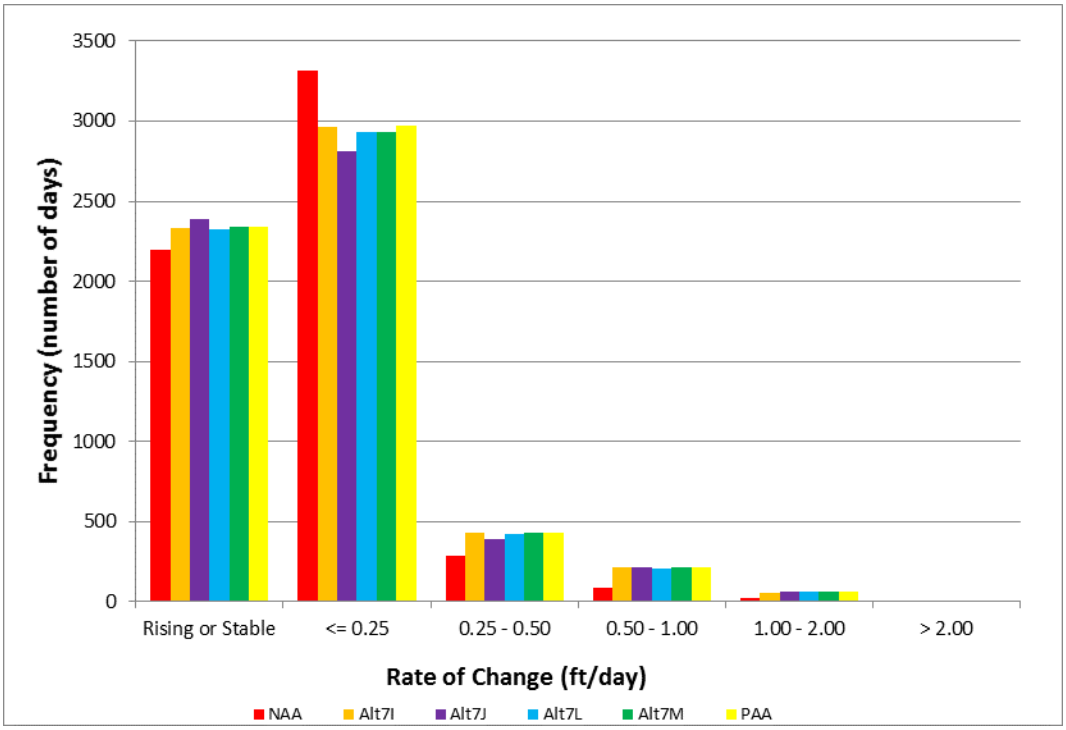


Figure 6.4-31. Frequency (# of days) of Daily Stage Changes (ft/day) over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

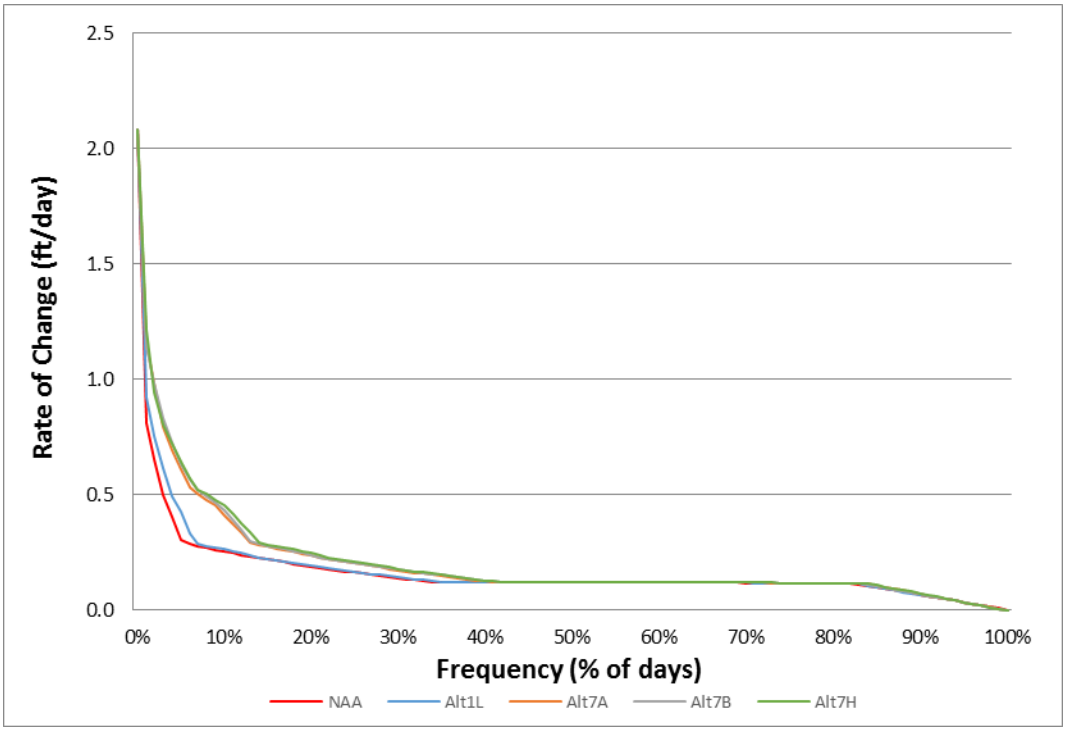


Figure 6.4-32. Frequency (% of days) of Daily Stage Changes (ft/day) when Releases at Woodruff Dam Are < 10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H.

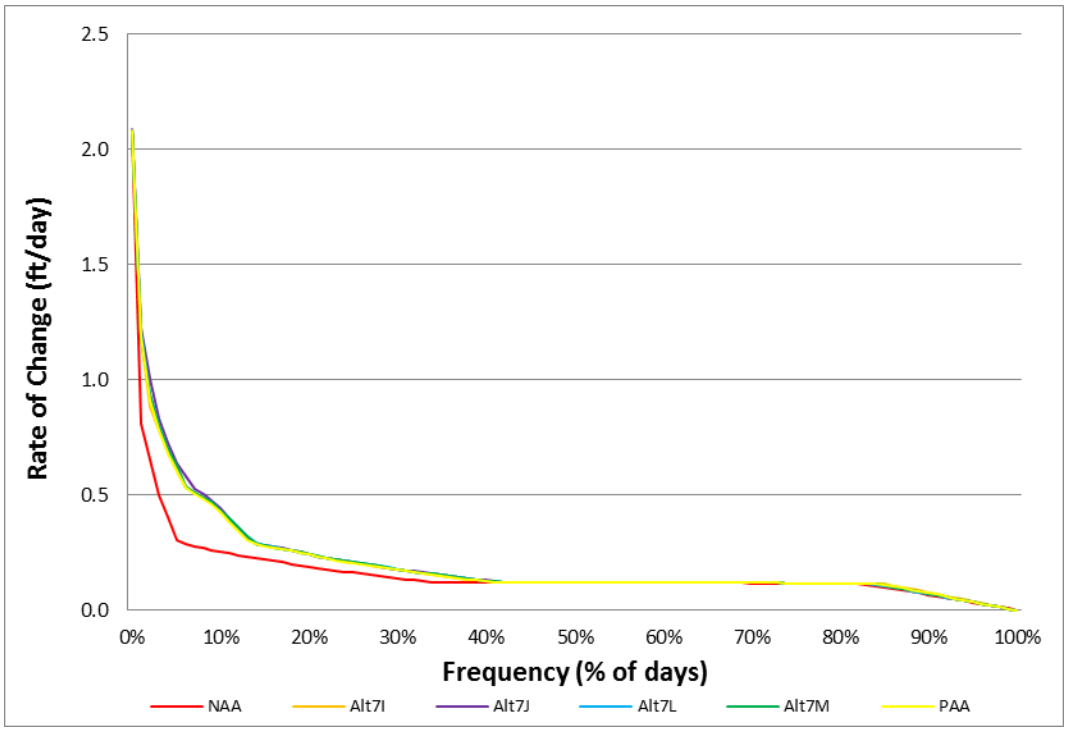


Figure 6.4-33. Frequency (% of days) of Daily Stage Changes (ft/day) When Releases at Woodruff Dam Are < 10,000 cfs over the Modeled Period of Record (1939–2011) for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA.

Table 6.4-11.
Summary of the Effects of Alternatives on Mussels

Mussels	NAA	Alt1L	Alt7A	Alt7B	Alt7H	Alt7I	Alt7J	PAA	Alt7L	Alt7M
Interannual frequency (% of yrs) of flow rates < 5,000–10,000 cfs	Baseline	Negligible/ No change	Slightly adverse	Negligible/ No change	Slightly adverse	Slightly adverse	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse
Median # of days/yr with flows < 10,000 cfs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly beneficial	Slightly beneficial	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change
Median # of consecutive days/yr with flows < 10,000 cfs	Baseline	Negligible/ No change	Negligible/ No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Maximum # of days/yr flows are < 5,000–10,000 cfs	Baseline	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Slightly beneficial	Negligible/ No change	Negligible/ No change
Maximum # of consecutive days/yr flows are < 5,000–10,000 cfs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Lowest daily flow/yr	Baseline	Negligible/ No change	Slightly adverse	Negligible/ No change	Slightly adverse	Slightly adverse	Negligible/ No change	Slightly adverse	Slightly adverse	Slightly adverse
Frequency (# of days) of daily stage changes (ft/day)	Baseline	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Frequency (% of days) of daily stage changes (ft/day) when releases at Woodruff Dam are < 10,000 cfs	Baseline	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Median fall rates when discharge < 10,000 cfs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change
Maximum fall rates when discharge < 10,000 cfs	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.

Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

Adverse—Any adverse impact is clearly detectable and would have an appreciable effect.

6.4.4.3.2.1 No Action Alternative

Under the NAA, fall rates along the Apalachicola River below Jim Woodruff Lock and Dam would remain relatively steady. Interannual frequency of flow rates greater than 5,000 cfs would occur in 92 percent of years. The maximum number of consecutive days on which flows would be less than 10,000 cfs would be 244. The maximum number of days per year when the flow would be less than 10,000 cfs would be 244. Flows would be less than 5,000 cfs for 9 days for both the maximum number of days per year and maximum consecutive days per year. The median number of consecutive days on which flows would be less than 10,000 cfs would be 25. The median number of days per year when the flow would be less than 10,000 cfs is 63. Flows would not be less than 5,000 cfs for either median number of

days per year or median consecutive days per year. The median fall rate would be 0.12 ft/day when discharge is less than 10,000 cfs. The maximum fall rate would be 2.08 ft/day when discharge is less than 10,000 cfs. The effects to mussels occur at the lower range of flows. The lowest range of flows for each year of the modeled period was above 5,000 cfs for the NAA. These data serve as the baseline for comparing the potential effects of the other alternatives.

River stage fall rates were examined because rapidly declining river stages have the potential to increase the risk of mussel exposure and stranding. Fall rates for the NAA and the aternatives below Jim Woodruff Lock and Dam when releases are less than 10,000 cfs indicate a high degree of similarity with the less than-0.25 ft/day category comprising more than 80 percent (the largest proportion) of fall rates. Any adverse effects of the alternatives resulting from the fall rates would likely occur between the fall rate range of 0.25–2.00 ft/day. The frequencies (number of days and percent of days) of the fall rate range of 0.25–2.00 ft/day for the NAA were compared across alternatives. Under the NAA, the number of days the stage change (ft/day) is between 0.25 and 2.00 over the modeled period would be 397. The percent of years the stage change is between 0.25 and 2.00 would be 10 percent. The frequencies of stage changes for the number of days and percent of years were similar between the NAA and all the alternatives; however, an adverse effect would be expected if the number of days of daily stage changes between 0.25 and 2.00 ft/day increased above the NAA by 5 percent or the percent of days was above 10 percent. All alternatives discussed in the following sections would have frequencies in the 0.25–2.00 ft/day stage change range above the NAA and would result in adverse effects.

6.4.4.3.2.2 Alternative 1L

Overall, implementing Alt1L would be expected to have negligible incremental effects on mussels compared to the NAA. Interannual frequency of flow rates greater than 5,000 cfs would be the same for Alt1L as for the NAA. Additionally, negligible effect would be expected from a decrease of 1 day in the median number of days per year with flows less than 10,000 cfs or an increase of 2 days in median number of consecutive days per year with flow rates less than 10,000 cfs. The lowest daily flow rate for each year over the modeled period was greater than 5,000 cfs for Alt1L and for the NAA. The maximum number of days per year and maximum consecutive days per year when the flow would be less than 10,000 cfs would decrease by 1 day for Alt1L compared to the NAA, and negligible effects would be expected. The median and maximum fall rates are the same for Alt1L as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 427, which is greater than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.3 Alternative 7A

Overall, implementing Alt7A would be expected to have negligible incremental impacts on mussels compared to the NAA. A slightly adverse effect would be expected from a decrease of 3 percent of years with flow rates greater than 5,000 cfs. Negligible effects would be expected from a decrease of 1 day in the median number of days per year with flows less than 10,000 cfs or an increase of 1 day in median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7A as for the NAA. The lowest daily flow rate for each year over the modeled period was less than 5,000 cfs for Alt7A compared to the NAA which was greater than 5,000 cfs, a slightly adverse effect would be expected. The maximum number of days per year when the flow would be less than 10,000 cfs would increase by 5 days compared to the NAA, and a slightly beneficial effect would be expected. The maximum consecutive days per year when the flow would be less than 10,000 cfs is the same for Alt7A as for the NAA. Additionally, the median and maximum fall rates are the same for Alt1L as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be

682, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.4 Alternative 7B

Overall, implementing Alt7B would be expected to have negligible incremental impacts on mussels compared to the NAA. Negligible effects would be expected from a decrease of 2 percent of years with flow rates greater than 5,000 cfs. Additionally, negligible effects would be expected from a decrease in 2 days in the median number of days per year with flows less than 10,000 cfs. A slightly beneficial effect would be expected from an increase of 3 days in the median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7B as for the NAA. The lowest daily flow rate for each year over the modeled period was greater than 5,000 cfs for Alt7B and for the NAA. The maximum number of days per year and maximum consecutive days per year when the flow would be less than 10,000 cfs would decrease by 1 day for Alt7B compared to the NAA, and negligible effects would be expected. Additionally, the median and maximum fall rates are the same for Alt7B as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 666, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.5 Alternative 7H

Overall, implementing Alt7H would be expected to have negligible incremental impacts on mussels compared to the NAA. A slightly adverse effect would be expected from a decrease of 3 percent of years with flow rates greater than 5,000 cfs. Slightly beneficial effects would be expected from an increase of 1 day in the median number of days per year with flows less than 10,000 cfs and an increase of 3 days in median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7H as for the NAA. The lowest daily flow rate for each year over the modeled period was less than 5,000 cfs for Alt7H compared to the NAA which was greater than 5,000 cfs, , and a slightly adverse effect would be expected. The maximum number of days per year when the flow would be less than 10,000 cfs would increase by 1 day compared to the NAA, and negligible effects would be expected. The maximum consecutive days per year when the flow would be less than 10,000 cfs would increase by 1 day for Alt7H as for the NAA, and negligible effect would be expected. Additionally, the median and maximum fall rates are the same for Alt1L as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 717, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.6 Alternative 7I

Overall, implementing Alt7I would be expected to have negligible incremental impacts on mussels compared to the NAA. A slightly adverse effect would be expected from a decrease of 3 percent of years with flow rates greater than 5,000 cfs. Slightly beneficial effects would be expected from a 1-day increase in the median number of days per year with flows less than 10,000 cfs and a 3-day increase in median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7I as for the NAA. The lowest daily flow rate for each year over the modeled period was less than 5,000 cfs for Alt7I compared to the NAA which was greater than 5,000 cfs, a slightly adverse effect would be expected. The maximum number of days per year when the flow would be less than 10,000 cfs would increase by 2 days compared to the NAA, and negligible effects would be

expected. The maximum consecutive days per year when the flow would be less than 10,000 cfs would decrease by 3 days for Alt7I compared to the NAA, and negligible effect would be expected. Additionally, the median and maximum fall rates are the same for Alt1L as for the NAA, and no effects would be expected. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 699, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.7 Alternative 7J

Overall, implementing Alt7J would be expected to have negligible incremental impacts on mussels compared to the NAA. Negligible effect would be expected from a decrease of 1 percent of years with flow rates greater than 5,000 cfs. Negligible effect would be expected from a decrease of 3 days in the median number of days per year with flows less than 10,000 cfs. A slightly beneficial effect would be expected from an increase of 3 days in the median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7J as for the NAA. The lowest daily flow rate for each year over the modeled period was greater than 5,000 cfs for Alt7J and for the NAA. The maximum number of days per year and maximum consecutive days per year when the flow would be less than 10,000 cfs would decrease by 1 day for Alt7J compared to the NAA, and negligible effects would be expected. Additionally, the median and maximum fall rates are the same for Alt7J as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 662, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.8 Alternative 7K (PAA)

In its BA for ESA section 7 consultation with USFWS, USACE determined that implementing the PAA would be expected to adversely affect the fat threeridge *(Amblema neislerii)*, purple bankclimber *(Elliptoideus sloatianus)*, and Chipola slabshell *(Elliptio chipolaensis)*, but would not be likely to adversely affect their designated critical habitats. A slightly adverse effect would be expected from a decrease of 3 percent of years with flow rates greater than 5,000 cfs. Slightly beneficial effects would be expected from an increase of 1 day for the median number of days per year with flows less than 10,000 cfs and an increase of 3 days for the median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for the PAA as for the NAA. The lowest daily flow rate for each year over the modeled period was less than 5,000 cfs for the PAA compared to the NAA which was greater than 5,000 cfs, a slightly adverse effect would be expected. The maximum number of days per year when the flow would be less than 10,000 cfs would increase by 2 days compared to the NAA, and negligible effects would be expected. The maximum consecutive days per year when the flow would be less than 10,000 cfs would decrease by 3 days for the PAA compared to the NAA, and negligible effect would be expected. Additionally, the median and maximum fall rates are the same for the PAA as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 699, which is more than a 5 percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

In its September 2016 BO, USFWS concurred with the USACE effects determination for the listed mussel species and their associated critical habitats. The BO provided an Incidental Take Statement, Reasonable and Prudent Measures (RPMs) to avoid and minimize incidental take, and Terms and Conditions for implementing the RPMs. These provisions in the BO are summarized in section 6.4.4

above, and the BO in its entirety is included in appendix J. Compliance with the RPMs and Terms and Conditions will assure that incidental take is limited to the extent possible.

6.4.4.3.2.9 Alternative 7L

Overall, implementing Alt7L would be expected to have negligible incremental impacts on mussels compared to the NAA. A slightly adverse effect would be expected from a decrease of 3 percent of years with flow rates greater than 5,000 cfs. Negligible effect would be expected from a decrease of 3 days in the median number of days per year with flows less than 10,000 cfs. A slightly beneficial effect would be expected from an increase of 3 days in the median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7L as for the NAA. The lowest daily flow rate for each year over the modeled period was less than 5,000 cfs for Alt7L compared to the NAA which was greater than 5,000 cfs, a slightly adverse effect would be expected. The maximum number of days per year when the flow would be less than 10,000 cfs would increase by 2 days compared to the NAA, and negligible effects would be expected. The maximum consecutive days per year when the flow would be less than 10,000 cfs is the same for Alt7L as for the NAA. Additionally, the median and maximum fall rates are the same for Alt7L as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 690, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

6.4.4.3.2.10 Alternative 7M

Overall, implementing Alt7M would be expected to have negligible incremental impacts on mussels compared to the NAA. A slightly adverse effect would be expected from a decrease of 3 percent of years with flow rates greater than 5,000 cfs. The median number of days per year with flows less than 10,000 cfs would be the same for Alt7M as for the NAA. A slightly beneficial effect would be expected from an increase of 3 days in the median number of consecutive days per year with flow rates less than 10,000 cfs. The median and maximum fall rates are the same for Alt7M as for the NAA. The lowest daily flow rate for each year over the modeled period was less than 5,000 cfs for Alt7M compared to the NAA which was greater than 5,000 cfs, a slightly adverse effect would be expected. The maximum number of days per year when the flow would be less than 10,000 cfs would increase by 2 days compared to the NAA, and negligible effects would be expected. The maximum consecutive days per year when the flow would be less than 10,000 cfs would decrease by 1 day for Alt7M compared to the NAA, and negligible effect would be expected. Additionally, the median and maximum fall rates are the same for Alt7M as for the NAA. The number of days of daily stage changes between 0.25 and 2.00 ft/day would be 702, which is more than a 5-percent increase from the NAA, and an adverse effect would be expected. Additionally, the percent of years of daily stage changes between 0.25 and 2.00 ft/day is more than 10 percent higher than for the NAA, and an adverse effect would be expected.

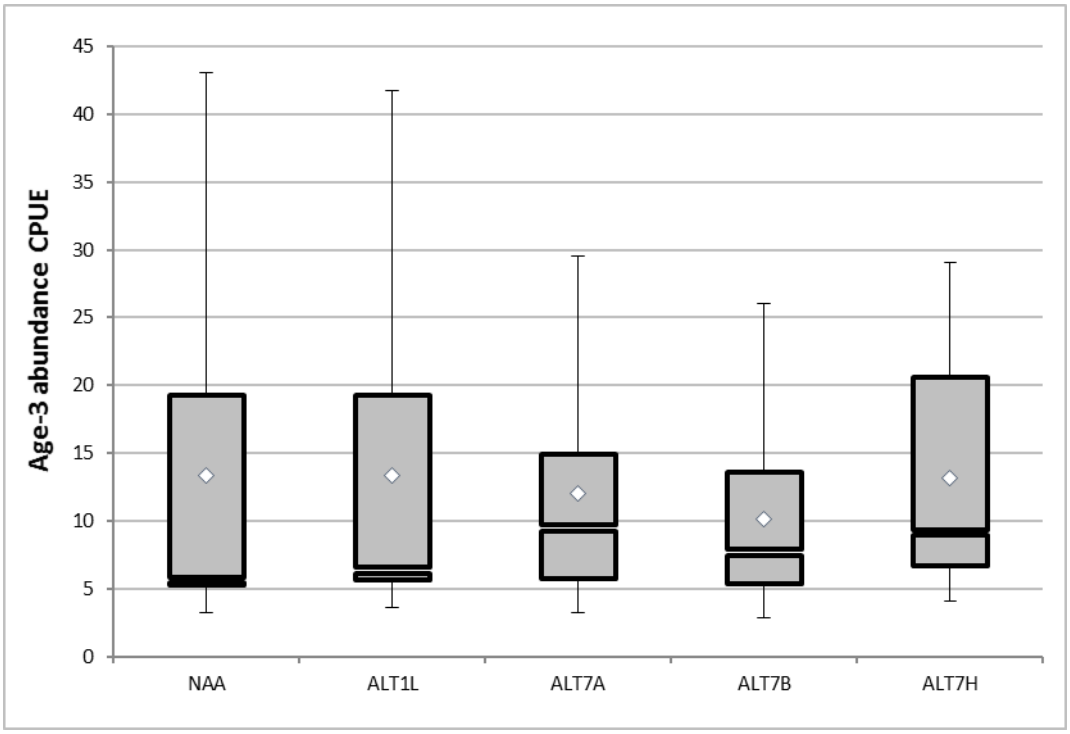
6.4.4.3.3 Shoal Bass

Shoal bass (*Micropterus cataratae*) is a fairly recently described species in the centrarchid (sunfish) family and is endemic to the ACF Basin (Williams and Burgess 1999). Shoal bass frequently occur in shoals (commonly co-occurring with other species) over rocky sediments in water exceeding 0.66 ft per second. Recruitment of age-3 bass is of particular interest since that cohort has survived prevalent river conditions and has the potential to be stocked to support the recreational fishery. Recruitment success is largely dependent on surface water and spring temperature and is highly correlated with discharge. Therefore, results from both the HEC-5Q and HEC-ResSim modeling efforts were used to evaluate the effects of various alternatives using the Chattahoochee River Shoal Bass Recruitment Performance

Measure (CRSBPM) defined by USFWS (USFWS 2013). The median age-3 shoal bass abundance over the modeled period for each alternative was compared to the NAA and determined to have the following impacts:

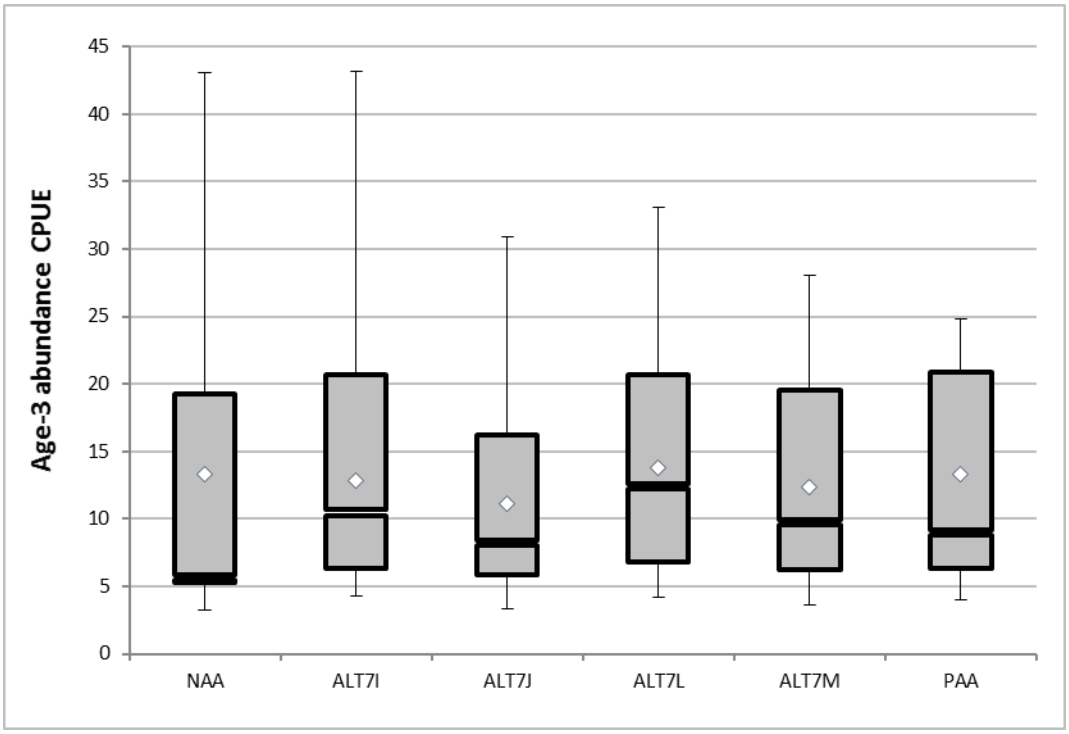
- Negligible impact if the median age-3 shoal bass abundance was between 5–6
- A slightly adverse impact if the median age-3 shoal bass abundance was between 4–5
- An adverse impact if the median age-3 shoal bass abundance was between 1–4
- A substantial adverse impact if the median age-3 shoal bass abundance was < 1
- A slightly beneficial impact if the median age-3 shoal bass abundance was between 6–7
- A beneficial impact if the median age-3 shoal bass abundance was between 7–10
- A substantially beneficial impact if the median age-3 shoal bass abundance was > 10

Figure 6.4-34, Figure 6.4-35, and Table 6.4-12 present model results for the catch per unit effort of age-3 shoal bass for the NAA and the alternatives.



Note: CPUE = catch per unit effort.

Figure 6.4-34. Shoal Bass Age-3 Abundance at Atlanta, GA, for the NAA and Alt1L, Alt7A, Alt7B, and Alt7H (min; 25th and 75th percentiles; median; max; and mean [represented by diamond]).



Note: CPUE = catch per unit effort.

Figure 6.4-35. Shoal Bass Age-3 Abundance at Atlanta, GA, for the NAA and Alt7I, Alt7J, Alt7L, Alt7M, and the PAA (min; 25th and 75th percentiles; median; max; and mean [represented by diamond])

Table 6.4-12.
Median Shoal Bass Age-3 Abundance at Atlanta, GA

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Shoal bass recruitment	5.6	6.3	9.4	7.6	9.1	10.4	8.2	9.0	12.4	9.7

Table 6.4-13.
Summary of the Effects of Chattahoochee River Shoal Bass Recruitment Performance Measures Applied at Atlanta, GA

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Shoal bass recruitment	Baseline	Slightly beneficial	Beneficial	Beneficial	Beneficial	Substant-ially beneficial	Beneficial	Beneficial	Substant-ially beneficial	Beneficial

Notes:
Beneficial—Beneficial impact if the median age-3 shoal bass abundance is between 7–10.
Substantially beneficial—Substantially beneficial impact if the median age-3 shoal bass abundance was > 10.

6.4.4.3.3.1 No Action Alternative

No effects on shoal bass recruitment would occur under the NAA, which represents the baseline for comparison of the effect of the other nine alternatives.

6.4.4.3.3.2 Alternative 1L

A slightly beneficial effect would be expected on shoal bass recruitment under Alt1L. The population of age-3 fish under Alt1L would be slightly higher than under the NAA.

6.4.4.3.3.3 Alternative 7A

A beneficial effect on shoal bass recruitment would be expected under Alt7A. Recruitment would be higher under Alt7A than under the NAA.

6.4.4.3.3.4 Alternative 7B

A beneficial effect on shoal bass recruitment would be expected under Alt7B. Recruitment would be higher under Alt7B than under the NAA or Alt1L.

6.4.4.3.3.5 Alternative 7H

A beneficial effect on shoal bass recruitment would be expected under Alt7H. Recruitment would be higher under Alt7H than under the NAA or Alt7B, but slightly less than under Alt7A.

6.4.4.3.3.6 Alternative 7I

A substantially beneficial effect on shoal bass recruitment would be expected under Alt7I. Recruitment would be higher under Alt7I than under NAA and any of the discussed alternatives.

6.4.4.3.3.7 Alternative 7J

A beneficial effect on shoal bass recruitment would be expected under Alt7J. Recruitment would be higher under Alt7J than under the NAA or Alt7B.

6.4.4.3.3.8 Alternative 7K (PAA)

A beneficial effect on shoal bass recruitment would be expected under the PAA. Recruitment would be higher under the PAA than under the NAA and Alt7J.

6.4.4.3.3.9 Alternative 7L

A substantially beneficial effect on shoal bass recruitment would be expected under Alt7L. Recruitment would be higher under Alt7L than under the NAA or any of the other alternatives except Alt7I.

6.4.4.3.3.10 Alternative 7M

A beneficial effect on shoal bass recruitment would be expected under Alt7M. Recruitment would be higher under Alt7M than under the NAA or any of the other alternatives except Alt7I and Alt7L.

6.4.5 Fish and Wildlife Management Facilities

6.4.5.1 Eufaula National Wildlife Refuge

The differences between the mean daily water surface elevations at Walter F. George Lake are negligible on the operation of the Eufaula National Wildlife Refuge (NWR) across all alternatives and are discussed

in section 6.1.1.1.3. Therefore, negligible change would be expected to the Eufaula NWR or the biological communities within it under any of the alternatives, as shown in Table 6.4-14.

Table 6.4-14.
Summary of the Effects of Alternatives on Eufaula National Wildlife Refuge

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Eufaula NWR	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.4.5.2 Fish Hatcheries

Four major fish hatcheries are located in the ACF Basin. The Buford Trout Hatchery is the only one that relies on surface flows for its operations and is the largest user of water. Changes in flow on the Chattahoochee River over the period of record (1939–2011) are negligible between alternatives, and would not be expected to affect operations at that hatchery (see section 6.1.1.2). No changes would be expected at any of the hatcheries under any of the alternatives considered.

6.5 Socioeconomics

6.5.1 Municipal and Industrial Water Supply

This section provides a summary of the effects of M&I water supply (see Table 6.5-1). The water supply needs for Metro Atlanta were revised by the State of Georgia and submitted to USACE in December 2015 during the public comment period for the draft EIS. The revised water supply needs provided to USACE by Georgia are provided in appendix B, the *Water Supply Storage Assessment Report*. Details on the effects of the alternatives with respect to M&I water supply are discussed below.

Table 6.5-1.
Summary of the Effects of Alternatives on M&I Water Supply

Water supply withdrawals	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
From Lake Lanier	Baseline	Negligible/ No change	Negligible/ No change	Substant-ially adverse	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial
From Metro Atlanta, downstream of Buford Dam	Baseline	Substant-ially beneficial	Negligible/ No change	Negligible/ No change	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.
Substantially adverse—Any adverse impact would result in a highly noticeable effect.
Substantially beneficial—Any beneficial impact would result in a highly noticeable effect.

Lake Lanier withdrawals currently occur without the benefit of contractual arrangements that would ensure the long-term availability of any amount of withdrawal, except for 20 mgd under existing relocation contracts. Some alternatives would limit the withdrawals from Lake Lanier to 20 mgd, leaving most communities currently withdrawing from Lake Lanier without any reasonably available water supply source. That effect would be "substantially adverse" from the standpoint of M&I water supply.

Other alternatives provide for reallocation of some amount of Lake Lanier conservation storage to the water supply purpose and support withdrawal amounts in excess of the current amounts. Additionally, each of the reallocation alternatives would entail the execution of water supply agreements that include a perpetual right to use the amount of storage reallocated to the water supply purpose. Compared to the NAA, any of those alternatives could be considered "substantially beneficial," even though the reallocated storage might not fully satisfy the State of Georgia's request. Downstream of Buford Dam, any alternatives that provide for increased withdrawals above the NAA would be considered "substantially beneficial."

6.5.1.1 Water Supply Withdrawals from Lake Lanier

6.5.1.1.1 No Action Alternative

Under the NAA, 128 mgd of water would be withdrawn from Lake Lanier, representing the current level of direct withdrawals. That amount, however, is less than the total 242 mgd withdrawal total from Lake Lanier included in the State of Georgia's 2015 request to meet projected 2050 demands. The NAA assumes a deficit of 114 mgd from the requested amount. Other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.2 Alternative 1L

Alt1L assumes 128 mgd would be withdrawn from Lake Lanier, which represents the current level of direct withdrawals from the lake. As with the NAA, other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.3 Alternative 7A

Alt7A assumes 128 mgd would be withdrawn from Lake Lanier, which represents the current level of direct withdrawals from the lake. As with the NAA, other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.4 Alternative 7B

Alt7B assumes 20 mgd would be withdrawn from Lake Lanier, which represents the direct water withdrawals covered under relocation agreements. As with the NAA, other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.5 Alternative 7H

Under Alt7H, 185 mgd of water would be withdrawn from Lake Lanier, including 20 mgd for relocation contracts and reallocation of storage to support withdrawal of an another 165 mgd. An additional 40 mgd would be provided by Glades Reservoir which, together with a reallocation to support a withdrawal of 165 mgd, would satisfy a substantial portion (76 percent) of Georgia's stated 2050 water supply need. The gross withdrawal of an additional 165 mgd would require a reallocation of about 188,910 acre-feet (ac-ft) of storage at a first cost of about $45.0 million (September 2016FY 2016 price level) (see appendix B for details).

Note: Alt7H was the PAA in the draft EIS, but is no longer the PAA since Georgia's revised 2015 water supply request was received by USACE. Georgia's 2015 request eliminated Glades Reservoir from consideration and reduced the projected 2050 water demands for Metro Atlanta. Alt7H was retained in the

final EIS, however, for continuity and to enable comparison to the additional alternatives reflecting the 2015 water supply request.

6.5.1.1.6 Alternative 7I

Under Alt7I, 225 mgd would be withdrawn from Lake Lanier, including 20 mgd for relocation contracts. The gross withdrawal of 205 mgd would require a reallocation of about 234,706 ac-ft of storage at a first cost of about $55.9 million (September 2016[FY 2016] price level) (see appendix B for details). Other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.7 Alternative 7J

Alt7J assumes 20 mgd would be withdrawn from Lake Lanier, which represents the direct water withdrawals covered under relocation agreements. As with the NAA, other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.8 Alternative 7K (PAA)

Under Alt7K, 242 mgd would be withdrawn from Lake Lanier, including 20 mgd for relocation contracts. The gross withdrawal of 222 mgd would require a reallocation of about 254,170 ac-ft of storage at a first cost of about $60.5 million (September 2016[FY 2016] price level) (see appendix B for details). Under the PAA, the specified need in the State of Georgia's 2015 revised request would be met.

6.5.1.1.9 Alternative 7L

Under Alt7L, 128 mgd would be withdrawn from Lake Lanier, which represents the current level of direct withdrawals from the lake. As with the NAA, other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.1.10 Alternative 7M

Under Alt7H, 185 mgd would be withdrawn from Lake Lanier, including 20 mgd for relocation contracts. That gross withdrawal of 165 mgd would require a reallocation of about 188,910 ac-ft of storage at a first cost of about $45.0 million (September 2016[FY 2016] price level) (see appendix B for details). Other alternatives would need to be implemented to accommodate the remainder of the stated need.

6.5.1.2 Metro Atlanta Water Supply Withdrawals Downstream of Buford Dam

6.5.1.2.1 No Action Alternative

Under the NAA, releases from Buford Dam would be sufficient to support gross water withdrawals of 277 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the current level of withdrawals from the Chattahoochee River serving Metro Atlanta, which would be insufficient to meet the estimated 2050 need of 379 mgd. Other sources of supply would be required to satisfy the unmet need, which would increase the costs of water supply.

6.5.1.2.2 Alternative 1L

Under Alt1L, releases from Buford Dam would be sufficient to support gross water withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the requested 2050 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta; therefore, Alt1L would have a substantially beneficial socioeconomic effect.

6.5.1.2.3 Alternative 7A

Under Alt7A, releases from Buford Dam would be sufficient to support gross water withdrawals of 277 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. There would be negligible change from the NAA. That amount represents the current level of direct withdrawals from Chattahoochee River serving Metro Atlant and would be insufficient to meet the estimated 2050 need of 379 mgd. Other sources of supply would be required to satisfy the unmet need, which would increase the costs of water supply.

6.5.1.2.4 Alternative 7B

Under Alt7B, releases from Buford Dam would be sufficient to support gross water withdrawals of 277 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. There would be negligible change from the NAA. That amount represents the current level of direct withdrawals from Chattahoochee River serving Metro Atlanta and would be insufficient to meet the estimated 2050 need of 379 mgd. Other sources of supply would be required to satisfy the unmet need, which would increase the costs of water supply.

6.5.1.2.5 Alternative 7H

Under Alt7H, 408 mgd would be released from Buford Dam to support withdrawals out of the Chattahoochee River below Buford Dam, which represents the requested 2040 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta (per the 2013 Georgia request); therefore, there would be a substantially beneficial socioeconomic effect. Alt7H was based on Georgia's 2013 request, which was the basis for alternatives analyzed in the draft EIS. Alt7H has been superceded by Georgia's 2015 request and is no longer under consideration as the PAA. Alt7H has been retained in the final EIS, however, for continuity and comparison purposes.

6.5.1.2.6 Alternative 7I

Under Alt7I, releases from Buford Dam would be sufficient to support gross water withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the requested 2050 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta; therefore, Alt7I would result in a substantially beneficial socioeconomic effect.

6.5.1.2.7 Alternative 7J

Under Alt7J, releases from Buford Dam would be sufficient to support gross water withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the requested 2050 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta; therefore, Alt7J would result in a substantially beneficial socioeconomic effect.

6.5.1.2.8 Alternative 7K (PAA)

Under the PAA, releases from Buford Dam would be sufficient to support gross water withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the requested 2050 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta; therefore, the PAA would result in a substantially beneficial socioeconomic effect.

6.5.1.2.9 Alternative 7L

Under Alt7L, releases from Buford Dam would be sufficient to support gross water withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the requested 2050 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta; therefore, Alt7L would result in a substantially beneficial socioeconomic effect.

6.5.1.2.10 Alternative 7M

Under Alt7M, releases from Buford Dam would be sufficient to support gross water withdrawals of 379 mgd from the Chattahoochee River between Buford Dam and Peachtree Creek, consistent with other operational requirements. That amount represents the requested 2050 water supply need of direct withdrawals from Chattahoochee River serving Metro Atlanta; therefore, Alt7M would result in a substantially beneficial socioeconomic effect.

6.5.2 Navigation

This section provides a summary of the effects of navigation, an authorized purpose of the ACF Basin system (Table 6.5-2). Channel availability was modeled for both 7-ft and 9-ft channels, which was measured by evaluating the modeled flow at the Blountstown, Florida, gage. A 7-ft channel would be considered "available" with a flow greater than 16,200 cfs. A 9-ft channel would be considered "available" with a flow greater than 20,600 cfs.

Table 6.5-2.
Summary of the Effects of Alternatives on Navigation

Channel	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
7-ft	Baseline	Negligible/ No change	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial	Substant-ially beneficial
9-ft	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:

Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

Substantially beneficial—Any beneficial impact would result in a highly noticeable effect.

Increasing the reliability of navigation in the ACF system by including operational measures to provide sufficient flows to support a defined, albeit limited, navigation season was intended to provide the opportunity for commercial navigation to occur, not to ensure that some sustainable level of commercial navigation would necessarily return to the system. While the conditions conducive to the use of the navigation channel would likely improve under several alternatives, individual shippers would be responsible for making the decision to use the increased channel availability. Use of the waterway under

these alternatives would likely be shipment-specific and opportunistic, and not subject to traditional navigation benefit estimation techniques.

6.5.2.1 No Action Alternative

Under the NAA, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May. A 7-ft channel would be available 20.5 percent of the time during that period.

6.5.2.2 Alternative 1L

Under Alt1L, as under the NAA, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May. Also as under the NAA, a 7-ft channel would be available 20.5 percent of the time during that period.

6.5.2.3 Alternative 7A

Under Alt7A, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May (the same as under the NAA). A 7-ft channel would be available 42.5 percent of the time during that period, which represents a 22-percent difference over the NAA. Alt7A could have a beneficial effect on commercial navigation in the system.

6.5.2.4 Alternative 7B

Under Alt7B, a 9-ft channel would be available 4.1 percent of the time during the period of record between January and May, which is slightly more than under the NAA. A 7-ft channel would be available 43.8 percent of the time during that period, which represents a 23.3-percent difference over the NAA. Alt7B could have a beneficial effect on commercial navigation in the system.

6.5.2.5 Alternative 7H

Under Alt7H, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May (the same as under the NAA). A 7-ft channel would be available 42.5 percent of the time during that period,which represents a 22-percent difference over the NAA. Alt7H could have a beneficial effect on commercial navigation in the system.

6.5.2.6 Alternative 7I

Under Alt7I, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May (the same as under the NAA). A 7-ft channel would be available 42.5 percent of the time during that period, which represents a 22-percent difference over the NAA. Alt7I could have a beneficial effect on commercial navigation in the system.

6.5.2.7 Alternative 7J

Under Alt7J, a 9-ft channel would be available 4.1 percent of the time during the period of record between January and May, which is slightly more than the NAA. A 7-ft channel would be available 43.8 percent of the time during the period of record from January to May, which represents a 23.3-percent difference over the NAA. Alt7J could have a beneficial effect on commercial navigation in the system.

6.5.2.8 Alternative 7K (PAA)

Under the PAA, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May (the same as under the NAA). A 7-ft channel would be available 42.5 percent of the time during that period, which represents a 22-percent difference over the NAA. The PAA could have a beneficial effect on commercial navigation in the system.

6.5.2.9 Alternative 7L

Under Alt7L, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May (the same as under the NAA). A 7-ft channel would be available 42.5 percent of the time during that period, which represents a 22-percent difference over the NAA. Alt7L could have a beneficial effect on commercial navigation in the system.

6.5.2.10 Alternative 7M

Under Alt7M, a 9-ft channel would be available 2.7 percent of the time during the period of record between January and May (the same as under the NAA). A 7-ft channel would be available 42.5 percent of the time during that period, which represents a 22-percent difference over the NAA. Alt7M could have a beneficial effect on commercial navigation in the system.

6.5.3 Hydroelectric Power Generation

The hydropower analysis was performed over the entire ACF Basin system, including both federal and private generation plants. The analysis is discussed in detail in the *Water Supply Storage Assessment Report* in appendix B of this final EIS. Table 6.5-3 displays the energy and capacity values for each alternative based on October 2016 (FY2017) price levels and FY 2017 interest rate over a 50-year period of analysis, and Table 6.5-4 summarizes the effect of various alternatives on hydroelectric power generation.

Table 6.5-3.
Energy and Capacity Values for Each Alternative
(October 2016 [FY2017] price levels and FY 2017 interest rate and 50-year period of analysis)

Alternative	Energy Value	Capacity Value	Total Value	Change in Value Compared to the NAA
NAA	$94,971,114	$76,675,023	$171,646,137	$0
Alt1L	$95,523,621	$76,813,043	$172,336,664	$690,527
Alt7A	$94,784,501	$76,536,270	$171,320,772	($325,365)
Alt7B	$96,678,574	$76,753,023	$173,431,597	$1,785,460
Alt7H	$94,462,701	$76,569,530	$171,032,231	($613,907)
Alt7I	$94,343,573	$76,484,658	$170,828,231	($817,906)
Alt7J	$97,248,157	$76,881,293	$174,129,450	$2,483,313
PAA	$94,259,411	$76,471,479	$170,730,890	($915,247)
Alt7L	$95,364,366	$76,728,440	$172,092,807	$446,669
Alt7M	$94,905,078	$76,569,556	$171,474,634	($171,503)

Table 6.5-4.
Summary of the Effects of Alternatives on Hydroelectric Power Generation

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Hydroelectric Power Generation	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.5.3.1 No Action Alternative

Under the NAA, the total energy and capacity benefit is $171.6 million, which represents the current system energy value.

6.5.3.2 Alternative 1L

Under Alt1L, the total energy and capacity benefit increase is $691,000 when compared to the NAA, which represents less than a 1-percent increase over the NAA.

6.5.3.3 Alternative 7A

Under Alt7A, the total energy and capacity benefit decrease is $325,000 when compared to the NAA, which represents less than a 1-percent decrease over the NAA.

6.5.3.4 Alternative 7B

Under Alt7B, the total energy and capacity benefit increase is $1.79 million when compared to the NAA, which represents about a 1-percent increase over the NAA.

6.5.3.5 Alternative 7H

Under Atl7H, the total energy and capacity benefit decrease is $614,000 when compared to the NAA, which represents less than a 1-percent decrease over the NAA.

6.5.3.6 Alternative 7I

Under Atl7I, the total energy and capacity benefit decrease is $818,000 when compared to the NAA, which represents less than a 1-percent decrease over the NAA.

6.5.3.7 Alternative 7J

Under Alt7J, the total energy and capacity benefit increase is $2.48 million when compared to the NAA, which represents about a 1.4-percent increase over the NAA.

6.5.3.8 Alternative 7K (PAA)

Under the PAA, the total energy and capacity benefit decrease is $915,000 when compared to the NAA, which represents less than a 1-percent decrease over the NAA.

6.5.3.9 Alternative 7L

Under Atl7L, the total energy and capacity benefit increase is $447,000 when compared to the NAA, which represents less than a 1-percent increase over the NAA.

6.5.3.10 Alternative 7M

Under Atl7M, the total energy and capacity benefit decrease is $172,000 when compared to the NAA, which represents less than a 1-percent decrease over the NAA.

6.5.4 Agricultural Water Supply

Agricultural water withdrawals occur in the lower half of the Chattahoochee River system and the Flint River. Modeling assumed that the current level of agricultural water withdrawals would be supported in the ACF Basin by using it as an input to the HEC-ResSim operations model. Therefore, little to no changes to agricultural water supply would be assumed from the alternatives (see Table 6.5-5).

Table 6.5-5.
Summary of the Effects of Alternatives on Agricultural Water Supply

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Agricultural water supply	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.5.5 Oyster Industry of Apalachicola Bay

The change in flows in the Apalachicola River can be used as a metric for potential effects to the oyster populations in Apalachicola Bay. See section 6.1.1.2.5 for a discussion of changes in median and low flows in the Apalachicola River, including presenting information showing that flow conditions in the Apalachicola River downstream from Jim Woodruff Lock and Dam under the proposed alternatives do not differ appreciably from flows under the NAA. Consequently, differences in freshwater inflow into Apalachicola Bay among the alternatives would not be expected (Table 6.5-6).

Table 6.5-6.
Summary of the Effects of Alternatives on the Oyster Industry in Apalachicola Bay

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Oyster Industry in Apalachicola Bay	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.5.6 Flood Risk Management

A constraint on the Master Manual update process included no reduction to the current level of flood risk management, which is discussed in section 2.6.5. The effect of various alternatives on flood risk management is defined in Table 6.5-7.

Table 6.5-7.
Summary of the Effects of Alternatives on Flood Risk Management

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Flood risk management	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible / No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.5.6.1 No Action Alternative

Under the NAA, flood risk management operations would remain unchanged from those currently employed, which are achieved by storing damaging floodwater. That reduces downstream river levels below those that would have occurred without the dams in place. Of the five USACE reservoirs, only the Buford Dam (Lake Lanier) and West Point Dam and Lake projects were designed with space to store floodwaters.

6.5.6.2 Alternative 1L

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.3 Alternative 7A

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.4 Alternative 7B

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.5 Alternative 7H

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.6 Alternative 7I

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.7 Alternative 7J

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.8 Alternative 7K (PAA)

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.9 Alternative 7L

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.6.10 Alternative 7M

Since no guide curves are modified under this alternative, it would not likely have any beneficial or adverse influence on flood risk management in the ACF Basin. The level of flood risk would be the same as under the NAA.

6.5.7 Recreation

National Economic Development (NED) recreation benefits were used as the basis for comparing alternatives. The methodology used for computing the benefits is described in appendix M, together with a detailed presentation of the resulting benefits. Table 6.5-8 summarizes the economic effects of various alternatives on recreation. The recreation benefits were computed using the unit day values (updated to September 2016 [FY2016] price levels) and interest rate for FY 2017 of 2.875 percent over a 50-year period of analysis.

Table 6.5-8.
Summary of the Effects of Alternatives on Recreation

Reservoir	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Lake Lanier	Baseline	Slightly Adverse	Slightly beneficial	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly adverse
West Point Lake	Baseline	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Walter F. George Lake	Baseline	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse

Notes:

Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.

Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

6.5.7.1 Lake Lanier

The average annual NED recreation benefits for the NAA and the nine other alternatives are shown in Table 6.5-9. As shown in the table, the benefits for any alternative vary less than 0.7 percent. The PAA would have average annual benefits of $79,363,000, or only 0.27 percent less than the NAA.

Table 6.5-9.
Lake Lanier Recreation Benefit Summary
(September 2016 [FY2016] price levels, FY 2017 interest rate and 50-year period of analysis)

Alternative	Annualized Recreation Value ($)	Annualized Change vs. without Project	Percent Change
NAA	$79,579,000	$0	0.00%
Alt1L	$79,406,000	($173,000)	-0.22%
Alt7A	$79,699,000	$119,900	0.15%
Alt7B	$80,131,000	$551,300	0.69%
Alt7H	$79,336,000	($243,200)	-0.31%
Alt7I	$79,384,000	($195,000)	-0.25%
Alt7J	$80,052,000	$472,600	0.59%
PAA	$79,363,000	($216,000)	-0.27%
Alt7L	$79,648,000	$68,400	0.09%
Alt7M	$79,516,000	($63,700)	-0.08%

6.5.7.2 West Point Lake

The average annual NED recreation benefits for the NAA and the nine other alternatives are shown in Table 6.5-10. As shown in the table, the benefits for any alternative vary significantly less than 0.2 percent. The PAA would have average annual benefits of $21,566,000, only 0.16 percent greater than the NAA.

Table 6.5-10.
West Point Lake Recreation Benefit Summary
(September 2016 [FY 2016] price levels FY 2017 interest rate and 50-year period of analysis)

Alternative	Annualized Recreation Value ($)	Annualized Change vs. without Project	Percent Change
NAA	$21,532,000	$0	0.00%
Alt1L	$21,567,000	$35,900	0.17%
Alt7A	$21,520,000	($11,600)	-0.05%
Alt7B	$21,526,000	($5,100)	-0.02%
Alt7H	$21,573,000	$40,900	0.19%
Alt7I	$21,558,000	$26,700	0.12%
Alt7J	$21,565,000	$33,700	0.16%
PAA	$21,566,000	$34,800	0.16%
Alt7L	$21,575,000	$43,200	0.20%
Alt7M	$21,568,000	$36,800	0.17%

6.5.7.3 Walter F. George Lake

The average annual NED recreation benefits for the NAA and the nine other alternatives are shown in Table 6.5-11. As shown in the table, the benefits for any alternative vary less than 0.15 percent. The PAA would have average annual benefits of $33,459,000, only 0.08 percent less than the NAA.

Table 6.5-11.
Walter F. George Lake Recreation Benefit Summary
(Spetember 2016 [FY 2016] price levels FY 2017 interest rate and 50-year period of analysis)

	Annualized recreation value ($)	Annualized change vs. without project	Percent change
NAA	$33,485,000	$0	0.00%
Alt1L	$33,486,000	$200	0.00%
Alt7A	$33,443,000	($42,200)	-0.13%
Alt7B	$33,438,000	($47,900)	-0.14%
Alt7H	$33,459,000	($26,500)	-0.08%
Alt7I	$33,486,000	$600	0.00%
Alt7J	$33,459,000	($27,000)	-0.08%
PAA	$33,459,000	($26,200)	-0.08%
Alt7L	$33,474,000	($11,700)	-0.03%
Alt7M	$33,460,000	($25,500)	-0.08%

6.5.7.4 Riverine Recreation within the Chattahoochee River National Recreation Area

As discussed in section 2.6.6.5, the CRNRA provides recreational opportunities for a variety of activities. Releases from Buford Dam provide flows that support CRNRA activities, although the releases might not be sufficient at all times to provide optimum flows for all recreational activities, as described in sections 0 and 6.1.1.2.2. Buford Dam releases a continuous minimum flow of 600 cfs, however, which provides dependable downstream flow conditions at all times that at least minimally support recreational activities in the CRNRA, even during severe droughts, a benefit to the CRNRA that would not occur without the Buford project. Additionally, Buford Dam reduces peak discharges in the Chattahoochee River during flood events that could increase the usability of the CRNRA for recreation during and after those events and is likely to reduce safety risks to recreational users. Table 6.5-12 describes the impacts to recreation using riverine flows as a metric. In the CRNRA above Morgan Falls, flows would be slightly higher under the PAA than under the NAA because more water would be released from Buford Dam, resulting in a slightly beneficial impact on recreation within the CRNRA. In the CRNRA below Morgan Falls, flows would be slightly lower under the PAA than the NAA because more water would be withdrawn from the river and not returned until downstream of Peachtree Creek. The result is a slightly adverse impact on recreation within the CRNRA.

Table 6.5-12.
Summary of the Effects on Riverine Recreation in the CRNRA

Recreation	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Buford Dam to Bull Sluice Lake (Buford Dam gage)	Baseline	Negligible/ No change	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Morgan Falls Dam to Peachtree Creek (Atlanta gage)	Baseline	Negligible/ No change	Negligible/ No change	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse

Notes:

Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

Slightly adverse—Any adverse impact is perceptible and measurable, but would not have an appreciable effect.

Slightly beneficial—Any beneficial impact is perceptible and measurable, but would not have an appreciable effect.

6.5.8 Environmental Justice

Executive Order (EO) 12898 requires federal agencies to consider and address the impacts of their activities on minority and low-income populations (see section 2.6.10 for details). Water management activities at the USACE reservoirs in the ACF Basin for the NAA and AltIL, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M were reviewed with respect to environmental justice considerations. Table 6.5-13 summarizes the effects of the alternatives.

During the scoping process for this EIS, no significant environmental justice concerns relative to water management operations in ACF Basin reservoirs were identified. Commenters on the draft EIS raised environmental justice concerns regarding potential adverse effects of proposed changes to USACE water management practices on (1) minority and low-income users of USACE reservoirs downstream of Metro Atlanta and (2) low-income populations along the Apalachicola River and Bay, particularly those involved in commercial fishing and oyster harvesting in the bay.

Access and use of the USACE reservoirs in the basin by minority and low-income populations would most likely focus on shoreline access activities like picnicking, wading/swimming, and recreational and subsistence fishing, primarily from the bank or public docks/piers, rather than on boating-related activities that would tend to be somewhat less dependent on high lake levels. Low water levels in the lakes would tend to affect the shoreline access activities slightly more than boating-related activities. Therefore, the access and usability of the lake resources for all visitors could be negatively affected by low lake levels but are likely to be marginally higher for low-income and minority visitors.

Updates to USACE reservoir water management practices from the NAA would not have an adverse effect on low-income populations along the Apalachicola River and Bay under any of the alternatives unless those updates would change conditions in the river and bay to the extent that populations of commercially harvested species would be adversely affected. None of the alternatives, including the PAA, would have an appreciable incremental effect on environmental conditions in Apalachicola Bay compared to the NAA. Thus, no incremental socio-economic effects on minority and low-income populations in that area would be expected.

Table 6.5-13.
Summary of the Effects of Alternatives on Environmental Justice

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Environmental justice	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.5.8.1 No Action Alternative

Seasonal fluctuations in the water surface elevations under the NAA, even with relatively normal rainfall conditions in the basin, could create minor inconveniences for local residents, including low-income and minority populations, who use USACE reservoirs for fishing and other forms of recreation. Those uses might be more constrained during extreme drought years, but those constraints and their associated effects are not likely to be disproportionately higher for low-income and minority populations. All lake users could be affected under those conditions, which might last for months at a time but are temporary. USACE resource managers at the lakes work closely with the public under such circumstances and pursue reasonable temporary measures to maintain at least a minimum level of access to the lakes until the extreme conditions improve.

The Master Manual and the individual project WCMs outline current communication measures to promote and maintain public safety at USACE projects, both in the reservoirs and the tailrace areas below the dams. Those measures include automated warning systems associated with rapid changes in flow and stage conditions downstream of the dams when hydropower generation is initiated and/or spillway gates are opened.

6.5.8.2 Alternative 1L

Alt1L would have essentially the same effects as for NAA with respect to minority and low-income populations.

6.5.8.3 Alternative 7A

Alt7A would have essentially the same effects as the NAA with respect to minority and low-income populations.

6.5.8.4 Alternative 7B

Alt7B would have essentially the same effects as the NAA in section 6.5.8.1 with respect to minority and low-income populations.

6.5.8.5 Alternative 7H

Alt7H would have essentially the same effects as the NAA with respect to minority and low-income populations.

6.5.8.6 Alternative 7I

Alt7I would have essentially the same effects as the NAA with respect to minority and low-income populations.

6.5.8.7 Alternative 7J

Alt7J would have essentially the same effects as the NAA with respect to minority and low-income populations.

6.5.8.8 Alternative 7K (PAA)

Seasonal fluctuations in the water surface elevations under the PAA, even with relatively normal rainfall conditions in the basin, could create minor inconveniences for local residents, including low-income and minority populations, who use the USACE reservoirs for fishing and other forms of recreation. Those uses might be more constrained during extreme drought years, but those constraints and their associated effects are not likely to be disproportionately higher for low-income and minority populations. All lake users could be affected under those conditions, which might last for months at a time but are temporary. USACE resource managers at the lakes work closely with the public under such circumstances and pursue reasonable temporary measures to maintain at least a minimum level of access to the lakes until the extreme conditions improve.

There are no expected impacts to anglers downstream of reservoirs caused by minimal change in flows in comparison to the NAA.

The Master Manual and the individual project WCMs outline current communication measures to promote and maintain public safety at USACE projects, both in the reservoirs and the tailrace areas below the dams. Those measures include automated warning systems associated with rapid changes in flow and stage conditions downstream of the dams when hydropower generation is initiated and/or spillway gates are opened.

6.5.8.9 Alternative 7L

Alt7L would have essentially the same effects as the NAA with respect to minority and low-income populations.

6.5.8.10 Alternative 7M

Alt7M would have essentially the same effects as the NAA with respect to minority and low-income populations.

6.5.9 Protection of Children

EO 13045 requires federal agencies to consider and address the impacts of their activities on children with respect to environmental health and safety risks (see section 2.6.12 for details). Operation of large reservoir projects provide increased opportunities for public access and use, particularly in the form of water-based recreation. Public use of the projects inherently includes a level of health and safety risk to both adults and children. USACE pursues extensive measures at operating projects to minimize the risks by implementing water safety and other education programs, providing clear signage, marking designated uses areas, removing hazards where appropriate, restricting public access to certain areas designated for authorized personnel only, and other measures designed to promote safe use, many of which are directly focused on children who visit the projects. Table 6.5-14 summarizes the effects of alternatives.

Table 6.5-14.
Summary of the Effects of Alternatives on Protection of Children

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Protection of children	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.5.9.1 No Action Alternative

The current environmental health and safety activities at USACE projects would be expected to continue and would be adjusted over time as needs change. Existing water management activities at the reservoirs do not impose any undue risks to children that are not effectively addressed by current activities.

6.5.9.2 Alternative 1L

Alt1L would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed increased water supply.

6.5.9.3 Alternative 7A

Alt7A would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices.

6.5.9.4 Alternative 7B

Alt7B would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices.

6.5.9.5 Alternative 7H

Alt7H would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices or increased water supply.

6.5.9.6 Alternative 7I

Alt7I would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices or increased water supply.

6.5.9.7 Alternative 7J

Alt7J would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices or increased water supply.

6.5.9.8 Alternative 7K (PAA)

The PAA would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices or increased water supply.

6.5.9.9 Alternative 7L

Alt7L would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices or increased water supply.

6.5.9.10 Alternative 7M

Alt7M would have the same effects relative to protection of children as the NAA. No additional risks would be imposed by the proposed updates to water management practices or increased water supply.

6.6 Aesthetic Resources

The effects of various alternatives on aesthetic resources are summarized in Table 6.6-1 and discussed below.

Table 6.6-1.
Summary of the Effects of Alternatives on Aesthetic Resources

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Aesthetic resources	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.6.1 No Action Alternative

Under the NAA, both USACE and nonfederal reservoirs serve as valuable aesthetic assets in the ACF Basin as indicated in section 2.7. Likewise, the unimpounded reaches of rivers and streams in the basin, natural streams and wetlands, and diverse upland areas across the basin are also important visual assets.

6.6.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Even though there would be slight differences (higher or lower) in water surface elevations in the USACE reservoirs over time compared to the NAA, the other alternatives—Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M—would not result in an appreciable change in aesthetic resources and values in the basin.

Compared to the NAA, deviations in flow conditions downstream of the USACE projects in the ACF Basin under Alt1L, Alt7A, Alt7B, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M would be visually imperceptible. Negligible changes to aesthetic resources and values in these areas would be expected if any of these alternatives were implemented.

6.7 Cultural Resources

The effects of various alternatives on cultural resources are summarized in Table 6.7-1 and detailed in the subsections that follow.

Table 6.7-1.
Summary of the Effects of Alternatives on Cultural Resources

	NAA	ALT1L	ALT7A	ALT7B	ALT7H	ALT7I	ALT7J	PAA	ALT7L	ALT7M
Cultural resources	Baseline	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change	Negligible/ No change

Notes:
Negligible/No change—Any positive or negative impacts would be negligible, amounting to no effective beneficial or adverse change.

6.7.1 No Action Alternative

Under the NAA, the operation of USACE projects in the ACF Basin would be expected to remain unchanged. Therefore, effects on cultural resource sites would be expected to be the same as they have been in the past. Based on the 2009 evaluation of current conditions (Brockington 2010), most of the ACF Basin sites are expected to experience three distinct effects: erosion, deposition, and access. Quantifying those effects has been problematic, as no specific framework has been established to track site-specific information needed over time to evaluate the multivariant and dynamic systems involved with these natural and man-made fluvial processes as they relate to cultural resources. Additionally, without these

historic data, it is difficult to ascertain what observed conditions are natural versus functions of a USACE undertaking. For instance, based on the existing data, it is currently unrealistic to determine scientifically if site erosion is a function of USACE operation versus natural rain events, natural ecosystem changes over time, or all of the above.

Although there has been no quantified longitudinal study of past erosion and deposition impacts to cultural sites, Brockington's 2009 study inventoried 93 percent of the cultural sites located in the ACF Basin sample as experiencing erosion and 33 percent experiencing deposition (Brockington 2010). However revealing they might be, those percentages should be taken as multivariant trends rather than adverse effects to cultural resources specifically tied to USACE water management. Another perspective could include these trends correlating more with the geomorphology of the existing environment than existing water management practices under the NAA. Regardless, it can be assumed that these trends would continue under the NAA.

Historically, conservation measures have not been undertaken along the shoreline, and it might be too late to preserve any remaining intact site contexts by implementing them now. As erosion and deposition over time could pose risks to specific sites, options to mitigate effects will be evaluated and implemented, as needed, based on the nature of the cultural resource as well as engineering and cost-effectiveness considerations. Potential options could range from protection by way of structural measures (e.g., fill, rip-rap, sheet pile) to excavation of the site(s), all in consultation with the state historic preservation office and tribal interests (as appropriate). Available data from the ACF Basin reviewed by Fedoroff (2014) concluded that access rates occur at a near-constant rate regardless of current water management practices in the ACF Basin—with the exception of a few cultural resource sites as identified in the study. Additionally, a geographical information system (GIS) framework was created to track exposure rates based on water level to generate the longitudinal data needed for a monitoring and adaptive management plan tailored to specific cultural resources in the ACF Basin in need of additional access protection.

6.7.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7L, and 7M

As stated in the NAA evaluation, there are not enough significant differences between any of the alternatives to quantify a specific increase or decrease of impacts to cultural resources outside of the general statements outlined in the previous sections. However, a monitoring and adaptive management plan has been implemented for the ACF Basin study of sample cultural sites that will aid in implementing mitigation measures for any of the alternatives evaluated for this final EIS.

6.7.3 Alternative 7K (PAA)

Hydrologic models are not particularly meaningful for cultural resources assessments as impacts to cultural resources are site-type-specific and often require longitudinal data sets linked to specific archaeological research questions of site significance. Additionally, as the cultural resources for this project were initially reviewed from a programmatic level and next assessed from a sample size of n=15, the current state of knowledge on site-specific impacts in the ACF Basin is lacking and, at best, is not sufficient in the scientific literature to marry with hydrologic model projections. With these caveats in mind, several general statements can be made about impacts to cultural resources from the evaluated alternatives, including the PAA.

First, under the PAA, the rate of erosion at cultural resources sites would be expected to remain generally the same, based on the baseline No Action Study (Fedoroff 2014). It is unlikely that the PAA would reduce the percentage of sites (93 percent of the sites known and unknown) undergoing erosion from the NAA as the baseline inundation rates for the No Action Study largely remained constant despite changes in current USACE water management activities (Fedoroff 2014). Additionally under the PAA, an estimated 33 percent of sites undergoing the effects of deposition also would remain relatively the same.

Second, although the PAA does not approach the issue of flow rate as it specifically affects cultural resource sites, it can be assumed to some degree that the sites within the ACF Basin that would experience high flow action scenarios would experience negative impacts on cultural resources. Areas such as riverbeds located below dam spill gates and in shoals, outside river bends, and steep riverbank slopes with erodible soils would be impacted; however, the actual rate and extent of effects would need to be quantified based on observable data linked to the specific cultural site information. Furthermore, those areas are typical of high-flow scenarios, thus the effects also could be constant relative to the NAA.

Finally, there are not enough significant differences between the PAA and the NAA in scale to evaluate specific differences in effects to cultural resources in the existing data. However, the 2014 baseline study has illustrated that, with proper monitoring and management using the existing GIS tools available to USACE, mitigations can be recommended as effects are observed over time (Fedoroff 2014). Although the percentage of sites that undergo the effects of erosion and deposition is expected to remain relatively consistent across all the alternatives, some of the effects might be positive for the preservation of cultural resources site, while others will be negative. As with both the NAA and the PAA, either protection or excavation mitigation measures would be pursued when the site is at risk for observable adverse impact.

6.8 Climate Change Analysis

This section addresses the issue of climate variability and change in the ACF Basin from two perspectives: (1) the extent to which updates or revisions to the operation of USACE reservoirs in the basin may affect greenhouse gas (GHG) emissions and climate conditions, and (2) the effect that projected future climate variability and change may have on current and proposed ACF reservoir project operations.

6.8.1 Potential Effects of WCM Update Alternatives on Climate Conditions

6.8.1.1 No Action Alternative

Other than minor emissions associated with vehicle and equipment use to conduct routine operation and maintenance activities around the reservoir projects, the projects do not serve as a source of greenhouse gas emissions. Rather, the projects produce substantial hydroelectric power which serves as a clean alternative source of energy to fossil fuels.

6.8.1.2 Alternatives 1L, 7A, 7B, 7H, 7I, 7J, 7K (PAA), 7L, and 7M

Minor emissions associated with vehicle and equipment use to conduct routine operation and maintenance activities around the reservoir projects would continue for all these alternatives at about the same level as for the NAA. The amount of hydropower likely to be produced under each of these alternatives would vary compared to the NAA, some higher and some lower. The following paragraphs discusse the extent of the change in GHG emissions resulting from increases or decreases in hydropower production among the alternatives compared to the NAA, including the relative significance of those changes in terms of GHG emissions in the region and their potential to affect climate conditions.

Table 6.8-1 provides a summary of changes in annual GHG emissions that would be caused by changes in hydropower production for each alternative. Further details of this analysis can be found in appendix B (appendix D). Modeling in support of the hydropower analysis indicates that Alt7J would likely reduce the carbon dioxide equivalent by approximately 77 million pounds compared to the NAA. The PAA (Alt7K) would be expected to add approximately 80 million pounds of carbon dioxide equivalent annually compared to the NAA. GHG emissions for all of the other alternatives would fall between the results for Alt7J and the PAA.

Table 6.8-1.
Annual Greenhouse Gas Emissions due to Changes in Hydropower Production for Each Alternative as compared to the No Action alternative

Alternative	Carbon Dioxide (lbs)	Methane (lbs)	Nitrous Oxide (lbs)	Carbon Dioxide Equivalent (lbs)
No Action				
Alt1L	-15,132,989	-298	-204	-15,202,394
Alt7A	17,000,195	335	229	17,078,164
Alt7B	-50,643,230	-999	-683	-50,875,500
Alt7H	59,587,435	1,175	803	59,860,727
Alt7I	2,922,034	58	39	2,935,436
Alt7J	-77,491,932	-1,528	-1,045	-77,847,341
Alt7K	79,814,162	1,574	1,076	80,180,222
Alt7L	-29,353,631	-579	-396	-29,488,259
Alt7M	12,150,055	240	164	12,205,780

To put these values in perspective, the following paragraphs provide examples to demonstrate the relative magnitude of the potential changes in GHG emissions.

The average vehicle (including cars, minivans, pick-ups, vans, and SUVs) running an average of 12,000 miles per year at an average of 25.5 miles per gallon produces 8,320 pounds of carbon dioxide per year (American Forests 2016). Alt7J, the alternative that would reduce emissions the most, would equate to taking approximately 9,314 cars off the road. The PAA (Alt7K), the alternative that would result in the largest reduction in hydropower (and, in turn, the largest increase in GHG emission of the alternatives considered), would equate to running an additional 9,593 cars on the road. In a 2011 report, the Atlanta Regional Commission estimated that there were approximately 3.6 million vehicles on the road in the Metro Atlanta area (ARC 2011b). Thus, taking the equivalent of 9,314 cars off the road under Alt7J would represent a decrease in vehicles of approximately 0.26 percent compared to the NAA. Adding the equivalent of about 9,593 cars to the road in the Metro Atlanta area would represent an increase of about 0.27 percent. Both of these alternatives, representing the highest and lowest deviation from the NAA, would result in a negligible change in GHG emissions.

Another way to consider these emissions is to compare the changes to the GHG emissions produced by the regional energy producers. Together, Alabama and Georgia energy producers produce 253 million metric tons of carbon dioxide annually (DOE EIA 2016). The PAA (Alt7K) would likely produce 39,907 additional metric tons of carbon dioxide, or 0.016 percent of the total produced by Alabama and Georgia. Alt 7J would likely lead to a decrease of 0.015 percent in GHG emissions of the total produced by energy producers in Alabama and Georgia. The percent change in GHG emissions for Alt7J and the PAA compared to the NAA would be negligible.

Regional GHG emissions are partially a function of population and land use. For the purposes of this EIS, population and land use across the entire basin are not expected to change appreciably associated with the proposed ACF Master Manual update, although there are likely to be some substantial localized changes in the Metro Atlanta area and in other growth oriented areas of the basin (such as the Columbus, Georgia/Phenix City, Alabama area). As a result, it is assumed that most changes in greenhouse gas GHG emissions would occur at about the same rate as for the NAA.

6.8.2 Potential Effects of Climate Change on Future ACF Basin Project Operations

Scientific evidence from the immediately preceding decades demonstrates that natural climate variability might be changing. The anticipated changes could reflect shifts in the average or baseline conditions, regional meteorological phenomena, and the range of variability of those phenomena. These changes have potential implications for the capacity of USACE projects and operations to accommodate different climatological baselines, greater climatological variation, and a wider range of meteorological conditions.

In response to USACE guidance and public interest and input, the Master WCM update project delivery team engaged the Institute for Water Resources to develop a numerical model to evaluate the resilience and limitations of proposed ACF Basin water management scenarios in response to potential climate change conditions. The ACF numerical model was developed to correlate with the HEC-ResSim and HEC-5Q models for the ACF system. Simulating the model-projected critical yield in HEC-ResSim and HEC-5Q would provide an indication of the effects of prospective climate change on hydrology and water quality in the ACF Basin. The objective of this effort was a quantitative analysis of potential climate change in ACF Basin hydrology and, by extension, ACF Basin water management.

The climate change analysis capitalized on existing data and methodologies developed by a coalition of agencies and academic institutes as part of the Coupled Model Intercomparison Project, Phase 5 (LLNL 2015). In broad terms, a general circulation model (GCM) numerically representing the physical processes of the ACF Basin (e.g., atmospheric, land surface) was employed to estimate basin climate change resulting from human influences. The GCM outputs were statistically scaled to a finer time and space scale, and bias corrected. The scaled and corrected GCM outputs were applied to a variable infiltration capacity (VIC) model. The Liang VIC model is a globally applied, open-source, macroscale hydrologic model that solves for water-energy balance (University of Washington 2015).

The methodologies applied for the ACF Basin climate change analysis and the approach by which the results were used in the HEC-ResSim and HEC-5Q models are described in detail in appendix N.

For the climate change analysis in support of the Master WCM update process, the climate change-affected unimpaired flow (UIF) results for 2021–2050 were carried forward for comparison to results for the NAA and the PAA (Alt7K). Years 2021–2050 most closely match the anticipated project lifespan for the Master WCM update and the WSSA analyses, as reflected in the project NEPA documentation. The climate change-affected UIF values were used in the ACF Basin HEC-ResSim and HEC-5Q models to compute a range of outputs for various parameters (e.g., BI, reservoir pool elevations, hydropower production, streamflow) that could be affected should climate change trends continue.

Appendix N contains figures depicting average and median basin inflow values, reservoir water surface elevation values, hydropower production values, and streamflow values at selected points in the basin. Results for the NAA and PAA (Alt7K) are plotted along with the range of climate change-affected values. The plots in appendix N revealed no noteworthy deviations between the NAA and the PAA. This finding implies that the effects of operating under the PAA are essentially the same as those from operating under the NAA. Both scenarios are sufficiently resilient to effectively manage the federal projects for authorized purposes under the climate change-affected UIFs.

The high-low range of potential climate change-affected outputs generally follows the same seasonal trends as the NAA values. However, the range of high and low boundaries for the modeled climate change-affected values generally indicate greater extremes. Comparing the climate change-adjusted high and low extremes to the period of record identify no conditions that were consistently more severe than those that have been historically experienced in the ACF Basin. Generally, the plotted PAA values tend to fall within the range of climate change-affected results, indicating that the PAA water management

scenario would likely be flexible and adaptable enough to perform effectively within the range of hydrologic conditions represented.

Similarly, water quality simulations with HEC-5Q indicate that climate-affected water quality conditions would not be expected to deviate significantly from results for the NAA or the PAA. Based on the simulations, water quality concentrations (median) between the PAA (Alt7K) and the Alt7K-2050-Q1 (Dry) scenario would be similar; median concentrations during wet years would generally be lower. The climate-adjusted water quality scenarios indicate increased water temperature, as compared to the PAA, throughout the length of the ACF Basin. The system-wide consistency of the increased temperatures implies that it is the function of a systemic condition that is outside the influence of the NAA or PAA. For the purposes of modeling and analysis of the model outputs, it was assumed that the increased water temperature was attributable to the increased air temperature projected in the climate change model.

Appendix N provides further details on potential water quality effects associated with climate change, including several figures with model results for specific water quality parameters (e.g., biochemical oxygen demand, TP, ammonia, chlorophyll *a*, nitrogen, and DO).

6.9 Cumulative Impact

Cumulative impact in ecosystems is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 C.F.R. § 1508.7). Constructing dams in riverine ecosystems abruptly, severely, and permanently alters many important physical and biological processes involving the movement of water, energy, sediments, nutrients, and biota. Fourteen major dams impound mainstem channels of the ACF Basin, eliminating, fragmenting, and dramatically altering riverine habitat (Table 2.1-3).

The WCM update and the WSSA process for the USACE projects in the ACF Basin is an undertaking to update reservoir water management practices and address water supply storage reallocation issues in a manner that best meets the federally authorized projects' purposes by both applying a systemwide approach to project operations and considering current conditions and needs in the basin. Consequently, the process and the impact analysis presented in this final EIS consider the cumulative effects of the continued operation of these USACE projects in the basin.

Numerous other federal and nonfederal activities already are occurring and will likely continue to occur in the ACF Basin in the future. Those activities might affect the water resources and other important natural and human resources in the ACF Basin, and in some cases beyond the basin boundaries. Those other pertinent federal and nonfederal activities that are reasonably foreseeable and their associated cumulative effects in conjunction with USACE project operations are summarized in the following paragraphs.

As described in section 2.1.1.1.6.10, USACE conducted a preliminary survey in 2002 of existing reservoirs in the ACF Basin in Alabama and Georgia that are not on the mainstem rivers of the basin. The survey identified 411 reservoirs in the ACF Basin (Alabama and Georgia) that are 20 ac or larger (USACE, Mobile District 2002a). In Alabama, 25 reservoirs larger than 20 ac were identified, for a total surface area of about 1,900 ac with an average reservoir size of about 77 ac. In Georgia, 386 reservoirs were identified with a total surface area of about 23,800 ac and an average reservoir size of about 62 ac (USACE, Mobile District 2002a). Those existing impoundments serve a variety of purposes, including water supply for livestock and irrigation, fish and wildlife conservation, recreation, and M&I water supply. Hundreds of other smaller ponds and impoundments are scattered across the basin. While the preliminary survey may not have identified and included every impoundment in the ACF Basin and today might be considered somewhat dated, it is detailed enough to provide a reasonably accurate summary of the noteworthy surface water impoundments in the ACF Basin.

Table 2.1-4 summarizes nonfederal reservoir projects in the ACF Basin for which USACE has issued a Department of the Army (DA) permit under section 404 of the Clean Water Act (CWA) since 1988 (a total of nine) or for which a DA permit has been pending until recently (two). Those two proposed reservoir projects are Bear Creek Reservoir in south Fulton County and Glades Reservoir in Hall County. DA permit applications for these projects were temporarily withdrawn at the request of the applicants in late 2015 and early 2016, respectively, as described in section 2.1.1.1.6.10. All the reservoir projects in Table 2.1-4 represent local water supply projects to address public supply needs in the Metro Atlanta portion in Georgia and, whether completed or pending (and on hold), represent a total surface area of about 5,000 ac and a safe yield of about 175 mgd.

Georgia, MNGWPD, and the affected counties have undertaken a number of actions to meet projected future demands for public water supply. Those efforts, which include both instituting aggressive conservation measures and developing new sources of water, are described in detail in appendix G. A 2008 study by the Georgia Environmental Finance Authority (GEFA)—summarized in section 2.1.1.2.10.1.4 and appendix G—identified ongoing and potential future investments in new reservoirs to address water supply needs in Georgia (GEFA 2008). The GEFA study revealed that four existing local reservoir projects (three in the Flint River Basin and one in the Chattahoochee River Basin) have the potential to expand storage volume by about two times the current level of about 6.4 billion gallons. The Dog Creek Reservoir expansion in Douglas County, Georgia, was completed in 2009. At the time of the GEFA study, one proposed new reservoir (Lake McIntosh in Fayette County, Georgia) was under construction; it was completed in 2012. Two reservoirs, Bear Creek Reservoir (Bear Creek, Fulton County, Georgia) and Glades Reservoir (Flat Creek, Hall County, Georgia) were in the DA permit process at the draft stage of this EIS for the ACF WCM update, but those applications have since been withdrawn by the local government applicants (see section 2.1.1.1.6.10).

Both the Bear Creek and Glades reservoirs were considered to be reasonably foreseeable local water supply projects and were included in the HEC-ResSim modeling at the draft stage of this EIS. At the time, these local water supply reservoir projects were considered to have an inconsequential overall cumulative effect on the water resources (quantity) in the ACF Basin. That conclusion was generally supported in the draft EIS by the minor variations between alternatives with and without the proposed Glades Reservoir and Bear Creek Reservoir. The proposed projects were geographically dispersed throughout the ACF Basin, one upstream of Lake Lanier and one off the Chattahoochee River between Atlanta and West Point Lake. The potential effects of the proposed reservoirs on Master Manual update alternatives were expected to be minor. Because their DA permit applications were withdrawn following public coordination of the draft EIS, Glades Reservoir and Bear Creek Reservoir operations were not included in the HEC-ResSim modeling for the final EIS.

The PAA (Alternative 7K) as presented in the final EIS would accommodate the stated 2050 water supply needs for Metro Atlanta and eliminate the foreseeable need for construction of Glades Reservoir, Bear Creek Reservoir, or other potential local water supply reservoirs in the upper portion of the ACF Basin for at least 20 years. Thus, the PAA would have the effect of reducing potential long-range cumulative effects on natural resources in the ACF Basin that would likely include habitat fragmentation, loss of wetlands and natural stream habitat, and water quality degradation.

The State of Georgia had determined in a 2008 report (GEFA 2008) that as many as 16 additional locations in its portion of the ACF Basin were generally suitable from an engineering and site development standpoint for future water supply reservoir projects (see Table 3 in appendix G). Those locations were identified from a variety of different studies and reports. Future development at any of them would be highly speculative (i.e., not reasonably foreseeable for purposes of this cumulative effects analysis). Neither Alabama nor Florida have completed any similar regional or statewide studies, and those states have no known plans for water supply reservoir development in their portions of the ACF Basin.

One effect of converting flowing water habitat to still water by dam construction along ACF Basin mainstem rivers and tributaries has been the decline or loss of river-dependent species of freshwater fishes, mussels, and snails. The habitat fragmentation effects of dams in the ACF Basin have resulted in declines in habitat for anadromous fishes. USACE, GPC, and other reservoirs in the ACF Basin have changed the frequency of floodplain inundation in some areas and altered the ecology of the affected rivers and streams. New dams in the basin would replicate many of those effects elsewhere in the tributary streams and add to the cumulative alteration of natural flow regimes and habitat fragmentation. Depending on the location, size, and operating modes, amid other resources that new dams being built to meet water supply demands could be adversely affecting, and possibly jeopardizing the continued existence of, are some protected aquatic species.

As discussed in section 2.1.1.1.6.6, various private sector hydroelectric power interests started taking steps to acquire licenses from FERC for nonfederal hydroelectric power development at George W. Andrews Lock and Dam beginning in the early 1980s. It is reasonable to expect that a cost-effective project to produce nonfederal hydropower under a FERC license is likely to occur in the future for a variety of reasons, including greater emphasis on developing clean energy sources, increases in fossil fuel costs, and less challenging environmental requirements associated with retrofitting an existing structure versus developing a new power generation source.

On June 19, 2014, FERC issued a 3-year preliminary permit to Mid-Atlantic Hydro, LLC, for purposes of studying the feasibility of nonfederal hydropower development at George W. Andrews Lock and Dam (FERC 2014). If that effort does not result in the production of nonfederal hydropower, it is likely that other permit applications will be forthcoming. If so, the proposed hydropower development at the dam and other pertinent issues will be addressed through the FERC nonfederal hydropower licensing process.

As outlined in section 2.1.1.2.5.1.3, demands for public and agricultural water supply in the ACF Basin have steadily increased since 1970 and are expected to continue to increase. In 1990, agricultural water supply represented more than 10 percent of surface water withdrawals in the ACF Basin. As water efficiency and conservation measures associated with public water supply become more institutionalized through education, incentives, and enforceable laws/regulations (particularly in portions of the ACF Basin in Metro Atlanta), the rate of increase in water demand is likely to appreciably decline. Industrial water use in the ACF Basin has declined dramatically in the past 40 years with more efficient uses of water for industrial and thermoelectric power generation.

For purposes of this cumulative effects analysis, it is not appropriate to speculate on what specific actions Alabama, Florida, Georgia, MNGWPD, or local water providers might take in the future in response to water resource-related litigation or water allocations formula derived by those states. In general, more aggressive conservation measures could be likely to reduce or curtail the growth of current water demands, as would the implementation of any feasible water reuse projects. In the portion of the ACF Basin within Metro Atlanta, interbasin transfers are likely to continue for the foreseeable future, reflecting a minor net loss of water from the Chattahoochee River Basin to the Ocmulgee River Basin. Existing laws and regulatory mechanisms limiting interbasin transfers in Georgia would likely have to be modified to enable this option to be implemented on a larger scale. Other specific recommendations to address future shortfalls in water supply will likely be included in the regional water plans developed by the regional water councils established under Georgia's state water plan.

For the Master Manual update process, the region of influence for land use is the USACE project land and the adjacent shoreline. The PAA would affect water surface elevations in reservoirs along the Chattahoochee River and, in turn, potentially affect project shorelines. Therefore, the focus of the land-use analysis is on the project land over which USACE has proprietary or managerial jurisdiction and the immediately adjacent land. The alternatives analyzed in this EIS would not change land-use allocations or

zoning, would not change established land uses, and would not disrupt or divide established land-use configurations. Therefore, no cumulative effects would be expected.

USACE typically considers requests for a variety of real estate easements/leases at its projects. Numerous real estate easement activities are in place in the ACF Basin. Recent examples include additional easements for new roadwork at Lake Lanier and Walter F. George Lake and utility crossings above Walter F. George Lake. Such actions are not expected to have impacts on water management decisions or project purposes nor would they be impacted by the PAA.

Cumulative Impacts to Biological Resources. Human-induced inputs of various stressors into aquatic and terrestrial ecosystems can further compromise the ability of an ecological system to support a healthy biota. As growth—increased density of human habitation—continues, terrestrial ecosystems and wetlands adjacent to water bodies in the ACF Basin are expected to become more degraded in spite of various levels of regulation and conservation efforts (e.g., stream buffers and wetland mitigation requirements). If, however, additional attention is given to protecting the integrity of floodplains and restrictions are placed on land cover conversions from residential/suburban/urban development, those areas could retain their function in fluvial processes. Those factors are expected to influence conditions in tributaries, but they are expected to have little, if any, effect on the inundation of floodplains and wetlands in the Chattahoochee River corridor, since it is largely driven by reservoir operations.

The Apalachicola Bay estuary faces a variety of anthropogenic pressures, including upland development and associated pollution, groundwater pumping, recurring droughts, fishery pressures, sea level rise, wetland destruction, and flow modification from upstream reservoirs. Amid that pressure and signs of increased stress in recent years, even with variable system conditions, the Apalachicola Bay estuary has remained a productive estuarine ecosystem.

Appreciable flow alteration (in terms of quantity, quality, timing, and distribution) would be likely to have potential effects on the Apalachicola Bay estuary, including its commercial fisheries. Because flow conditions in the Apalachicola River downstream of Jim Woodruff Lock and Dam would not differ appreciably for the PAA and other alternatives compared to the NAA (see section 6.1.1.2.5), the proposed update to the Master Manual would likely have a negligible effect on the aquatic resources and ecological function of the Apalachicola Bay estuary. As indicated in section 2 of the EIS, the ACF Basin upstream of Jim Woodruff Lock and Dam contributes roughly 80 percent of the total flow to the Apalachicola River. Review of HEC-ResSim model outputs for flow on the Apalachicola River at Chattahoochee, Florida (see section 6.1.1.2.5) and Blountstown, Florida, indicate that the PAA would have little effect on the flow regime on the river at those locations and further downstream entering Apalachicola Bay compared to the NAA. Therefore, the PAA, or any of the other alternatives, would be expected to have a negligible incremental effect on the hydrodynamic regime, aquatic resources, and ecological function of the Apalachicola Bay estuary compared to the NAA.

Any negligible changes to hydrodynamic conditions in the bay that would occur under the PAA would most likely be inconsequential compared to the cumulative effects of anticipated sea level rise on physical and ecological conditions in the estuary. Initial vulnerability assessments conducted by USACE in accordance with the *Comprehensive Evaluation of Projects with Respect to Sea-Level Change* indicate that sea level at Apalachicola, Florida, would be estimated to rise by 0.16–0.39 ft between 2015 and 2050 and by 1.21–4.51 ft between 2015 and 2100 (USACE 2014a, 2014b).

Cumulative Impacts to Water Quality. A number of factors, including pollutant loads and in-stream flows (water quantity), influence water quality. Pollutant loads include both point sources—which are regulated by EPA through the NPDES under the Water Pollution Act of 1972, as amended—and nonpoint sources—which also are targeted to reduce pollutant loads under the Water Pollution Act of 1972, as amended, through TMDLs. Enforcement of reductions is varied because of limited resources. As

activities in the ACF Basin change from forested to urban land cover, peak flows in the system are likely to increase and baseflows in the system are likely to decrease. Urban land cover generally decreases interception of rainfall and infiltration, increasing stormwater runoff, which would be expected to result in less assimilative capacity during periods of low flow because baseflow decreases.

A water body's ability to assimilate pollutants is dependent on the amount of water in-stream, especially during low-flow periods. That is why the HEC-ResSim and HEC-5Q models have been used to ascertain the relationship between water quantity and quality in the ACF Basin. Agencies regulating water quality in rivers and reservoirs will continue to monitor for impairment and improvement, and to enforce reductions until standards are met. That balance of what is allowable and what is discharged is an ongoing cycle of monitoring, assessment, and implementation.

Implementing the PAA (Alt7K) and other alternatives would result in cumulative effects in the ACF Basin with respect to water quality. Changes in discharges during low-flow conditions by some entities holding NPDES permits would affect DO, TP, and TN levels from Atlanta, Georgia, to West Point Lake. For the most part, those effects would be expected to occur only during low-flow periods.

It is assumed that over time, water quality standards will be met because of reductions achieved through the Water Pollution Act of 1972, as amended. Nutrient loads also are expected to decrease because of stringent new criteria for Florida finalized in November 2010. The criteria establish freshwater standards in Lake Seminole that might require upstream reductions to ensure compliance. Compliance with the new water quality standards will be determined by state water quality regulating agencies—Alabama Department of Environmental Management, Florida Department of Environmental Protection, and GAEPD.

Cumulative Impacts on Cultural Resources. Regardless of changes in reservoir operation, the population in the ACF Basin is expected to increase in the future, bringing more people into potential contact with known significant archaeological sites along the lakeshores and waterways. Increased human interaction is likely to increase the impact of access due to vandalism or artifact collection. Considering other past, present, and reasonably foreseeable actions in the ACF Basin, the PAA is not expected have an appreciable cumulative effects on cultural resources in the basin.

6.10 Mitigation Considerations

CEQ regulations for the implementation of the National Environmental Policy Act (NEPA) define mitigation at 40 CFR 1508.20 to include:

- Avoiding the impact altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments.

Mitigation measures are to be considered for adverse impacts that would be expected to result from 6.10 a selected course of action; in this case, the update of the Master Manual for the ACF Basin consistent with the purpose and need described in section 1.2. As potential water management measures were identified and alternatives were developed and analyzed for beneficial and adverse effects to be addressed in this EIS, potential mitigative actions were considered in the planning process.

The iterative process employed by USACE to formulate and evaluate water management alternatives and water supply options was coupled with substantial coordination with USFWS and others. These factors provided a strong framework for (1) considering the incremental effects of the various components of the alternatives, and (2) adjusting proposed operations to minimize adverse effects on the natural environment, as well as social, cultural, and economic impacts. Updating the reservoir operations in the ACF Basin and the Master Manual and project WCMs that guide project operations would not involve construction or any other activity that would result in a permanent and irreversible physical change to natural systems of the ACF Basin to an extent greater than has already occurred under the NAA.

USACE consistently seeks opportunities to improve operations as they arise when USACE authorities limit actions. For example, structural modifications were screened out during the initial stages of the WCM update process because doing so would be outside USACE authority; therefore, structural modifications were not included among the alternatives that were carried forward for evaluation in the EIS. However, USACE does minor modifications using the best available technology as was done at the Buford Dam project when vented turbines were installed to improve dissolved oxygen issues below the dam as part of regular maintenance to replace the turbines. Otherwise, to further improve water quality through structural modifications would require a study under Section 216 of the Flood Control Act of 1970. (P. L 91-611) or additional congressional authorization and appropriations. Structural modifications to completed USACE projects would generally require the completion of a study and additional congressional authorization and appropriations.

Water Quality Adverse Effects. Based on information provided by the state of Georgia, the model assumptions for Alt1L, Alt7H, Alt7I, Alt7J, the PAA, Alt7L, and Alt7M all included the increase in treated wastewater discharges into the Chattahoochee River from Metro Atlanta. Implementing any one of those alternatives would be expected to result in adverse effects on water quality from Atlanta to West Point Lake because of increased TP loads. They also would be expected to result in adverse effects in TN levels along the reach from Atlanta to West Point Lake. Both Alt1L, which includes USACE current management operations, and the PAA demonstrate comparable effects to water quality, whereas Alt7A, which includes updated water management operations but no changes to wastewater returns downstream of Buford Dam, has negligible effects on water quality. This shows that the effects to water quality would principally be the result of increases in treated wastewater returns to the Chattahoochee River system resulting from proposed increases in water supply withdrawals to meet future needs in Metro Atlanta and, for some alternatives, higher assumed return rates for treated wastewater as a percentage of withdrawals than presently occurs. As much as 100–160 mgd of additional treated wastewater discharges to the Chattahoochee River would be expected under these alternatives. If GAEPD permits additional discharges, it could require changes to discharge permits for some facilities to ensure that water quality is maintained in this reach of the river. As in past years, USACE, working closely with states and affected stakeholders, could make special releases from USACE projects to support public health and safety throughout the ACF Basin. USACE will periodically notify users when such releases are made; water users also can directly notify USACE of their needs for special releases.

The effects on water quality described above would be an indirect effect of the features of the PAA and other alternatives that address water supply needs for Metro Atlanta. Treatment and return of increased amounts of wastewater to the rivers and streams in the ACF Basin would be an issue that the State of Georgia would address regardless of the source of future water supply if alternative sources had to be developed and implemented to meet future needs in lieu of the water supply features in the PAA (and other alternatives).

Riverine Fish and Aquatic Resources Adverse Effects. The effects of wastewater returns to water quality, as described previously, would be expected to adversely effect riverine fish and aquatic resources from Atlanta downstream to Walter F. George Lake as indicated in section 6.4.3.1.

Endangered Species Adverse Effects. Potential adverse effects to federally listed species in the Apalachicola River (Gulf sturgeon and three species of mussels) have been addressed through ESA section 7 consultation with the USFWS. The effects on these species, potential incidental take, and reasonable and prudent measures to avoid and minimize incidental take are summarized in section 6.4.4.

Other Adverse Effects. Other adverse effects identified in the EIS for the PAA and other alternatives on flow conditions, land use, socioeconomic considerations, and other resource areas generally range from negligible, or discountable, to slightly adverse. None of those effects rise to a level of significance compared to the NAA that would warrant specific mitigation measures or a degree of uncertainty that would warrant extensive new monitoring activity.

As previously stated, the substantially adverse effects to water quality and to riverine fish and aquatic resources due to water quality would not warrant specific mitigation measures because they would be expected from wastewater returns and not reservoir operations. This EIS evaluated effects based on assumptions regarding wastewater and available models to allow comparison of various alternatives with the NAA to select a PAA. As the permitting agency for wastewater returns, GAEPD, through their NPDES program, will be responsible for defining wastewater return loads to ensure water quality standards are met in the Chattahoochee River from Atlanta to Walter F. George Lake.

Consequently, specific compensatory mitigation measures would not be necessary for USACE to implement based on the analysis of the PAA (Alt7K) and other alternatives, which shared model assumptions about water supply and wastewater returns. No specific mitigation commitments are included in the PAA or other alternatives, but all the alternatives incorporate measures known to benefit fish and wildlife such as current fish spawning and passage procedures and ramping rates and flow targets in the Apalachicola River at Chattahoochee, Florida.

Water management inherently involves adapting to unforeseen conditions. The development of water control criteria for the management of water resources is conducted throughout all phases of a water control project. Water control criteria are based on sound engineering practices using the latest approved models and techniques for all reasonably foreseeable conditions. There could be further refinements or enhancements of the water control procedures to account for changed conditions resulting from new requirements, additional data, or changed social or economic goals. However, it is necessary to define the water control plan in precise terms at a particular time to ensure implementation of the intended functional commitments in accordance with the authorizing documents (e.g., Engineer Manual 1110-2-3600, *Management of Water Control Systems*). Because adverse effects of the water control plan might occur due to unforeseen conditions, actions would be taken within applicable authority and policies, and in coordination with other interests, to address those conditions when they occur through the implementation of temporary deviations to the water control plan (e.g., interim operations plans).

Such temporary deviations from the approved water control plan might have effects that go beyond the scope of the current evaluation. An evaluation of each potential action would be made at the time of its consideration because it is not possible to predict the entire range of possible water management responses to extraordinary circumstances. If it is determined that an action was not previously considered by the NEPA evaluation, a supplemental EIS or an environmental assessment may be required.

6.11 Other NEPA Considerations

6.11.1 Irreversible or Irretrievable Commitments of Resources

Irreversible or irretrievable resource commitments relate to the use of nonrenewable resources and the effects that use of those resources will have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a

reasonable amount of time. Irretrievable resource commitments involve the use or loss in value of an affected resource that cannot be restored because of the action (e.g., extinction of a threatened or endangered species).

The PAA (Alt7K) and the other Master Manual update alternatives are generally not consumptive in nature. Maintaining peak hydropower production as an objective in the development of the Master Manual update promotes continued use of renewable resources (water) to meet peak power demands in lieu of using fossil fuels. The reallocation of conservation storage at Lake Lanier for water supply under the PAA would represent an administrative commitment of reservoir storage from one use to another even though the net loss of water to the ACF Basin system would be limited to the consumptive use associated with the additional water supply. The PAA for the Master Manual update would be expected to have generally positive effects on resources (e.g., potential reduction of damages from flooding) with the exception of the indirect adverse effects of TP levels on riverine fish and aquatic resources from Atlanta to West Point Lake and from West Point Dam to Walter F. George Lake (as discussed in section 6.1.2.3.8). Overall, irreversible or irretrievable commitments of resources under the PAA would be negligible.

6.11.2 Short-Term Uses of the Human Environment and Maintenance of Long-Term Productivity

The construction of large dams in the ACF Basin altered the environment in various ways. For instance, the creation of reservoirs replaced free-flowing rivers and streams and adjacent floodplains, significantly altering the habitat and the composition of aquatic species that favor living in high-velocity water or wide, slow-moving rivers versus those that thrive in a series of large impoundments. Dams with large storage capacity have the effect of reducing the occurrence and magnitude of peak flows; those periods are typically used as opportunities to refill reservoirs and reduce downstream flooding. These projects provide substantial opportunities for economic growth and development and an improved quality of life in the southeast region of the United States through improved flood risk management, increased hydropower production, new recreational opportunities, dependable navigation channels, more stable sources of water supply, and other benefits to the public. Operations to reduce flood risk have decreased the occurrence and severity of damaging floods but also have changed the character of floodplain vegetation and available habitats. In addition, construction of dams has allowed maintenance of minimum flows downstream of the dams during critically dry periods. Before dam construction and reservoir creation, water levels would have likely decreased well below acceptable levels for aquatic species and water withdrawal intakes. Since dam construction, a coldwater fishery was created downstream of Buford Dam and a bass fishery was created in West Point Lake.

The features of the PAA (Alt7K) that address projected water supply needs for the Metro Atlanta area through 2050 (reallocation of conservation storage in Lake Lanier to water supply and increased releases from Buford Dam to ensure downstream water withdrawal needs are met) would likely preclude the need for the construction of addition water supply reservoirs in the basin or implementation of some other water supply alternative likely to have greater impacts on natural resources at least through 2050. The update of the Master Manual as proposed in the PAA would not be expected to substantially alter the present relationship between short-term uses of man's environment and maintenance and enhancement of long-term productivity. The proposed Master Manual update includes operational adjustments that best balance the multiple purposes of the USACE projects in the ACF Basin, including those that would sustain and improve environmental conditions in the basin.

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9 Persons and Agencies Consulted

Tanya Blalock, Environmental Manager, Georgia Power Company, Water and Waste Programs. August 2010.

Angela Chelette, Northwest Florida Water Management District. Havana, Florida. January 2011.

Kenneth Day. U.S. Army Corps of Engineers, Mobile District, Operations Division, Natural Resource Management Section. 2010, December 1, and 2016, April 29.

Jim Greenfield, Senior Water Quality Modeler retired U.S. Environmental Protection Agency Region 4, Atlanta, Georgia. June 2010 and July 2014.

Cindy House, U.S. Army Corps of Engineers, Mobile District, Regulatory Division. December 2010.

Sarah Jernigan, Lake George W. Andrews, Resource Manager. July 2010.

Ed Johnson, U.S. Army Corps of Engineers, Savannah District, Regulatory Division, Piedmont Field Office. December 2010.

Kimberly Minton, Chief Technical Support Section, Water Division, Alabama Department of Environmental Management, May 2014.

B. Mortimer, Environmental Coordinator, ACF Rivers Project. Email on 2010 December 27.

Ernest Noe, U.S. Army Corps of Engineers, Lake Sidney Lanier, Chief Ranger. 2010 December 7, 2014 July 3, and 2016 June 15.

Joseph Paine, U.S. Army Corps of Engineers, Mobile District, Planning Division, Plan Formulation Branch. 2012, September 6.

Kevin Parsons, U.S. Army Corps of Engineers, West Point Lake, Park Ranger. 2016 June 15.

David Scott, U.S. Army Corps of Engineers, West Point Lake, Park Ranger. 2014 July 8.

Walid Shaaban, Georgia Environmental Protection Division, Watershed Protection Branch, Water Supply Program, Surface Water Unit. 2016 July 13.

William Smallwood, U.S. Army Corps of Engineers, Operations Division, Walter F. George Project Office, Project Manager. 2010, December 16.

Jody Timmons, U.S. Army Corps of Engineers, Lake Seminole. 2010 December 1, 2014 July 9, and 2016 June 15.

Ben Williams, U.S. Army Corps of Engineers, West Point Lake, Park Ranger. 2010, December 1.

Brian Zettle, Biologist, Inland Environment Team Chief, U.S. Army Corps of Engineers Mobile District. 2014, August and November. Personal communication.

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10 Distribution List

The EIS was distributed both in hard copy by the US Postal Service and electronically through the project website. Notification of availability was distributed through the *Federal Register* and an email sent to those on the project mailing list. Electronic copies were also made available at libraries throughout the ACF Basin and sent to stakeholders who had requested copies. The project mailing list includes Federal, State, and local agencies, Native American tribes, elected officials, other organizations, and individuals.

10.1 Federal Agencies

ADVISORY COUNCIL ON HISTORIC PRESERVATION
APALACHICOLA NATIONAL ESTAURINE RESEARCH RESERVE
CHATTAHOOCHEE FOREST NATIONAL FISH HATCHERY
CHATTAHOOCHEE RIVER NATIONAL RECREATION AREA
CONGRESSIONAL RESEARCH SERVICE
FEDERAL EMERGENCY MANAGEMENT AGENCY
FEDERAL MARITIME COMMISSION
FEDERAL ENERGY REGULATORY COMMISSION
FOREST SERVICE SOUTHERN REGION
GULF OF MEXICO FISHERY MANAGEMENT COUNCIL
GULF OF MEXICO PROGRAM
HORSESHOE BEND NATIONAL MILITARY PARK
MARITIME ADMINISTRATION
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE, NOAA
NATIONAL OCEAN SERVICE, NOAA
NATIONAL PARK SERVICE
NATIONAL WEATHER SERVICE
NATURAL RESOURCES CONSERVATION SERVICE
STATE CONSERVATIONIST, ALABAMA
STATE CONSERVATIONIST, FLORIDA
STATE CONSERVATIONIST, GEORGIA
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
SOUTHEASTERN POWER ADMINISTRATION
SOUTHEAST RIVER FORECAST CENTER
TENNESSEE VALLEY AUTHORITY
US COAST GUARD AUXILIARY
US ARMY
US ARMY CORPS OF ENGINEERS
US COAST GUARD GROUP
US DEPARTMENT OF AGRICULTURE
US DEPARTMENT OF COMMERCE
US DEPARTMENT OF HEALTH & HUMAN SERVICES
US DEPARTMENT OF JUSTICE
US DEPARTMENT OF INTERIOR
US DEPARTMENT OF ENERGY
US ENVIRONMENTAL PROTECTION AGENCY
US FISH & WILDLIFE SERVICE
US FOREST SERVICE
US GEOLOGICAL SURVEY
US PUBLIC HEALTH SERVICE, FDA

10.2 State Agencies

ALABAMA BUREAU OF TOURISM & TRAVEL
ALABAMA COOPERATIVE EXTENSION SYSTEM
ALABAMA DEPARTMENT OF AGRICULTURE & INDUSTRIES
ALABAMA DEPARTMENT OF COMMERCE
ALABAMA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
ALABAMA DEPARTMENT OF ECONOMIC AND COMMUNITY AFFAIRS
ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
ALABAMA DEPARTMENT OF LABOR

ALABAMA DEPARTMENT OF PUBLIC HEALTH
ALABAMA EMERGENCY MANAGEMENT AGENCY
ALABAMA FORESTRY COMMISSION
ALABAMA HISTORICAL COMMISSION
ALABAMA OFFICE OF WATER RESOURCES
ALABAMA SOIL AND WATER CONSERVATION COMMITTEE
ALABAMA STATE CLEARINGHOUSE, ADECA
ALABAMA STATE PARKS
ALABAMA STATE PORT AUTHORITY
ALABAMA WATER RESOURCES COMMISSION
FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES
FLORIDA DEPARTMENT OF HEALTH
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA DEPARTMENT OF ECONOMIC OPPORTUNITY
FLORIDA DEPARTMENT OF STATE, DIVISION OF HISTORIC RESOURCES
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
FLORIDA NATURAL AREAS INVENTORY
FLORIDA OFFICE OF POLICY AND BUDGET
FLORIDA PUBLIC SERVICE COMMISSION
FLORIDA STATE CLEARINGHOUSE
GEOLOGICAL SURVEY OF ALABAMA
GEORGIA DEPARTMENT OF AGRICULTURE
GEORGIA DEPARTMENT OF COMMUNITY AFFAIRS
GEORGIA DEPARTMENT OF NATURAL RESOURCES
GEORGIA EMERGENCY MANAGEMENT AGENCY
GEORGIA ENVIRONMENTAL FACILITIES AUTHORITY
GEORGIA DNR ENVIRONMENTAL PROTECTION DIVISION
GEORGIA DNR HISTORIC PRESERVATION DIVISION
GEORGIA DNR WILDLIFE RESOURCES DIVISION
GEORGIA MUSEUM NATURAL HISTORY
GEORGIA PORTS AUTHORITY
GEORGIA SENATE RESEARCH OFFICE
GEORGIA OFFICE OF PLANNING AND BUDGET
GEORGIA WATER TASK FORCE
LAKEPOINT STATE PARK
MS DEPT. OF ARCHIVES & HIST

10.3 Local Agencies and Chambers of Commerce

ABBEVILLE CHAMBER OF COMMERCE
ALBANY-DOUGHERTY CLEAN COMMUNITY COMMISSION
APALACHEE REGIONAL PLANNING COUNCIL
APALACHICOLA BAY AREA CHAMBER OF COMMERCE
ATLANTA REGIONAL COMMISSION
ATLANTA-FULTON COUNTY WATER RESOURCES COMMISSION
BAINBRIDGE-DECATUR COUNTY CHAMBER OF COMMERCE
BALDWIN COUNTY COMMISSION
BARBOUR COUNTY COMMISSION
BLAKELY-EARLY COUNTY CHAMBER OF COMMERCE
CENTRAL ALABAMA PLANNING AND DEVELOPMENT COMMISSION
CHAMBERS COUNTY COMMISSION
CHAMBERS COUNTY DEVELOPMENT AUTHORITY
CHATSWORTH WATER COMMISSION
CHATTAHOCHEE FLINT REGIONAL DEVELOPMENT COMMISSION
CHOCTAWHATCHEE, PEA & YELLOW RIVERS WATERSHED MANAGEMENT AUTHORITY
CITY COUNCIL OF LAGRANGE, GA
CITY COUNCIL OF GAINESVILLE, GA
CITY OF ACWORTH, GA
CITY OF ALBANY, GA
CITY OF ANDERSONVILLE, GA
CITY OF APALACHICOLA, FL
CITY OF ASHFORD, AL
CITY OF ATLANTA, GA
CITY OF AUBURN, AL
CITY OF AUSTELL, GA
CITY OF AVONDALE ESTATES GA

CITY OF BARNESVILLE, GA
CITY OF BERKELY LAKE, GA
CITY OF BAINBRIDGE, GA
CITY OF BLAKELY, GA
CITY OF BLOUNTSTOWN, FL
CITY OF BLUFFTON, GA
CITY OF BRISTOL, FL
CITY OF BUFORD, GA
CITY OF CALHOUN, GA
CITY OF CAMILLA, GA
CITY OF CARRABELLE, FL
CITY OF CHAMBLEE, GA
CITY OF CHATTAHOOCHEE, FL
CITY OF CLARKESVILLE, GA
CITY OF CLARKSTON, GA
CITY OF COLLEGE PARK, GA
CITY OF CORDELE, GA
CITY OF CORNELIA, GA
CITY OF CUMMING, GA
CITY OF CUTHBERT, GA
CITY OF DACULA, GA
CITY OF DAHLONEGA, GA
CITY OF DONALSONVILLE, GA
CITY OF DOTHAN, AL
CITY OF DOUGLASVILLE, GA
CITY OF DULUTH, GA
CITY OF EAST POINT, GA
CITY OF EUFAULA, AL
CITY OF FAYETTEVILLE, GA
CITY OF GAINESVILLE, GA
CITY OF GRETNA, FL
CITY OF GRIFFIN, GA
CITY OF HAPEVILLE, GA
CITY OF HEADLAND, AL
CITY OF HEFLIN, AL
CITY OF HELEN, GA
CITY OF HIRAM, GA
CITY OF HOGANSVILLE, GA
CITY OF JACKSON, GA
CITY OF JONESBORO, GA
CITY OF LAFAYETTE, AL
CITY OF LA GRANGE, GA
CITY OF LANETT, AL
CITY OF LILBURN, GA
CITY OF LINCOLN, AL
CITY OF LULA, GA
CITY OF LUMPKIN, GA
CITY OF MANCHESTER, GA
CITY OF LUTHERSVILLE, GA
CITY OF MARIETTA, GA
CITY OF NORCROSS, GA
CITY OF OAKWOOD, GA
CITY OF OPELIKA, AL
CITY OF PHENIX CITY, AL
CITY OF POWDER SPRINGS, GA
CITY OF QUINCY, FL
CITY OF RIVERDALE, GA
CITY OF ROME, GA
CITY OF ROSWELL, GA
CITY OF SANDY SPRINGS, GA
CITY OF SMYRNA, GA
CITY OF SUGAR HILL, GA
CITY OF SYLVESTER, GA
CITY OF VALLEY, AL
CITY OF VILLA RICA, GA
CITY OF WEST POINT, GA
CLAY COUNTY BOARD OF COMMISSIONERS, GA
CLAY COUNTY CHAMBER OF COMMERCE, GA
CLAY COUNTY COMMISSION, GA
CLAYTON COUNTY BOARD OF COMMERCE, GA
CLAYTON COUNTY CHAMBER OF COMMERCE, GA
CLAYTON COUNTY WATER AUTHORITY, GA
COBB CHAMBER OF COMMERCE, GA
COBB COUNTY-MARIETTA WATER AUTHORITY, GA
COBB COUNTY COMMISSION, GA
COBB COUNTY COMMUNITY DEVELOPMENT, GA
COBB COUNTY WATER, GA
COLUMBUS WATERWORKS, GA
CORDELE CITY COMMISSION, GA
COWETA COUNTY PLANNING AND ZONING, GA
COWETA COUNTY WATER & SEWER DEPARTMENT, GA
CRENSHAW COUNTY COMMISSION, AL
CRISP COUNTY, GA
CRISP COUNTY POWER COMMISSION
DAUPHIN ISLAND SEA LAB, AL
DECATUR CHAMBER OF COMMERCE, GA
DECATUR COUNTY COMMISSION, GA
DEKALB CHAMBER OF COMMERCE, GA
DEKALB COUNTY, GA
DEKALB COUNTY COMMISSION, GA
DEKALB COUNTY WATER AND SEWER DEPARTMENT, GA
DEKALB PUBLIC WORKS, GA

DONALSONVILLE CHAMBER OF COMMERCE, GA
DOTHAN AREA CHAMBER OF COMMERCE, AL
DOTHAN CITY COMMISSION, AL
DOTHAN UTILITIES, AL
DOTHAN HOUSTON COUNTY EMA, AL
DOUGHERTY COUNTY ENVIRONMENTAL HEALTH, GA
DOUGLAS COUNTY COMMISSION, GA
DOUGLASVILLE-DOUGLAS COUNTY WATER & SEWER AUTHORITY, GA
EARLY COUNTY BOARD OF COMMISSIONERS, GA
EARLY COUNTY COMMISSION, GA
EAST ALABAMA REGIONAL PLANNING AND DEVELOPMENT COMMISSION
EAST ALABAMA WATER, SEWER, AND FIRE PROTECTION
EAST WALKER CHAMBER OF COMMERCE, AL
ECONOMIC DEVELOPMENT, CITY OF LAGRANGE, GA
ENTERPRISE CHAMBER OF COMMERCE, AL
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ETOWAH WATER & SEWER AUTHORITY, AL
EUFAULA BARBOUR COUNTY CHAMBER OF COMMERCE, AL
EUFAULA CHAMBER OF COMMERCE, AL
EUFAULA PARKS AND RECREATION, AL
EUFAULA WATER & SEWER DEPARTMENT, AL
FAYETTE COUNTY, GA
FAYETTE COUNTY COMMISSION, GA
FAYETTE COUNTY WATER SYSTEM, GA
FORSYTH COUNTY, GA
FORSYTH COUNTY BOARD OF COMMISSIONERS, GA
FORSYTH COUNTY PARKS & RECREATION, GA
FORSYTH COUNTY WATER & SEWER DEPARTMENT
FRANKLIN COUNTY CLERK
FRANKLIN COUNTY COMMISSION, FL
FRANKLIN COUNTY TOURIST DEVELOPMENT COMMISSION, FL
FULTON COUNTY COMMISSION, GA
FULTON COUNTY-ENVIRONMENT & COMMUNITY DEVELOPMENT, GA
FULTON COUNTY PUBLIC WORKS DEPARTMENT, GA
FULTON COUNTY WATER DEPARTMENT, GA
GADSDEN BOARD OF COUNTY COMMISSIONERS, CHAIRMAN, FL
GADSDEN COUNTY CHAMBER OF COMMERCE, FL
GADSDEN COUNTY GROWTH MANAGEMENT DEPARTMENT, FL
GAINESVILLE CITY COUNCIL, GA
GAINESVILLE PUBLIC UTILITIES
GAINESVILLE DEPARTMENT OF WATER RESOURCES, GA
GARDENDALE CHAMBER OF COMMERCE, AL
GEORGIA MOUNTAINS REGIONAL DEVELOPMENT CENTER (GMRDC)
GREATER COLUMBUS GEORGIA CHAMBER OF COMMERCE
GREATER HALL CHAMBER OF COMMERCE, GA
GREATER VALLEY AREA CHAMBER OF COMMERCE, AL
GULF COUNTY BOARD OF COUNTY COMMISSIONERS, FL
GULF COUNTY FLORIDA CHAMBER OF COMMERCE
GWINNETT CHAMBER OF COMMERCE, GA
GWINNETT COUNTY, GA
GWINNETT COUNTY BOARD OF COMMISSIONERS, GA
GWINNETT COUNTY DEPARTMENT OF WATER RESOURCES, GA
GWINNETT COUNTY PLANNING & DEVELOPMENT, GA
GWINNETT COUNTY WATER SYSTEM, GA
HALL COUNTY, GA
HALL COUNTY BOARD OF COMMISSIONERS, GA
HARRIS COUNTY BOARD OF COUNTY COMMISSIONERS
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HENRY COUNTY BOARD OF COMMISSIONERS, GA
HISTORIC CHATTAHOOCHEE COMMISSION, EUFAULA, AL
HOUSTON COUNTY COMMISSION, AL
HOUSTON COUNTY PORT AUTHORITY, AL

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METROPOLITAN NORTH GEORGIA WATER PLANNING DISTRICT
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MIDDLE GEORGIA WATER SYSTEMS, INC.
MITCHELL COUNTY COMMISSION, GA
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PAULDING COUNTY WATER AUTHORITY, GA
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RANDOLPH COUNTY CHAMBER OF COMMERCE, AL
RANDOLPH COUNTY COMMISSION, AL
RIVER VALLEY REGIONAL COMMISSION
ROCKDALE COUNTY, GA
ROCKDALE COUNTY COMMISSION, GA
ROSWELL CITY COUNCIL, GA
RUSSELL COUNTY COMMISSION, AL
SANDY SPRING PERIMETER CHAMBER OF COMMERCE
SMITHS WATER & SEWER AUTHORITY
SOUTH ALABAMA REGIONAL PLANNING COMMISSION
SOUTH FULTON MUNICIPAL REGIONAL WATER AND SEWER AUTHORITY
SOUTHEAST ALABAMA REGIONAL PLANNING AND DEVELOPMENT CENTER
SOUTHEAST GEORGIA WATER TASK FORCE
SOUTHWEST GEORGIA REGIONAL DEVELOPMENT COMMISSION
STEWART COUNTY COMMISSION, GA
SUWANNEE RIVER WATER MANAGEMENT DISTRICT, FL
THREE RIVERS REGIONAL COMMISSION
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TOWN OF BRASELTON GA
TOWN OF BRINSON, GA
TOWN OF BROOKS, GA
TOWN OF BUENA VISTA, GA
TOWN OF COLUMBIA, AL
TOWN OF COTTONWOOD, AL
TOWN OF COWARTS, AL
TOWN OF FRANKLIN, AL
TOWN OF GEORGETOWN, GA
TOWN OF GORDON, AL
TOWN OF GREENSBORO, FL
TOWN OF HAVANA, FL
TOWN OF HURTSBORO, AL
TOWN OF JACKSON'S GAP, AL
TOWN OF INDIAN SPRINGS, AL
TOWN OF KINSEY, AL
TOWN OF LOUISVILLE, AL
TOWN OF MIDWAY, AL
TOWN OF NEWVILLE, AL
TOWN OF PROVIDENCE, GA
TOWN OF SAND ROCK, AL
TOWN OF SHILOH, GA
TOWN OF TAYLOR, AL
TOWN OF TURIN, GA
TOWN OF TYRONE, GA
TOWN OF WEBB, AL

TROUP COUNTY, GA
TROUP COUNTY BOARD OF COMMISSIONERS, GA
TROUP COUNTY MANAGER
TROUP COUNTY PARKS & REC, GA
TWO RIVERS RC&D COUNCIL, GA
UNIFIED GOVERNMENT CUSSETA-CHATTACHOOCHEE COUNTY, GA
UTILITIES, CITY OF LA GRANGE, GA
WALTON COUNTY BOARD OF COMMISSIONERS, GA
WALTON COUNTY WATER DEPARTMENT, GA

10.4 Native American Tribes

ABSENTEE-SHAWNEE TRIBE OF OKLAHOMA
ALABAMA-COUSHATTA TRIBE OF TEXAS
ALABAMA-QUASSARTE TRIBAL TOWN OF THE CREEK NATION OF OKLAHOMA
CHEROKEE NATION
CHEROKEE NATION OF OKLAHOMA
CHOCTAW NATION OF OKLAHOMA
COUSHATTA TRIBE OF LOUISIANA
EASTERN BAND OF THE CHEROKEE NATION
EASTERN SHAWNEE TRIBE OF OKLAHOMA
JENA BAND OF CHOCTAW INDIANS
KIALEGEE TRIBAL TOWN OF THE CREEK NATION OF OKLAHOMA
MICCOSUKEE TRIBE OF FLORIDA
MISSISSIPPI BAND OF CHOCTAW INDIANS
MUSCOGEE (CREEK) NATION OF OKLAHOMA
POARCH BAND OF CREEK INDIANS
SEMINOLE NATION OF OKLAHOMA
SEMINOLE TRIBE OF FLORIDA
SEMINOLE TRIBE OF OKLAHOMA
SHAWNEE TRIBE
THE CHICKASAW NATION
THLOPTHLOCCO TRIBAL TOWN
TUNICA-BILOXI TRIBE OF LOUISIANA
UNITED KEETOOWAH BAND OF CHEROKEE INDIANS IN OKLAHOMA
UNITED SOUTHERN AND EASTERN TRIBE

10.5 Federal, State and Local Elected Officials

ALABAMA ATTORNEY GENERAL
ALABAMA-US CONGRESS, 1ST DISTRICT
ALABAMA-US CONGRESS, 2ND
ALABAMA-US CONGRESS, 3RD
ALABAMA-US CONGRESS, 4TH
ALABAMA-US CONGRESS, 5TH
ALABAMA-US CONGRESS, 6TH
ALABAMA-US CONGRESS, 7TH
ALABAMA-US SENATE
ALABAMA STATE HOUSE, DISTRICT 1
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FLORIDA-US SENATE
FLORIDA-US CONGRESS, 1ST
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FLORIDA-US CONGRESS, 23RD
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FLORIDA-US CONGRESS, 26TH
FLORIDA-US CONGRESS, 27TH
FLORIDA ATTORNEY GENERAL
FL-SENATE DISTRICT 1
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FL-SENATE DISTRICT 9
GEORGIA ATTORNEY GENERAL
GEORGIA-U.S. SENATE
GEORGIA-US CONGRESS 1ST
GEORGIA-US CONGRESS 2ND
GEORGIA-US CONGRESS 3RD
GEORGIA-US CONGRESS 4TH
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GEORGIA-US CONGRESS 13TH
GEORGIA-US CONGRESS 14TH

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GEORGIA STATE SENATE 9
MAYOR, ALBANY, GA
MAYOR, ALPHARETTA, GA
MAYOR, ALTHA, FL
MAYOR AMERICUS, GA
MAYOR, APALACHICOLA, FL
MAYOR, ARABI, GA
MAYOR, ARLINGTON, GA
MAYOR, AUBURN, GA
MAYOR, AVONDALE ESTATES, GA
MAYOR, BACONTON, GA
MAYOR, BAINBRIDGE, GA
MAYOR, BALDWIN, GA
MAYOR, BASCOM, FL
MAYOR, BARNESVILLE, GA
MAYOR, BERKELEY LAKE, GA
MAYOR, BLAKELY, GA
MAYOR, BLOUNTSTOWN, FL
MAYOR, BRASELTON, GA
MAYOR, BRENT, AL
MAYOR, BRINSON, GA
MAYOR, BROOKS, GA
MAYOR, BUTLER, GA
MAYOR, BYROMVILLE, GA
MAYOR, CAIRO, GA
MAYOR, CARRABELLE, FL
MAYOR, CHAMBLEE, GA
MAYOR, CHATTAHOOCHEE, FL
MAYOR, COLLEGE PARK, GA
MAYOR, COLUMBUS, GA
MAYOR, CONCORD, GA
MAYOR, COTTONDALE, FL
MAYOR, CUMMING, GA
MAYOR, CUTHBERT, GA
MAYOR, DACULA, GA
MAYOR, DAMASCUS, GA
MAYOR, DECATUR, GA
MAYOR, DONALSONVILLE, GA
MAYOR, DORAVILLE, GA
MAYOR, DOTHAN, AL
MAYOR, DOUGLASVILLE, GA
MAYOR, EDISON, GA
MAYOR, ELLAVILLE, GA
MAYOR, EUFAULA, AL
MAYOR, FAIRBURN, GA
MAYOR, FOREST PARK, GA
MAYOR, FORT GAINES, GA
MAYOR, FRANKLIN, AL
MAYOR, GAINESVILLE, GA
MAYOR, GAY, GA
MAYOR, GRANTVILLE, GA
MAYOR, GREENVILLE, GA
MAYOR, GRETNA, FL
MAYOR, HAMILTON, GA
MAYOR, HAPEVILLE, GA
MAYOR, HEFLIN, AL
MAYOR, HELEN, GA
MAYOR, HIRAM, GA
MAYOR, HOGANSVILLE, GA
MAYOR, IDEAL, GA
MAYOR, IRON CITY, GA
MAYOR, JONESBORO, GA
MAYOR, JUNCTION CITY, GA
MAYOR, LAFAYETTE, AL
MAYOR, LAKE CITY, GA
MAYOR, LEESBURG, GA
MAYOR, LINCOLN, AL
MAYOR, LITHONIA, GA
MAYOR, LOGANVILLE, GA
MAYOR, LULA, GA
MAYOR, LUTHERSVILLE, GA
MAYOR, MANCHESTER, GA
MAYOR, MARSHALLVILLE, GA

MAYOR, MEANSVILLE, GA
MAYOR, MIDWAY, FL
MAYOR, MONTEZUMA, GA
MAYOR, MORELAND, GA
MAYOR, MORGAN, GA
MAYOR, MORROW, GA
MAYOR, NEWTON, GA
MAYOR, OGLETHORPE, GA
MAYOR, OPELIKA, AL
MAYOR, ORCHARD HILL, GA
MAYOR, PALMETTO, GA
MAYOR, PARROTT, GA
MAYOR, PEACHTREE CITY, GA
MAYOR, PELHAM, GA
MAYOR, PERRY, GA
MAYOR, PHENIX CITY, AL
MAYOR, PINE HILL, AL
MAYOR, PINEHURST, GA
MAYOR, PLAINS, GA
MAYOR, POULAN, GA
MAYOR, POWDER SPRINGS, GA
MAYOR, PRESTON, GA
MAYOR, QUINCY, FL
MAYOR, RAGLAND, AL
MAYOR, RANBURNE, AL
MAYOR, REYNOLDS, GA
MAYOR, ROBERTA, GA
MAYOR, ROOPVILLE, GA
MAYOR, ROSWELL, GA
MAYOR, SALE CITY, GA
MAYOR, SASSER, GA
MAYOR, SENOIA, GA
MAYOR, SHILOH, GA
MAYOR, SUGAR HILL, GA
MAYOR, SMITHVILLE, GA
MAYOR, STONE MOUNTAIN, GA
MAYOR, SUMMERVILLE, GA
MAYOR, SUMNER, GA
MAYOR, SUWANEE, GA
MAYOR, TALBOTTON, GA
MAYOR, TURIN, GA
MAYOR, TUSKEGEE, AL
MAYOR, UNION CITY, GA
MAYOR, VIENNA, GA
MAYOR, WEST POINT, GA
MAYOR, WEWAHITCHKA, FL
MAYOR, WHIGHAM, GA
MAYOR, WOODLAND, GA

10.6 Academic Institutions

A.L. BURRUSS INSTITUTE FOR PUBLIC SERVICE-KENNESAW STATE UNIVERSITY
ALABAMA COOPERATIVE EXTENSION SERVICE
ALABAMA/MISSISSIPPI SEA GRANT CONSORTIUM
ALABAMA WATER RESOURCES RESEARCH INSTITUTE AT AUBURN
ALBANY STATE UNIVERSITY
ANDREW COLLEGE
AUBURN MARINE EXTENSION & RESEARCH CENTER
AUBURN UNIVERSITY
AUBURN UNIVERSITY WATER RESOURCES CENTER
CENTRAL ALABAMA COMMUNITY COLLEGE
CHATTAHOOCHEE VALLEY COMMUNITY COLLEGE
CHIPOLA COLLEGE
CLARK ATLANTA UNIVSERSITY
COLUMBUS STATE UNIVERSITY
DAUPHIN ISLAND SEA LAB
DRAKE STATE TECHNICAL COLLEGE
EMORY UNIVERSITY
EMORY UNIVERSITY-SCHOOL OF LAW
ENTERPRISE-OZARK COMMUNITY COLLEGE
FAULKNER STATE COMMUNITY COLLEGE
FLORIDA A&M UNIVERSITY
FLORIDA STATE UNIVERSITY
FORT VALLEY STATE UNIVERSITY
GAINESVILLE STATE COLLEGE
GEORGIA INSTITUTE OF TECHNOLOGY
GEORGIA SOUTHWESTERN STATE UNIVERSITY
GEORGIA STATE UNIVERSITY
INTERDENOMINATIONAL THEOLOGICAL CENTER
JACKSONVILLE STATE UNIVERSITY
LAGRANGE COLLEGE
LAWSON STATE COMMUNITY COLLEGE
LEVIN COLLEGE OF LAW
LURLEEN B WALLACE JUNIOR COLLEGE
MACARTHUR STATE TECHNICAL COLLEGE

MOREHOUSE COLLEGE
MORRIS BROWN
NORTHEAST ALABAMA COMMUNITY COLLEGE
NORTHWESTERN UNIVERSITY
NORTHWEST-SHOALS COMMUNITY COLLEGE
PIEDMONT COLLEGE
POPE HIGH SCHOOL
REID STATE TECHNICAL COLLEGE
SHELTON STATE COMMUNITY COLLEGE
SOUTHEAST CLIMATE CONSORTIUM
SOUTHERN UNION STATE COMMUNITY COLLEGE
SPARKS STATE TECHNICAL COLLEGE
SPELLMAN COLLEGE
TROY UNIVERSITY
UF WATER INSTITUTE
UNIVERISTY OF FLORIDA
UNIVERSITY OF FLORIDA- FRANKLIN COUNTY EXTENSION OFFICE
UNIVERSITY OF ALABAMA
UNIVERSITY OF ALABAMA LAW SCHOOL
UNIVERSITY OF ALABAMA, HUNTSVILLE
UNIVERSITY OF FLORIDA
UNIVERSITY OF GEORIGA
UNIVERSITY OF MICHIGAN
UNIVERSITY OF SOUTH ALABAMA
UNIVERSITY OF WEST GEORGIA
VALDOSTA STATE UNIVERSITY
WALLACE STATE COMMUNITY COLLEGE
WEST GA TECH
YALE UNIVERSITY

10.7 Other Organizations

100 BLACK MEN OF WEST GEORGIA
ABBOTT JORDAN AND KOON
ACE ALABAMA
ADDSCO INDUSTRIES
AECOM
ALABAMA ASSOCIATION OF CONSERVATION DISTRICTS
ALABAMA BASS FEDERATION
ALABAMA CATTLEMEN'S ASSOCIATION
ALABAMA ELECTRIC COOPERATIVE, INC.
ALABAMA FARMERS COOPERATIVE, INC.
ALABAMA FARMERS FEDERATION
ALABAMA FOREST RESOURCES CENTER
ALABAMA FORESTRY ASSOCIATION
ALABAMA LEAGUE OF MUNICIPALITIES
ALABAMA MUNICIPAL ELECTRIC AUTHORITY
ALABAMA NURSERYMEN'S ASSOCIATION
ALABAMA PEANUT PRODUCERS ASSOCIATION
ALABAMA PORK PRODUCERS ASSOCIATION
ALABAMA POULTRY & EGG ASSOCIATION
ALABAMA POWER COMPANY
ALABAMA RIVER CELLULOSE
ALABAMA RIVERS ALLIANCE
ALABAMA RURAL ELECTRIC ASSOCIATION
ALABAMA RURAL WATER ASSOCIATION
ALABAMA SIERRA CLUB
ALABAMA WATER & SEWER INSTITUTE, INC.
ALABAMA WATER WATCH
ALABAMA WILDLIFE FEDERATION
ALBANY AUDUBON SOCIETY
ALBANY BRANCH NAACP
AMAYSINC SERVICES
AMEC
AMERICAN RIVERS ASSOCIATION
AMERICAN WATER WORKS ASSOCIATION
APALACHEE AUDUBON SOCIETY
APALACHICOLA BAY OYSTER FARMERS ASSOCIATION
APALACHICOLA MARITIME MUSEUM
APALACHICOLA RIVERKEEPER
ARCADIS DESIGN & CONSULTANCY
ASR SYSTEMS
ASSOCIATION OF COUNTY COMMISSIONERS OF ALABAMA
ASSOCIATION OF COUNTY COMMISSIONERS OF GEORGIA
ATLANTA AUDUBON SOCIETY
ATLANTA ROWING CLUB
BALCH & BINGHAM
BALD RIDGE MARINA
BARBOUR COUNTY ALABAMA FARMERS FEDERATION
BAREFOOT SAILING CLUB/LAKE LANIER
BASS SOX MERCER

BATSON-COOK
BAY COUNTY BRANCH NAACP
BEEKEEPING / TUPELHONEY
BETBEZE REALTY CO., INC.
BIG BEND SIERRA CLUB
BLACK & VEATCH
BLACKWELL SANDERS
BLUE RIDGE CONSULTING, INC.
BOB KERR & ASSOC., LLC
BRADLEY ARANT ROSE & WHITE LLP
BROCKINGTON & ASSOCIATES
BROOKWOOD GROUP
BROWN & CALDWELL
BROWNS BRIDGE DOCK CO.
BWSC, INC
CAB INCORPORATED
CAHABA RIVER SOCIETY
CALHOUN-LIBERTY COUNTY BRANCH NAACP
CALLAWAY FOUNDATION
CAMERON POINT PROPERTY OWNERS ASSOC.
CAPELL & HOWARD, P.C.
CARLTON FIELDS
CARRABELLE CARES
CENTRAL ATLANTA PROGRAM
CENTRAL ATLANTA PROGRESS
CG MARINE
CH GUERNSEY & CO.
CH2M HILL
CHAMBERS COUNTY BRANCH NAACP
CHATTAHOOCHEE CHAPTER TROUTS UNLIMITED
CHATTAHOOCHEE NATURE CENTER
CHATTAHOOCHEE RIVERKEEPER, INC.
CHATTAHOOCHEE RIVERWARDEN
CHEROKEE FLOATING DOCKS
CHESTATEE NORTH
CHIPOLA BASIN FOUNDATION PROTECTION GRP
CHOATE CONSTRUCTION COMPANY
CIVIL ENGINEERING CONSULTANTS
COAST TO COAST COATINGS, INC.
COASTAL PLAINS INSTITUTE
COLDWELL BANKER
COLQUITT COUNTY BRANCH NAACP
COLUMBUS AUDUBON SOCIETY
COLUMBUS BANK & TRUST
COLUMBUS NAACP
COOSA-ALABAMA RIVER IMPROVEMENT ASSOCIATION
CORDELE-CRISP BRANCH NAACP
COUNCIL FOR QUALITY GROWTH
CRISP COUNTY POWER COMMISSION
DAMAYAN WATER PROJECT
DANIEL REALTY
DAVID H. MELVIN CONSULTING ENGINEERS
DEFENDERS OF WILDLIFE
DEV. AUTH. BAINBRIDGE
DH&A
DOTHAN WIREGRASS BRANCH NAACP
DRUMMOND COMPANY, INC.
DUKE REALTY
DUNWOODY NATURE CENTER
EAST ALABAMA FISH FARMERS ASSOCIATION
ECOLOGICAL STRATEGY
ENGINEERING MANAGEMENT, INC.
ENTRIX
ERNEST CONSTRUCTION COMPANY
EUFAULA BRANCH NAACP
EWING IRRIGATION
EXPONENT, INC
F/V MARGARITAS, INC.
FARNER BARLEY AND ASSOCIATION
FAYETTE COUNTY BRANCH NAACP
FL COASTAL & OCEAN COALITION
FLORIDA CHAPTER SIERRA CLUB
FLORIDA CONSERVATION COALITION
FLORIDA DEFENDERS OF THE ENVIRONMENT
FLORIDA FARM BUREAU
FLORIDA FORESTRY ASSOCIATION
FLORIDA SEAFOOD FESTIVAL, INC.
FLORIDA WILDLIFE FEDERATION
FOOD AND WATER WATCH
FORGOTTEN COASTAL ADVENTURES
FORMEX MANUFACTURING, INC.
FORT VALLEY BRANCH NAACP
FRANKLIN COUNTY OYSTER & SEAFOOD TASK FORCE
FRANKLIN COUNTY SEAFOOD WORKERS ASSOCIATION
FRIENDS OF LAKE EUFAULA
FRIENDS OF MCINTOSH RESERVE
FRIENDS OF THE APALACHICOLA NATIONAL FOREST
FULTON COUNTY SOIL AND WATER DISTRICT, GA
FUTREN CORPORATION
GA WATER PLANNING & POLICY CNTR.

GAINESVILLE MARINA
GARRETT & ROBINSON
GEO-MARINE, INC.
GEORGIA ASSOCIATION OF WATER PROFESSIONALS
GEORGIA CANOEING ASSOCATION
GEORGIA CHAMBER OF COMMERCE
GEORGIA CHAPTER OF THE SIERRA CLUB
GEORGIA CONSERVANCY
GEORGIA COUNCIL OF TROUT UNLIMITED
GEORGIA FARM BUREAU
GEORGIA MOUNTAINS REGIONAL ECONOMIC DEVELOPMENT CORP.
GEORGIA MUNICIPAL ASSOCIATION
GEORGIA OUTDOORS, INC.
GEORGIA PACIFIC CORPORATION
GEORGIA PEANUT COMMISSION
GEORGIA POULTRY FEDERATION
GEORGIA POWER COMPANY
GEORGIA PUBLIC POLICY FOUNDATION
GEORGIA RIVER NETWORK
GEORGIA WILDLIFE FEDERATION
GEOSYNTEC CONSULTANTS, INC.
GIBBS LANDSCAPE
GIBSON VENTURE
GLOBAL ENERGY & WATER CONSULTING, LLC
GOLDEN ASSOCIATES
GOLDER ASSOCIATES, INC.
GRADIENT CORP.
GRANGER INNS, INC.
GREAT LAKES & LAND CO.
GROUP SOLUTIONS
GULF POWER CORPORATION
GULF RESTORATION NETWORK
GULF UNMANNED SYSTEMS CENTER, LLC
GWINNETT WINDSONG SAILING
HAND-ARENDALL-BEDSOLE-GREAVES & JOHNSON
HARBOUR POINT YACHT CLUB
HARRISON BROTHERS DRY DOCK
HDR, INC.
HELP SAVE THE APALACHICOLA RIVER GROUP
HENRY COUNTY ALABAMA FARMERS FEDERATION
HIDDEN HARBOR HOA
HIGHLAND MARINA & RESORT
HISTORIC APALACHICOLA
HISTORICAL CHATTAHOOCHEE COMMISSION
HOGANSVILLE SENIOR CENTER
HORIZON ENVIRONMENTAL SERVS, INC.
HOUSTON COUNTY ALABAMA FARMERS FEDERATION
HR BLOCK
HYDROLOGICS
INDUSTRIAL ECONOMICS, INCORPORATED
INLAND RIVERS, PORTS, AND TERMINALS
INTERA INCORPORATED
INTERFACE FLOORING SYSTEM
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS, LOCAL UNION 1205
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS, LOCAL UNION 1316
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS, LOCAL UNION 1531
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS, LOCAL UNION 443
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS, LOCAL UNION 613
JH MENGE & CO., INC.
JACKSON COUNTY BRANCH NAACP
JACOBS
JB SYSTEMS
JLO ENTERPRISES & REAL ESTATE
KAZMAREK GEIGER & LASETER LLP
KAZMAREK MOWREY CLOUD LASETER LLP
KBR GOVERNMENT INFRASTRUCTURE
KEEP COLUMBUS BEAUTIFUL COMMISSION
KEEP TROUP BEAUTIFUL
KELLER WILLIAMS REALTY
KEYSTONE FOODS
KIMBLE'S FOOD BY DESIGN
KING & SPALDING LLP
KLEINSCHMIDT
KW REALTY
LAGRANGE MERCHANT ASSOC.
LAGRANGE SIERRA CLUB
LAKE BLACKSHEAR WATERSHED ASSOCIATION
LAKE HOMES REALTY. LLC
LAKE LANIER ASSOCIATION (LLA)

LAKE LANIER HOMEOWNERS ASSOCIATION
LAKE LANIER ISLANDS
LAKE LANIER OLYMPIC CENTER
LAKE LANIER ROWING CLUB
LAKE LANIER SAILING CLUB
LAKE SEMINOLE ASSOCIATION
LAMPL-HERBERT CONSULTANTS, INC.
LANDMARK LANDSCAPES
LANIER CANOE & KAYAK CLUB
LANIER GOVERNANCE COUNCIL
LATHAM & WATKINS LLP
LAURA W. BENZ, LLC
LEAPING SEAFOOD
LEE COUNTY NAACP
LIGHTFOOT, FRANKLIN & WHITE LLC
LIMNO TECH
LOGAN MARTIN LAKE ASSOCIATION
LORD NELSON CHARTERS
LORIS BRIDGES REALTOR
LOWE ENGINEERS
MACON COUNTY BRANCH NAACP
MAINSTREAM COMMERICIAL DIVERS
MALLORY AGENCY
MANUFACTURE ALABAMA
MARINA INNOVATIONS
MARION COUNTY BRANCH NAACP
MARINE SPECIALTIES, INC.
MAYNARD COOPER & GALE, LLP
MARTIN DOCKS, INC.
MCINNIS LLC
MCMILLIAN & ASSOCIATES
MEADWESTVACO PACKAGING RESOURCES GROUP
MEAG POWER (MUNICIPAL ELECTRIC AUTHORITY OF GEORGIA)
MIELL CONSULTING
MIKE DANIEL RECREATION CENTER
MILLIKEN & CO.
MITCHELL COUNTY BRANCH NAACP
MITCHELL MARINE, INC.
MSB ANALYTICS, INC.
NATIONAL WILDLIFE FEDERATION
NEW VENTURES, INC.
NEWTON FLORIST CLUB
NPDES TRAINING INSTITUTE
O'BRIEN & GERE
OGLETHORPE POWER CORPORATION
P/N TAC
PAMELA A KEENE PUBLIC RELATIONS INC.
PARK MARINE
PAUL FRENCH & PARTNERS
PBS&J
PEA RIVER ELECTRIC COOPERATIVE
PEACOCK ARCHITECTS
PEACH COUNTY, WOOLFOLK CITIZEN RESPONSE GROUP
PHENIX CITY BRANCH NAACP
PINELAND PROPERTIES
PRITCHETT LAW FIRM LLC
QUINTUS CORPORATION
RAINWATER COLLECTION SOLUTIONS
RANDOLPH CUTHBERT BRANCH NAACP
REMAX CULPEPPER
REMAX RESULTS LAGRANGE
RENASANT BANK
RESOURCE MANAGEMENT ASSOCIATES
RIVER MILL DATA MANAGEMENT
ROBINSON BROTHERS GUIDE SERVICE
ROCHESTER & ASSOCIATES
ROCK TENN MILL COMPANY
RUSSELL CORPORTATION
RUSSELL LANDS INC
RUSSELL LANDSCAPE GROUP
SANDERS AND DUNCAN, P.A.
SASSER, SEFTON, CONNALLY, TIPTON, AND DAVIS, P.C.
SAVE THE LAKE ASSOCIATION
SCHIFF HARDIN, LLP
SEA TECHNOLOGY
SIERRA CLUB
SMOKIN FISHERMAN
SOILTERRA LANDSCAPE, INC.
SOL ENGINEERING, LLC
SOUTH FORK CONSERVANCY
SOUTHEAST FEDERAL POWER CUSTOMERS
SOUTHERN COMPANY
SOUTHERN ENVIRONMENTAL LAW CENTER
SOUTHERN HARBOR RESORT & MARINA
SOUTHERN NUCLEAR OPERATING CO
SPECPRO ENVIRONMENTAL SERVICES LLC
SPECTRUM MARITIME, INC.
STANDING TREE LAND
STEVEDORING SERVICES OF AMERICA
STEVENSON & PALMER ENGINEERING, INC.
STEWART COUNTY BRANCH NAACP

STEWART, MELVIN & FROST ATTORNEYS AT LAW
SUMTER COUNTY BRANCH NAACP
SUNWARD PROPERTIES
SUPPORTERS OF ST. VINCENT NWR
SUSTAINABLE ECOSYSTEM RESTORATION, LLC
SYNERGY EDUCATION SERVICES
TALBOT COUNTY BRANCH NAACP
TALL TIMBERS RESEARCH STATION & LAND CONSERVANCY
TANNER & ASSOCIATES
THE DIXIE GROUP
THE MARTIN FIRM LAW OFFICES
THE NATURE CONSERVANCY
THE NATURE CONSERVANCY OF ALABAMA
THE NATURE CONSERVANCY GEORGIA CHAPTER
THE NORTON AGENCY
THE RAIN SAVER.COM
THOMPSON ENGINEERING
TOMMY MIKE GUIDE SERVICE
TRI-RIVERS WATERWAY DEVELOPMENT ASSOCIATION
TRINITY EPISCOPAL CHURCH
TROUTMAN SANDERS LLP
TSYS, INC.
TURNER ENVIRONMENTAL LAW CLINIC
UNITED STEELWORKERS DISTRICT 9 OFFICE
UNITED STEELWORKERS LOCAL 753L
UPPER CHATTAHOOCHEE RIVERKEEPER
UPPER CHATTAHOOCHEE TROUT UNLIMITED
VANNESS, FELDMAN LLP
VENTON BUSH SURVEYORS
VISION 2030
WALLACE SHEET METAL WORKS
WARDS SHRIMP HOUSE
WARRIOR & GULF NAVIGATION CO.
WARRIOR-TOMBIGBEE WATERWAY ASSOCIATION
WATER MEDIA, INC.
W.C. BRADLEY FARMS, INC.
WESTOVER PLANTING CO
WEST POINT LAKE ADVISORY COUNCIL
WEST POINT LAKE COALITION
WEST POINT LAKE SAILING CLUB
WEST POINT LAKE AUTHORITY
WESTREC MARINAS
WESTROCK
WHITEWATER EXPRESS
WIEDEMAN AND SINGLETON, INC
WINDSONG SAILING ACADEMY
WINGATE HOTEL, LAGRANGE, GA
WORLD WILDLIFE FUND

10.8 Individuals

Cynde Aaron
Jeanne Abbott
Sandy Abbott
Wayne Abbott
Georgia Ackeman
Laura Adams
Margaret Adams
Tom Adams
Tim Aderholt
David Adlerstein
Donna Ahlswede
Douglas Aiken
Cal Allen
Tamara Allen
Gina Alvarez
Charles Amason
Wayne Andelson
Elizabeth Anderson
Jerry and Ginger Anderson
David Andrews
Kathy Andrews
Robert Ansley
Donamika L. Apencer
David Archer
Frank Armstrong
John Asbell
Charles Atkins
Frank Atkinson
Ethyl Ault
Dan and Rosemary Autry
Anne Avera
Martin Avery
Shelley Avirett
Larry Ayers
Jack Bagley
Don Bailer
Michael Bailey
Sammy Bailey
Don Baker
Donald Baker
Lisa Baker
Tom Baldwin
M.H. Bales
Charles Ball
David Ballard
Mary Balthrop
Donald Bangs
P. Barmeyer
Casey Barnett
Douglas Barr
James Barrios
William Barwell
David Barry
Ron Barteaux
Tom Bartels
Mike Bass
Mark Beachler

Phillip Beard
Gwen Beatty
Roy Beavers
Gary Beck
Georgia Bell
Jackie Bennett
Tammy Bennett
Wayne and Diane Bennett
Nancy Bentin
Vicki Bentley
Laura Benz
Jack and Barbara Bernzott
John Blackmon
J. Blackwood
Terri Blair
Russell Blanks
Brian Blythme
Nathan Boddie
Jim Boff
Helen Bohannon
Claudette Bolles
H.E. Bolton, Jr.
Travis Bond
Ginger Booton
Allyson Bowers
Bob Boyd
Claude Boyd
Joanne Boyer
Richard Boykin
Virginia Boyll
Jamie Bradfield
Rachel Bradford
Dorothy C. Bradley
Laurel Bradley
Heather Brand
Diane Brewer
Mike Briggs
Philip Brive
Patrick Brock
Terri Brooke
Richard Brookfield
Bill Brooksher
Jane Browder
Jack and Glenda Brown
James Brown
Michael Brown
Roger Brown
Nancy Brush
Joanne Buck
Bruce Buckley
Martha Fisher Buckley
Debbie Buckner
Gail Buckner
Marcia Bumbalough
Ila Burdette
Debbie Burdette
Janie Burel
Capt. P.H. Burgher
Pam Burnett
Steve and Carol Burell
Kirby Burt
Linda Butts
James Cahillane
Angi Cain
Pauline N. Cain
Amy B. Camacho
David Campbell
P. Grey Cane, Jr.
John Cannon
Jack Carbone
Jimmy Carlisle
Gail Carmody
Carolyn Carr
Pat Carver
Kip Cary
Renee A. Casillas
Danny Catt
Susan Cerulean
Michael Chadwick
Wesley Chafin
F.C. Chamberlin
Clay Champey
Carol Chapman
Chris and Joani Chase
Lucius B. Chastain
Patty Chastain
Mary Chatfield
Jim and Kim Cherry
Tom Child
Jim Childress
Jon and Alice Christenson
Ellen Claesson
Brian Claise
Sheila and Fred Clause
Michael T. Cobb
Ed Coglianese
Steve Cole
Kim Collicott
John P. Collins
Barnet and Ellen Coltman
Frank Concoat
Ron Condon
Monty Conner
Gibby Conrad
Ken Conway
Dennis Cook
Marion Cook
Leslie Coon
Bob Cooper
Erica Copeland
Jim and Teri Coryell
Patty and Greg Cosnotti
Bill Couch
Diane Coulton
Phil Coulton
Lydia Countryman
Richard Court
C.J. Cox
Edsel Cox
J. Carlyle Cox
Lesley Cox
Daniel H. Cox, P.A.
Karen Cox-Dennis
Steve Craig
Kyle Crawford
Mike Criddle
Leroy Crosby
Louis Cue
Kay Culpepper
Jim Cummins
Betty Cummins
Jeff Daigrepont
Richard D'Antoni
A.E. Daniel, III
Jeff Daniel
Larry Daniel
Troy Dasher
Ed Davis
John D Davis
Kay T. Davis
Kenneth Davis
Matthew Davis
Sonny Davis
Steve Davis
Lee Dehihns
Karen Denham-Downen
John Depalma
Harvey Devane
Craig Diamond
George Dixon
Nancy Dixon
Beneta Dodd
James Dodd

Jon Dodson
Jimmy Doerr
Diane Doll
Dave Dorris
Amy Dove
Richard T Dozier
Jeanne Dreaop
Jamie Driggle
Judy Dube
Victor Dube
Kip Duchon
Brenda Duggan
Jim Duggan
Carol Dunaway
Bill J. Dunn
Lawrence Durden
Mary Ann Durrer
Lee Edmiston
Judy Bailey Edwards
Mark Eggers
Robert Ellis
Kris Ellrich
Bill England
Hank Erickson
Mark Erwin
Tom Ewert
Eugenia Fagan
Andrew Fahlund
Beth Farber
Frank and Jean Farrell
Ed Feaver
Marylyn Feaver
Chris Fenn
A. Drew Ferguson, IV
Carol Ferguson
Jack P. Ferguson
Jeff Findley
Nancy Fisher
Steve and Nancy Fisher
Paul M. Flood
Debbie Flowers
Jennifer Flowers
Patrick Floyd
Donald and Jeanette Flynn
Kathren Fogg
Mike Fogg
Vince Foody
Dan Forrest
Mike Forster
Ray Fortune
David Fowler
Mark Fowler
Fred Fox
Janet Fox
Jim Franks
Dieter Franz
Jeff Fredrickson
Charlie Freed
Jere French
Matt French
Betty Fugate
Thomas Fugate
Gerald Fulton
Andy Fritchley
Gary Gaines
Mr. Jack Gaines
Thomas Gay
Peter Gallant
Heath Galloway
Dariz Gamble
Kyle Gamble
Susan Garchow
Dan Garlick
Frances Garner
Jason Garoner
Donne Garrett
Ron Garrett
James Geist
Ron Gempel
Etienne Gentin
Jeremy Gentry
Rich Gibson
Francis Giknis
Judy Gilbert
Mary Gilbert
Jack Gleason
Angie and Dyke Goodin
Carole Goodyear
Julie Gordon
Margaret Gracey
Don Graff
Laura Graham
Lawson Graham
John Gram
Lindsay Granger
Dan Graveline
Mark Gravenhorst
Jane Graves
Wendy and Van Green
Cathy Greene
Ken Greene
Anita Grove
Richard Grove
Ed Gutzmann
Marilyn Haight
Jim Hake
James Hale
Chuck Hall
Rosemary Hall
Skye Hall
Betty Hampton
Sam Hancock
Elizabeth Hand
Chad Hanson
Robert Harald
Janace Harding
G. B. Harrington
Billy Harris
Carol Harris
Linda Harris
Robert Harris
Kathy Hart
Phil and Donna Hart
Steve Hart
Louis P. Harvath, III
Karen Harvey
Heather Hauser
Arthur J. Hausmann
Ben Hawkins
Doug Hayes
Carol Heard
George Henderson
Gordon Hendley
Jennie Hendley
Aron Hendrix
David Hendirx
George Henry
Harvey Hepner
Kevin Herbert
Laura Herbig
Kathleen Herzog
Jim Hesser
Adam Hicks
John and Virginia Hicks
Terrie Higley
Mike and Geri Hildebrand
Douglas Hill
Holly and Forrest Hill
Carlos Hodges
Phillip Hodges
Dean Hoffman
Guy Hogan
Joyce and Richard Hoge

Eugene Holmes
Judy Holt
Richard Hopkins
Jennifer Hopper
Patrick Horgan
LeAnn Horne
Robert Horne
Matthew Hortman
Phil Horton
Shannon Hortsfield
Daniel Houghton
Billy V. Houston
John Howard
William Howard
Clyde Hudson
Reginald Hudson
Jon Huffmaster
Jean Hufham
Dawn Hutchins
Tom Hyde
Diane Ilgner
Leonard Inghilleri
Jim and Sue Inglis
Ken Ingram
John Inzgha
John Inzetta
Phillip Ivey
Nick Jameson
Jim Jarzen
Jill Jeglie
John E. Jickers, III
Joe JenningsKevin Jeselnik
Rebecca Jetton
Betty Johnson
Carabeth Johnson
Terri Jondahl
Benjamin Jones
Gail Jones
Jay Jones
Jeffrey Jones
Jesse S. Jones
Judy Jones
Lois Jones
Polly Jones
William C. Jones
A.J. Jones, LTC, USAR Retired
Bennett Junkin
Jan Junkin
Larry Joyner
Kenny Kaas
Myrna and Stewart Kallam
James Karr
Ray Kasten
Steve Katz
Amanda Kelley
Mary Kerries
Mack and Coco Ketron
Charles Kienzle
Phyllis Kienzle
Kristina Ilgner Lamons
Lisa Keith-Lucas
Gary and Roxann Killco
Patsy Kilmartin
Kwan Kim
Susan Kincaid
Rey Kineard
Ted King
Dennis Kineout
Mark Kirves
Johnny R. Kistler, Sr.
Adelle Knight
Isabelle and Charles Knight
Majorie Knipp
Catherine Krofanty
Dale and Joyce Kramer
Kathi Kreisler
Ross Kuhl
Stuart and Karen Kyle
John Lamay
Scott and Sue Landa
Lee Langley
Casey Lanier
Serge Latour
Barry Lawson
Holly Lawrence-Neyman
Richard Latham
Bobby and Sissy Lawson
Dong Lee
Donna Legare
Paul Lemay
Scott Leonard
Jim Levesque
Lauren Levi
Herbert Lewis
Van Lewis
Britt Lifsey
Duncan Liles, III
Kelly Linch
Pat Little
Richard Little
Ada Long
Teresa and Pat Longo
Danny Lowery
LeAnn Luce
Barry Lucas
Michael T. Ludvigsen
Tim Lull
Susan Macken
Lee Maddox
Larry Maddren
Betsy Malcolm
Jack C. Mallory
Sarah Beth Mallory
Joe Maltese
Chuck Mangan
Chris Manganiello
Christina Manning
Philip Manor
Peter Mansolillo
Nick Margaritando
Carol Margron
Carolyn Markert
Phil Markert
Faye and Dave Markey
Thomas Marks
Sam Marley
Willoughby Marshall
E. Joy Martin
Frank Martin
John Martin
Linda Martin
Nicole Martin
Traci Martin
Ronald Martinez
Erica Martinson
Charles Mason, Jr.
Wayne and Kathy Mattox
Katie Maxwell
Frank May
Arthur Mazyck
Carley McBride
Mike McBride
William F. McBride
Robin McCallister
Jack McCarthy
Joey McCartney
Charles McClellan
Jim McClellan
Patrick McConnon
Donna McCoy
Johnnie McCoy
Ralph McCurdy

Dianne McGee
Norman McGinnis
Don McGough
Jerry McGowan
Karen Graffius-Ashcraft
John McGrew, Jr.
Charles McGuire
Jim McGuire
Christine McKay
Lee McKinstrey
David McLain
James McLaughlin
Tom McLaughlin
Richard McLean
Lee McLemore
Mea McLeod
James and Glenda McNeil
Steve McNitt
Joseph L. Meaher
Lou and Lilli Meier
Jane Merritt
Ira Meyer
Edward Michaels
Sharon Michel
John Robert Middlemas
Kelly Ann Miles
Rocky Millenbire
Robert Miller
Walter Miller
Willie Miller
Sheri Millwood
Kay Michen
Kay and Greg Minchew
Sharon Mitchell
Sue Mitchell
John Mock
Linda Mock
Colleen Monchilovich
Dave Montrois
Bill Moore
Brad Moore
William Moore
John Moran
Eddie Morgan
Tom and Carilyn Morgan
Jimmy Morris
Joe Morris
Paul Morris
Bill Morrison
Evelyn Morrison
Gayle Muenchow
Jack Murphy
Mike Murphy
Gary Myers
Richard Myers
Liz Naughton
Steve Naughton
Janet Neal
Charles Neely
A.J. Nelson
Allen Nelson
Mike Nepote
Eugenia Newman
Kathy and Charles Newman
Brogdon Nichols
Dave Nichols
Charley Nix
Ann Nixon
James Norman
Beth Norred
Randy Norred
Allix North
Heidi Nufer
Eric O'Kelley
Gayle O'Neal
Thomas O'Shea
Margene Off
William Ogletree
John (Jack) Oliaro
Eric Olson
Elissa Omohundro
Kathleen Onan
Ron Orr
John Orrison
Judi and Roy Overstreet
Dianne Oswald
Douglas Owen
James Owen
Kathy Owen
Tony D. Owens
Oysterling Family
Catherine Page
Michael B. Parcell
Kentucky Parkis
Gathana Parmenas
Mrs. Robert Patterson
Michael Paul
Robert and Verna Paul
Doug Pauley
Ben Payne
Steve Peene
Russ Pennington
Ken Penuel
Elizabeth Perkins
Bill Perry
Robert N. Peterson
Keith and Charlene Pettigrew
Jim Phillips
Jimmy Phillips
Tommy Phillips
Richard Pickering
Max Picklesimer
Joe Piersante
Hannamiah Pinto
Darby Pippin
Lisa Pirkle
Joe Plantz
Kathleen Plantz
Janet Plumlee
Ron Plumlee
Jody Poe
Larry Poole
Karen Porter
Linda Poston
Wilbur Poston
R.L. Pound
Frank Powe, Jr.
Charlene and Mark Powell
Bob Powers
Charles and Linda Pratt
Dick Pressnall
Daniel Price
Dan Provence
Ronnie Purcell
Matt Pursley
Bonny Putrey
Roxanne Raccanelli
Linda Raffield
Barry Raines
Ian W. Ramsay
Pam Ramsay
Aku Rainio
Thomas Rasmussen
Randall Raven
John Ray
Ronald Ready
Heidi Recksiek
Susan Reddaway
Jeanette Reeves
Lesley Reilly
Ted Resante
William M. Rezak
Adam Richards

Darrel Richardson
Ed Richardson
John Richardson
Margaret Dickey Richardson
Pam Richardson
Pat Richardson
Gail Riegelmayer
Paul Riegelmayer
Dave Rigdon
Ron Riggs
Sid W. Riley
Robert Rishel, III
Bruce Ritchie
Betty V. Ritter
Doug and Mary Robbins
J.N Robbins, Sr.
Mary Anna Robinson
Danny Rock
Ray Roesel
Charles Rogers
Linda Rogers
Mark Rogers
Jennifer Rojo
Diane Rooks
Diane Rothberg
Dan Rothwell
Jyll Rowe
Marilyn Royal
Robert Ruether
David Ruppenicker
Don Russell
Kenneth Russell
Sheri Russo
Barbara Rutherford-Dorris
Terry Ryan
David Rybick
Mr. and Mrs. Sager
Melissa Samet
Barbara Sanders
William Sanders
Kim Sash
Virginia Satterfield
Margo and Peter Savitz
Edwin Sawyer
John Sblendorio
James P. Scarborough
Ralph Schiefferle
Tony Schlich
Pamela Schock
Susan Schoering
Terrell Schroder
Robert Schurke
Carol Schwarz
Wm. T. Schwendler, Jr.
Paul Sconyers
Graham Scott
Hollie Scott
Larissa Scott
Sandra Seagraves
Ronald Seder
A. George Seelke
Anna Seely
Christopher Seely
Ronnie Segree
Jim Sexton
Dennis Shaeffer
C. Keith Shannon
Faye P. Sharit
Alan Shedd
Janice Shepard
Kathryn Sherlock
Robert Shiply
Kathy Shipman
Jane Shiver
Peter J. Shuba
Linda Shulin
Lawrance Simmons
Kathryn Simpson
Leo Singleton
P.G. Singleton
E.S. Singleston
Gary Sisco
Leonies Skaar
Brian Skeens
Frank and Leslie Smalley
Greg Smallwood
Dale and Barbara Smart
Rick Smathers
Ann Smith
Charles Smith
Edward Smith
Gary Smith
Jeanett Smith
Jeff Smith
Kenneth Smith
Leo Smith
Lori Smith
Ben Snowden
Clayton Solomon
Sharon Solomon
Wil Sommer
Eddie Sosebee
Regina and Jim Southerland
Andy Sparks
Mildred Speights
Edward Springer
Coral Sprouse
Mitch and Rachel Spruill
Robert Staines
R.E. Standland
John and Dorothy Stanford
Katherine Stanford
Bob and Cher Stiehler
Eric Steinhilper
Karen Sterling
Janice Stever
Tom Steusloff
Robert J. Stewart, Sr.
Robert Stilley
Beth Stinson
Elizabeth and James Stinson
Marjorie Stitt
Alison Stoddart
Charles Stradcutter
Chris Strickland
Daniel Strickland
Lynn Strickland
Richard Strickland
Tim Strickman
Ben Stump
Sharon Stump
Donald Styml
Mike Sullivan
Kathy Swaggerty
Kim Cole Sweazy
J.B. Swicord
Carol Talley
Bill Tannahill
Ben Taylor
Donald Taylor
Trudy Taylor
Patrick Terrell
Diedrich B. Timm
Mack Tharpe
Danny Thomas
Art Thompson
Bill Thompson
Denise Thompson
Lloyd Thompson
Mary Thompson
Tommy Thompson
Suzanne Tibbs
Siden Tilghman

Scott Tittle
Carol Todd
Hugh and Janice Toles
Minnich Tom
Mac Tonsmeire
David Tour
Dale Townsend
Clayton Triggs
Tom Troncalli
Billy Trotter
Helen Tudor
John Turner
Russ Turner
Ken Uyl
Katie Van Schoor
Nicki Vaughn
Dianna Van Horn
Ron Veal
George Verdier
Jim Vearil
Richard Vickers
Eucle Vickery
Thomas Vivelo
Steve Volino
Michael Vroegap
Robin Rickel Vroegap
Jodi Wacho
Stacy Wade
Dr. David B. Wagner
Tammi Wakem
Clinton Walker
Matthew Walker
Sherrie Walker
Rebecca Wallace
Kevin Waller
Carol Walston
Brian Wanamaker
George Wangemann
Steven Ward
Tim Ward
Steve Warlzek
Gene Watford
Gerald Watson
David Watts
John Watts
Daryl Weathers
John Webb
Caroline Weiler
Horace Welch
Tom Wenning
Ruth Werner
Carol Weyrich
Leo Whalen
John F. Whelchel
Bruce White
Alan Whitehouse
James Whitehouse
D.B. Whiting
David Whitley
Freddie Whitley
Chad Whitmire
Jean Whitney
Susan Whittle
Roy Wilcox
Lynn Wilder
David Wilkes
Asa Williams
Benton Williams
Dave Williams
Mike Williams
Carolyn Willis
Thomas Wilmoth
Kathi Wilson
Lynn Wilson
James C. Wingo
Dennis Winterringer
Sam O. Wolford
Terry Wolsifer
Jack and Elaine Wood
Mark Woodall
Julia Woodard
Marsha Woodward
Don Wright
T.J. Wright, LT.
Nancy and Bob Yate
Ben Yates
Jane Yates
Jonathan Yoder
Richard York
Evelyn Zarate
Brian Zimmel
Nicole Zitani
Shawn Zwilling

10.9 Libraries

Auburn University Libraries
Auburn, AL

Auburn Public Library
Auburn, AL

Montgomery City-County Public Library
Montomery, AL

Selma-Dallas County Public Library
Selma, AL

Eufaula Carnegie Library
Eufaula, AL

H. Grady Bradshaw-Chambers County Library
Valley, AL

Lafayette Pilot Public Library
Lafayette, AL

Abbeville Memorial Library
Abbeville, AL

Blanche R. Solomon Memorial Library
Headland, AL

Ashford Branch Library
Ashford, AL

Columbia Branch Library
Columbia, AL

Lewis Cooper Jr. Memorial Library
Opelika, AL

Annie L. Awbrey Public Library
Roanoke, AL

Phenix City–Russell County Public Library
Phenix City, AL

Dothan Houston County Main Branch Library
Dothan, AL

University of Alabama-Birmingham Library
Birmingham, AL

University of South Alabama Library
Mobile, AL

Calhoun County Public Library Blountstown Branch
Blountstown, FL

Altha Public Library
Altha, FL

Hugh Creek Park Public Library
Blountstown, FL

Kinard Park Public Libraries
Kinard, FL

Apalachicola Municipal Library
Apalachicola, FL

Franklin County Public Library Eastpoint Branch
Eastpoint, FL

Franklin County Public Library Carrabelle Branch
Carrabelle, FL

Cowen Public Library
Chattachoochee, FL

Florida State University Library
Tallahassee, FL

George A. Smathers Library
Gainesville, FL

Gulf County Public Library
Port St. Joe, FL

Charles Whitehead Wewahitchka Public Library
Wewahitchka, FL

Jackson County Public Library
Marianna, FL

Harrell Memorial Library of Liberty County
Bristol, FL

Baker County Library
Newton, GA

Calhoun County Library
Edison, GA

Whitesburg Public Library
Whitesburg, GA

Cusseta-Chattahoochee County Public Library
Cusseta, GA

Clayton County Headquarters Library
Jonesboro, GA

Lovejoy Library
Hampton, GA

Riverdale Library
Riverdale, GA

Central Library, Cobb Co. PLS
Marietta, GA

East Marietta Library
Marietta, GA

Hattie G. Wilson Library
Marietta, GA

Kemp Memorial Library
Marietta, GA

Lewis A Ray Library
Smyrna, GA

Cobb County Library System
Marietta, GA

East Cobb Library
Marietta, GA

Mountain View Regional Library
Marietta, GA

Powder Springs Library
Powder Springs, GA

Sibley Library
Marietta, GA

South Cobb Library
Mableton, GA

Stratton Library
Marietta, GA

Sweetwater Valley Library
Austell, GA

Vinings Library
Atlanta, GA

Central Library—Coweta
Newnan, GA

Grantville Public Library
Grantville, GA

Newnan-Coweta Public Library
Newnan, GA

Senoia Public Library
Senoia, GA

Crawford County Public Library
Roberta, GA

Cordele-Crisp Carnegie Library
Cordele, GA

Decatur County-Gilbert H. Gragg Library
Bainbridge, GA

Brookhaven Library
Atlanta, GA

Chamblee Library
Chamblee, GA

Clarkston Library
Clarkston, GA

Decatur Library
Decatur, GA

Doraville Library
Doraville, GA

Dunwoody Library
Dunwoody, GA

Embry Hills Library
Chamblee, GA

Northlake-Barbara Loar Branch
Tucker, GA

Scottdale-Tobie Grant Library
Scottdale, GA

Toco Hill-Avis G. Williams Library
Decatur, GA

Tucker-Reid H. Cofer Library
Tucker, GA

Byromville Public Library
Byromville, GA

Dooly County Library
Vienna, GA

Central Library
Albany, GA

Northwest Library
Albany, GA

Southside Library
Albany, GA

Tallulah Massey Library
Albany, GA

Westtown Library
Albany, GA

Douglas County Public Library
Douglasville, GA

Lithia Springs Public Library
Lithia Springs, GA

Jakin Public Library
Jakin, GA

Lucy Maddox Memorial Library
Blakely, GA

Fayette County Public Library
Fayetteville, GA

Peachtree City Library
Peachtree City, GA

Tyrone Public Library
Tyrone, GA

Cumming Branch & Headquarters
Cumming, GA

Sharon Forks Library
Cumming, GA

Adams Park Branch
Atlanta, GA

Adamsville-Collier Heights Branch
Atlanta, GA

Alpharetta Branch
Alpharetta, GA

Auburn Avenue Research Library
Atlanta, GA

Bankhead Courts Branch
Atlanta, GA

Bowen/Bankhead Branch
Atlanta, GA

Buckhead Branch
Atlanta, GA

Central Library (Atlanta-Fulton PLS)
Atlanta, GA

Ponce de Leon Branch Library
Atlanta, GA

College Park Branch
College Park, GA

Dogwood Branch
Atlanta, GA

East Point Branch
East Point, GA

Fairburn Branch
Fairburn, GA

Martin Luther King Jr Branch
Atlanta, GA

Northeast/Spruill Oaks Branch
Johns Creek, GA

Northside Branch
Atlanta, GA

Ocee Branch
Johns Creek, GA

Peachtree Branch
Atlanta, GA

Perry Homes Branch
Atlanta, GA

Roswell Branch
Roswell, GA

Sandy Springs Branch
Atlanta, GA

South Fulton Branch
Union City, GA

Southwest Branch
Atlanta, GA

Washington Park Branch
Atlanta, GA

West End Branch
Atlanta, GA

Buford-Sugar Hill Branch
Buford, GA

Duluth Branch
Duluth, GA

Peachtree Corners Branch
Norcross, GA

Suwanee Branch Library
Suwanee, GA

Clarkesville-Habersham County Library
Clarkeville, GA

Cornelia-Habersham Co. Lib.
Cornelia, GA

Hall County Headquarters Library
Gainesville, GA

East Hall Branch Library
Gainesville, GA

Murrayville Branch
Gainesville, GA

Harris County Public Library
Hamilton, GA

Williams Memorial Library
Fortson, GA

Heard County Public Library
Franklin, GA

Fortson Public Library
Hampton, GA

Leesburg Library
Leesburg, GA

Redbone Library
Leesburg, GA

Smithville Library
Smithville, GA

Lumpkin County Library
Dahlonega, GA

Ideal Public Library
Ideal, GA

Marshallville Public Library
Marshallville, GA

Montezuma Public Library
Montezuma, GA

Oglethorpe Public Library
Oglethrope, GA

Marion County Library
Buena Vista, GA

Greeneville Area Public Library
Greenville, GA

Manchester Public Library
Manchester, GA

James W. Merritt, Jr. Memorial Library
Colquitt, GA

DeSoto Trail Regional Library
Camilla, GA

Columbus Public Library
Columbus, GA

Mildred L Terry Branch Library
Columbus, GA

North Columbus Branch Library
Columbus, GA

South Columbus Branch Library
Columbus, GA

Maude P Ragsdale Library
Hiram, GA

New Georgia Public Library
Dallas, GA

J. Joel Edwards Public Library
Zebulon, GA

Quitman County Library
Georgetown, GA

Randolph County Library
Cuthbert, GA

Schley County Library
Ellaville, GA

Seminole County Public Library
Donalsonville, GA

Griffin-Spalding County Library
Griffin, GA

Georgia State University Library
Atlanta, GA

Parks Memorial Public Library
Richland, GA

Lake Blackshear Headquarters Library
Americus, GA

Talbot County Library
Talbotton, GA

Butler Public Library
Butler, GA

Reynolds Community Library
Reynolds, GA

Terrell County Public Library
Dawson, GA

Hogansonville Public Library
Hogansville, GA

LaGrange Memorial Library
LaGrange, GA

Hightower Memorial Library
Thomaston, GA

University of Georgia Libraries
Athens, GA

Webster County Library
Preston, GA

White County Library – Cleveland Branch
Cleveland, Georgia

White County Library – Helen Branch
Helen, GA

10.10 Media

Associated Press
Atlanta, GA

Eufaula Tribune
Eufaula, AL

Valley Times News
Lanett, AL

Dothan Eagle
Dothan, AL

Dothan Progress
Dothan, AL

The Auburn Plainsman
Auburn, AL

The Auburn Villager
Auburn AL

The Corner
Auburn, AL

OANow
Opelika, AL

The Tuskegee News
Tuskegee, AL

The Campus Digest
Tuskegee, AL

The Randolph Leader
Roanoke, AL

WTBF-AM 970 & FM 94.7
Troy, Alabama

WTLS-AM 1300
Tallassee, AL

WBAM-FM Star 98.9
Montgomery, AL

WDJR-FM 96.9
Dothan, AL

WESP-FM 102.5
Dothan, AL

WKMX FM 106.7
Dothan, AL

WOOF-AM 560 & FM 99.7
Dothan, AL

WTVY-FM 95.5
Dothan, AL

WTSU / WRWA / WTJB
Troy, AL

WDHN (Ch. 18)
ABC
Dothan, AL

WDFX (Ch. 34)
Fox
Dothan, AL

WTVY (ch. 4)
Dothan, AL

WAKA (Ch. 8)
CBS
Montgomery, Alabama

WCOV (Ch. 20)
Fox
Montgomery, AL

WSFA (Ch. 12)
NBC
Montgomery, AL

Tallahassee Democrat
Tallahassee, FL

The Bay County Press
Fountain, FL

The News Herald
Panama City, FL 32401

The County Record
Blountstown, FL

The Apalachicola Times
Apalachicola, FL

The Franklin Chronicle
Eastpoint, FL

The Gadsden County Times
Quincy, FL

Havana Herald
Havana, FL

JC Floridan
Marianna, FL

Jackson County Times
Marianna, FL32448

The Calhoun-Liberty Journal
Bristol, FL

The Star
Port St. Joe, FL

Washington County News
Chipley, FL

WOYS 100.5 FM
Eastpoint, Florida

WFSY 98.5 FM
Panama City, FL

WYYX 97.7 FM
Panama City Beach, Florida

WRBA 95.9 FM
Panama City Beach, FL

WPAP 92.5 FM
Panama City, FL

WLHR 107.9 FM
Panama City, FL

WFSU/WFSL 90.7 FM
Tallahassee, FL

WFSU TV
Public Television
Tallahassee, FL

WXTL TV (27)
Tallahassee, FL

WJHG (7)
NBC
Panama City Beach, FL

WMBB (13)
ABC
Panama City, FL

WCTV (6)
CBS
Tallahassee, FL

WTLH (49)
FOX
Midway, FL

WTWC (40)
NBC
Tallahassee, FL

WTXL (27)
ABC
Midway, FL

Atlanta Journal-Constitution
Atlanta, GA

Banks County News
Jefferson, GA

Times Georgian
Carrollton, GA

West Georgian
Carrollton, GA

Clayton News Daily
Jonesboro, GA

Clayton Neighbor
Forest Park, GA

Clayton Tribune
Clayton, GA

Stormy Petrel
Atlanta, GA

Signal
Atlanta, GA

The Daily Report
Atlanta, GA

The AUC Digest
Atlanta, GA

Atlanta Business Chronicle
Atlanta, GA

The Sentinel
Kennesaw, GA

Panther
Atlanta, GA

Northside Neighbor
Atlanta, GA

Mundo Hispanico
Atlanta, GA

Southeast Farm Press
St. Charles, IL

Georgia Bulletin
Smyrna, GA

Emory Wheel
Atlanta, GA

Atlanta Voice
Atlanta, GA

Creative Loafing
Atlanta, GA

Atlanta Jewish Times
Atlanta, GA

Atlanta Intown
Sandy Springs, GA

Atlanta Chinese News
Atlanta, GA

Atlanta Daily Word
Atlanta, GA

Sunday Paper
Atlanta, GA

Technique
Atlanta, GA

The Moultrie Observer
Moultrie, GA

Newnan Times-Herald
Newnan, GA

Loganville Times
Loganville, GA

The Cordele Dispatch
Cordele, GA

Dawson Community News
Dawsonville, GA

Dawson News & Advertiser
Dawsonville, GA

Champion Newspaper
Decatur, GA

Dekalb Neighbor
Roswell, GA

The Post Search light
Bainbridge, GA

News Observer
Vienna, GA

Citizen Georgian
Montezuma, GA

The Albany Herald
Albany, GA

The Early County News
Blakely,GA

Citizen
Fayetteville, GA

Fayette Daily News
Fayetteville, GA

Fayette Neighbor
Atlanta, GA

Forsyth County News
Cumming, GA

Forsyth Herald
Alpharetta, GA

Dunwoody Crier
Dunwoody, GA

S. Fulton Neighbor
Forest Park, GA

Roswell Neighbor
Roswell, GA

Revue News
Alpharetta, GA

Johns Creek Herald
Alpharetta, GA

Milton Herald
Alpharetta, GA

Cairo Messenger
Cairo, GA

Weekly
Peachtree Corners, GA

Gwinnett Citizen
Grayson GA

Gwinnett Daily Post
Lawrenceville, GA

The Northeast Georgian
Cornelia, GA

The Gainesville Times
Gainesville, GA

Lakeside on Lanier
Gainesville, GA

Harris County Journal
Hamilton, GA

Henry Neighbor
Forest Park, GA

Daily Herald
Forest Park, GA

Henry Herald
McDonough, GA

Henry County Times
McDonough, GA

Houston Home Journal
Perry, GA

Herald Gazette
Barnesville, GA

Lee County Ledger
Leesburg, GA

Dahlonega Nugget
Dahlonega,GA

Tri County Journal & Chattahoochee Chronicle
Buena Vista, GA

Manchester Star Mercury
Manchester, GA

Meriwether Vindicator
Manchester, GA

Miller County Liberal
Colquitt, GA

Mitchell County GA
Pelham, GA

Monroe County Reporter
Forsyth, GA

Paulding Neighbor
Hiram, GA

Leader Tribune
Fort Valley, GA

Journal Reporter
Zebulon, GA

Donalsonville News
Donalsonville, GA

Griffin Daily News
Griffin, GA

Toccoa Record
Toccoa, GA

Talbotton New Era
Talbotton, GA

LaGrange Daily News
LaGrange, GA

Hogansville Home News
Manchester, GA

West Georgia Beacon
Hogansville, GA

Thomaston Times
Thomaston, GA

White County News
Cleveland, GA

The Business Journals
Charlotte, NC

WUNV (91.7 FM)
Albany, GA

WUOG (90.5 FM)
Athens, GA

WGST (640 AM)
Atlanta, GA

WSB (750 AM and 95.5 FM)
Atlanta, GA

WCNN (680 AM and 93.7 FM)
Atlanta, GA

WABE (90.1 FM)
Atlanta, GA

WREK (91.1 FM)
Atlanta, GA

WRFG (89.3 FM)
Atlanta, GA

WSTH-FM 106.1
Columbus, GA

WUWG (90.7 FM)
Carrollton, GA

WRCG (1420 AM)
Columbus, GA

WTJB (91.7 FM)
Troy, Alabama

WPPR (88.3 FM)
Atlanta, GA

WJWV (90.9 FM)
Atlanta, GA

WDUN (550 AM and 102.9 FM)
Gainesville GA

WLAG (1240 AM)
Lagrange, GA

WFXL (Channel 31)
Fox
Albany, GA

WALB (Channel 10)
NBC
Albany, GA

WABW (Channel 14)
PBS
Atlanta, GA

WSB (Channel 2)
ABC
Atlanta, GA

WGLC (Channel 46)
CBS
Atlanta, GA

WAGA (Channel 5)
Fox 5 Atlanta
Atlanta, GA

WTBS (Channel 26)
Independent
Norcross, GA

WXIA (Channel 11)
NBC
Atlanta, GA

WGTV (Channel 8)
PBS
Atlanta, GA

WPBA (Channel 30)
PBS
Atlanta, GA

WUPA (Channel 69)
CW
Atlanta, GA

WATL (Channel 36)
My Network TV
Atlanta, GA

WTVM (Channel 9)
ABC
Columbus, GA

WRBL (Channel 3)
CBS
Columbus, GA

WLTZ (Channel 38)
NBC
Columbus, GA

WJSP (Channel 28)
PBS
Atlanta, GA

WYBU (Channel 16)
Independent
Phenix City , AL

WSST (Channel 55)
Independent
Cordele, GA

WACS (Channel 25)
PBS
Atlanta, GA

WPGA (Channel 58)
ABC
Macon, GA

WMAZ (Channel 13)
CBS
Macon, GA

WGXA (Channel 24)
Fox
Macon, GA

WMGT (Channel 41)
NBC
Macon, GA

WDCO (Channel 29)
PBS
Atlanta, GA

WCAG (Channel 33)
LaGrange, GA

11 Glossary

Number/Symbol

7Q10 flow: The lowest 7-day average flow that occurs on average once every 10 years at a flow-measuring station or gage.

A

Action zones: Partitions of a reservoir's conservation storage, as defined in the reservoir water control manual, and designated according to a range of surface elevations of the water pool for a reservoir; action zones are used to guide reservoir managers in meeting project purposes under a wide variety of hydrologic conditions. Each action zone has a set of specific operational rules or guidelines that govern water management operations for the reservoir when the pool elevation lies within that zone.

Allocation formula: See *water allocation formula.*

Anadromous fish: Fish with a migratory life cycle in which they live most of adult life in ocean water but breed in freshwater, with individual adults often returning from the sea to the rivers where they were spawned.

Assimilative capacity: The amount of pollutants that a water body can accommodate without violating a water quality standard or impairing the designated use.

Authorized project purpose: The legally mandated purpose for which USACE must manage each ACF project.

Available precipitation: The net available moisture in a system resulting from the balance between total precipitation (input) and potential evapotranspiration (loss). Also see *evapotranspiration*.

B

Bankfull capacity (or channel capacity: The discharge, or stage, at which a stream or river is at the top of its banks such that any further increase or rise would result in water moving into the flood plain.

Baseflow: The portion of streamflow from groundwater; not attributed to overland runoff.

Brackish: Describes water at the interface of freshwater and saltwater where river discharge is diluting salinity concentrations and average water salinity is between that of seawater (about 35 parts per thousand) and freshwater (upper threshold of about 0.5 parts per thousand).

C

Canopy: Tallest vegetation in a community, usually trees more than 30 feet tall or 3 inches in diameter; the tallest grasses or other herbaceous species.

Catadromous fish: Fish with a migratory life cycle in which they live most of adult life in freshwater but breed in the ocean.

Channel forming discharge: High river flows, with recurrence intervals of about 1.5 years, which are dominant in shaping the river channel.

Compact: See *River basin compact*.

Comprehensive Study: Consensus-based study in the 1990s to determine the capabilities of the water resources of the basin, describe the water resource demands of the basin, and evaluate alternatives that would use the water resources to benefit all user groups within the basin. The Comprehensive Study was commissioned in the 1992 tri-state (Alabama, Florida, Georgia) Memorandum of Agreement. It collected much valuable data but was never completed.

Composite conservation storage: The total available conservation storage (in ac-ft) at any point during the year within the federal projects in the ACF Basin, calculated by combining the total available conservation storage of Lake Sidney Lanier, West Point Lake, and Walter F. George Lake.

Confluence: The point of juncture of two or more streams.

Conservation pool: The portion of reservoir storage usually reserved for power production and water supply.

Conservation storage: The volume of reservoir storage available to meet authorized project purposes other than flood risk management (e.g., hydropower, water supply, recreation, etc.); equivalent to the storage volume between the top of the inactive pool and the top of the conservation pool.

Consumptive use (or, consumptive water use): The portion of water withdrawn from a water body for beneficial use that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the environment.

Critical drought: The most severe drought for a region, either recorded or constructed.

Critical period: The time period containing the critical drought. Usually the time starts as the drought begins and reservoirs are full. The time ends after the reservoirs have been returned to full condition.

Critical yield: The maximum amount of water that can be consistently removed from a reservoir(s) through releases from the dam and/or withdrawals from the reservoir, during the most severe drought in the hydrologic period of record, exactly depleting the reservoir conservation storage once during the period of record.

D

Delta: An increment of a variable; measure of change in a variable.

Designated use: A use that is established by state or tribal regulation as appropriate for individual waterbodies (rivers, streams, lakes, and such) under their jurisdiction and that is to be achieved or protected under water quality standards; regulatory designated uses include public water supply; aquatic life protection (protection of macroinvertebrates, fish, shellfish, and wildlife); and recreational (fishing and swimming); agricultural; industrial; and navigational purposes.

Detritus (detrital carbon): Fresh to partly decomposed plant and animal matter.

Draft Environmental Impact Statement (EIS): The publication that documents the environmental conditions, issues, and effects associated with an action affecting the environment and on which the public is invited to review and comment. Comments received from regulatory agencies, organizations, and individuals are addressed in the final EIS (see *final EIS*).

Drainage area: All of the surface area, including land and any water bodies, from which water upstream of a location on a stream, river, or water body drains to that location (see *drainage basin, drainage divide*).

Drainage basin: The region or area drained by a river and all of its tributaries, where water from rain and melting snow or ice drains downhill to that river (see *drainage area,* and *drainage divide*).

Drainage divide: The boundary line, along a topographic ridge or other landform that separates adjacent drainage basins (see *drainage area, drainage basin*).

Drawdown: The act of lowering a reservoir's water level by beginning or increasing reservoir releases.

Drought Zone: A volume of water equivalent to the inactive storage in lakes Lanier, West Point, and Walter F. George plus Zone 4 storage in Lake Lanier (see *Action zones*).

E

Ecoregion: An *ecological region*; a geographic area of broadly similar physiographic and environmental conditions (e.g., landforms, climate, and soil conditions) such that it supports broadly similar terrestrial and aquatic plant and animal communities.

Emergent: Describes plants that are entirely above water or mostly above water, with only the base remaining submerged.

Endemic: Characteristic of, or prevalent in, a particular area or environment.

Estuarine: Describes deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Euryhaline: Describes an aquatic organism that is able to tolerate wide fluctuations in salinity (contrast *stenohaline*).

Eutrophic (noun: *eutrophication)*: Describes a body of water—commonly a nonflowing body such as a lake, pond, or reservoir—that has high primary productivity resulting from excessive nutrients and can be subject to algal blooms resulting in poor water quality (compare *mesotrophic*).

Evapotranspiration: From *evapo*ration + *transpiration*; the combined discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soils and by transpiration from plants.

F

Fall rate (ramping rate): The vertical drop in water surface elevation that occurs over a given period.

Final EIS: The final product of the environmental impact statement process, which reflects comments received on the draft EIS (see *draft EIS*).

Fish Passage Operations: The USACE operation of the lock at Jim Woodruff Dam to facilitate downstream-to-upstream passage of Alabama shad and other anadromous fish.

Fish Spawning Operations: The USACE operation of the ACF Basin to provide favorable conditions for annual fish spawning in reservoirs and in the Apalachicola River. The goal is to operate for a generally stable or rising lake level and a generally stable or gradually declining river stage on the Apalachicola River for approximately 4 to 6 weeks during designated fish spawning periods.

Flood pool: Space above the conservation pool to hold waters throughout the year. Lake Lanier and West Point Lake are drawn down beginning in the fall through winter and into early spring to provide additional capacity to protect life and property in the basin.

Flood risk management: A systematic approach to both manage flood waters to reduce the probability of flooding (through structural measures such as levees and dams) and floodplains to reduce the consequences of flooding when it occurs. In the context of reservoirs, flood risk management includes water management operations to draw down reservoirs beginning in the fall through winter and into early spring to provide additional storage capacity to protect life and property in the basin. Section 2 of the River and Harbor Act of 1945 (Public Law 79-14) approved the general plan recommended in House Document 342, 76th Congress, for development of the Apalachicola, Chattahoochee, and Flint Rivers, Georgia and Florida, for multiple purposes, including flood damage reduction.

Flood storage: The volume of reservoir storage between the elevation of the top of the conservation pool and top of the flood storage pool, specifically for storing peak flows into the reservoir until those inflows can safely be passed through the downstream channel system with no or minimal flood damage.

Fork length: Length of a fish measured from the tip of the snout to the end of the middle caudal fin rays; used in fishes in which it is difficult to tell where the vertebral column ends

G

Guide curve: The seasonally variable desired pool elevation in a reservoir, normally defined as the elevation at the top of the conservation storage (synonymous with *rule curve*).

H

HEC: Hydrologic Engineering Center, an organization within the USACE that, among other things, developed the ResSim hydrologic modeling software used to analyze reservoir operations (see *ResSim*).

HEC-5Q: Water quality computer modeling software linked to reservoir operations modeling software, developed by the USACE Hydrologic Engineering Center (see *HEC*).

HEC-ResSim: Reservoir operations computer modeling software, developed by the USACE's Hydrologic Engineering Center.

Herbaceous: Describes nonwoody plant species, such as grasses.

Hydroelectric power (hydropower): Electricity produced by converting the energy released by water falling, flowing downhill, moving tidally, or moving in some other way into electrical energy. Section 2 of the River and Harbor Act of 1945 (Public Law 79-14) approved the general plan recommended in House Document 342, 76th Congress, for development of the Apalachicola, Chattahoochee, and Flint Rivers, Georgia and Florida, for the multiple purposes including hydroelectric power generation. Hydroelectric power generation is achieved by passing flow releases to the maximum extent possible through the turbines at each project, even when making releases to support other project purposes. The hours of operation are dependent on reservoir action zones. In the ACF Basin, Buford Dam, West Point Dam, Walter F. George Dam, and Jim Woodruff Dam include hydroelectric power plants.

I

Inactive pool: The portion of reservoir storage below the conservation pool that contains *inactive storage.* The top level of the inactive pool is defined for each reservoir as the elevation below which releases are limited to those necessary to meet water supply needs, maintain water quality, and sustain endangered or threatened species and their critical habitats. Releases from the inactive pool for these purposes could continue until the physical limits of the reservoir to release water are reached.

Inactive storage: The portion of reservoir storage in the *inactive pool.*

Interbasin transfer: The process of withdrawal of water from one river basin for beneficial use in another basin that is not naturally connected, resulting in a net loss of water from the donor basin and a net increase to the receiving basin.

L

Land use: Includes existing and planned land use activities and land ownership, as defined in an applicable land use planning document for the potentially affected area. Land use compatibility of a proposed action is determined by comparing the proposed use of the affected area to the existing and planned uses of the adjacent area.

M

Master Water Control Manual (Master Manual): A record of basin-wide water control objectives and operational guidelines developed with thorough consideration of all project purposes to cover a full array of all foreseeable hydrologic conditions, from flood to drought.

Mesic: Describes a condition of moderate moistness, as in a mesic soil.

Minimum flow (minimum stream flow): A low river flow at a specified point in a river. The minimum flow may be a regulated minimum flow or a specific level needed for water supply or other purposes.

Mitigation: Additional actions taken to avoid, minimize, rectify, reduce, eliminate, or compensate for impacts. The Council on Environmental Quality requires Federal agencies, in preparing an environmental impact statement, to identify appropriate mitigation measures for adverse impacts to significant resources not already addressed by the proposed action or alternatives.

N

Navigation: The act of conveying waterborne vessels from place to place. Section 2 of the River and Harbor Act of 1945 (Public Law 79-14) approved the general plan recommended in House Document 342, 76th Congress, for development of the Apalachicola, Chattahoochee, and Flint Rivers, Georgia and Florida, for multiple purposes, including navigation. The existing project authorizes a 9-foot-deep by 100-foot-wide waterway from Apalachicola, Florida, to Columbus, Georgia, on the Chattahoochee River, and to Bainbridge, Georgia, on the Flint River.

Navigation window: Typically, a 10-day to 2-week period in which stored water is released to the river and held at specified levels so that shippers have a predetermined depth and adequate lead time to move into the system.

No Action Alternative: The baseline or current operation condition against which the action alternatives are compared. The No Action Alternative provides the baseline flows needed to assess the impacts of the Proposed Action Alternative.

Non-consumptive use (or, *non-consumptive water use*): An activity, such as hydroelectric power generation, that uses water from the basin without any withdrawal or loss of water from the system.

Nonpoint source: Describes water pollution that does not originate only or exclusively from a single location (such as a pipe discharge) but rather is diffuse in origin. Nonpoint sources generally include runoff from broad areas of land wherein the runoff accumulates varieties of pollutants, such as from urban, industrial, agricultural, or silvicultural land areas, and delivers them to waterbodies.

O

Orographic effect: The effect that occurs when a moving air mass approaches a mountain range and is rapidly forced upward by the elevated land surface, thereby causing the air temperature to cool and the moisture in the air to condense and fall as precipitation.

P

Palustrine wetlands: Generally, refers to nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand.

Peaking project: A project in which hydroelectric power is generated several hours a day, typically on weekdays in the afternoons and early evenings, in response to peak demands on the power system. Flows downstream of a peaking project can fluctuate rapidly.

Period of record: Typically, the time period for which there are published records for a data collecting station, usually referring to a streamflow gaging station. The ResSim hydrologic modeling efforts used data from gages with periods of record ranging between 1939 and 2011.

Project site: For the proposed action of this EIS, the entire ACF Basin.

Proposed Action Alternative: Also known as the Preferred Action Alternative, this is the alternative that the USACE proposes to implement in the ACF Basin.

R

Reallocation (of storage): The reassignment of the use of existing storage space in a reservoir project from a currently authorized purpose to an alternate use for water supply (per the Water Supply Act of 1958). If provision of water supply would seriously affect a project's authorized purposes or cause a major operational change, the reallocation would require congressional authorization. Otherwise, it may be accomplished administratively. Reallocation of storage from a currently authorized purpose (e.g., hydropower or navigation) to municipal and industrial water supply use changes the types of benefits produced by a reservoir and the stakeholders served.

Record of Decision (ROD): Document that states the decision with respect to the update of the ACF Basin Master Manual and the individual project water control manuals, summarizes alternatives that were considered and relevant factors that were balanced in making the decision, and identifies means that have been adopted to mitigate for adverse effects. Federal agencies are required to prepare a public decision document that demonstrates consideration of the environmental impacts described in the EIS before a decision or a major Federal action. The ROD may also outline additional actions or conditions that may be required prior to implementation of the allocation formula or other management actions in the basin.

Region of Influence (ROI): An area with natural boundaries or geopolitical boundaries that covers the likely extent of impacts on a particular resource.

Regolith: The layer of loose material (consisting of soil, sand, weathered rock pieces, volcanic ash, glacial till, or other unconsolidated residual or transported earthen material) covering bedrock that constitutes the surface of most land.

Relocation contract (agreement): A legal instrument that provides for Fifth Amendment compensation to a property owner for the taking of property for purposes of a public works project construction.

ResSim: Reservoir operations computer modeling software, developed by the USACE Hydrologic Engineering Center (see *HEC*).

Return flow: Surface water withdrawn from the ACF system that is not consumed when used (see *consumptive use*) and that, subsequent to use, is returned (discharged with appropriate treatment) to the surface water system, generally at or near the point of withdrawal.

River basin compact (compact): An interstate agreement to equitably apportion the surface waters of the river basin. Compact negotiations to reach agreement on water allocation formulas for the ACF Basin and the Alabama-Coosa-Tallapoosa (ACT) Basin took place between 1998 and 2003 without success, and the compacts were allowed to expire in August 2003 (ACF Basin) and in July 2004 (ACT Basin).

River reach: The stream length between two specified points.

Riverine: Relating to, resembling, or having to do with a river.

Rock outcrop: Area of exposed bedrock.

Run-of-river project: A project in which the reservoir does not fluctuate on a seasonal basis or does not seasonally redistribute flows.

S

Salinity: Measure of the salt concentration in water.

Saprolite: Soft, disintegrated, mostly to thoroughly decomposed rock, often rich in clay, formed by the in-place weathering of rock and that remains in its original place.

Scoping: The process used to determine the range of issues to be addressed and to identify the significant issues to be analyzed in depth with respect to the proposed action and alternatives.

Shoreline: The points in a lake, river, or the ocean where the body of water and the land meet.

Stakeholders: Members of the public and representatives of various interest groups, all of whom have a vested interest, or "stake," in the outcome of a project and might have differing or competing values.

Stenohaline: Describes an aquatic organism that can only survive within a narrow range of salinity, e.g., a freshwater fish that cannot survive in seawater or an ocean fish that cannot survive in freshwater (contrast *euryhaline*).

Storage project: A reservoir designed to re-regulate natural streamflow, providing more dependable yield during the low-flow season. This involves redistributing flow volumes on a seasonal basis. In general, reservoirs are filled in high-flow seasons (winter and spring) and lowered during low-flow seasons (summer and fall).

Streamflow gage: Data-collecting location and device on a river at which water levels, streamflows, and sometimes other data are measured.

Subcanopy: Vegetation less than 30 feet tall or 3 inches in diameter in a vegetative community.

Submersed: In reference to vegetation, refers to plants that are adapted to living in and normally occur entirely below water.

Summer deficit: The available precipitation minus reservoir water withdrawals in June, July, and August—typically the three warmest months of the year which correspond to increased municipal, thermoelectric cooling, and irrigation water demand.

Surcharge storage: The portion of reservoir storage above the flood damage reduction level that stores water above the emergency spillway.

T

Tailwater: The water immediately downstream of a hydraulic structure, such a dam.

Tailwater rating: The unique relationship between flow (cfs) and water surface elevation (feet), that exists immediately downstream of a dam.

Transpiration: Discharge of water vapor from land plants into the atmosphere through a variety of biological processes, including evaporation through pores in leaves and through root surfaces; the continuous process caused by the evaporation of water from leaves of plants and the corresponding uptake of water from the soil by plant roots. See *evapotranspiration*.

Trophic level: Classification of organisms in an ecosystem according to feeding relationships.

U

Unimpaired flow: Historically observed flows adjusted to account for, and computationally remove the effects of, some of the human influence within river basins, such as the construction of large surface water reservoirs, withdrawals and returns for municipal and industrial water uses, and withdrawals for crop irrigation, that have altered the otherwise naturally expected flow regime of the system. An unimpaired flow data set is necessary to determine *critical yield* by removing (to the extent possible) identifiable and quantifiable alterations in flow regime attributable to man-made changes in the river basin.

Unregulated flow: Flows that would be present in a stream, at a specific location, if no reservoirs existed. This term also applies to flows after the effects of a reservoir have been removed by some computational method.

W

Water allocation formula (allocation formula): As defined by the river basin compact, a means of equitably apportioning the surface waters of the basin while protecting water quality, ecology, and biodiversity. Compact negotiations began in early 1998, with a December 31, 1998, deadline for reaching agreement on a water allocation formula. The state commissioners (governors of each state) were unable to reach an agreement on an equitable apportionment of the waters, and the compact was allowed to expire in August 2003.

Water control manual: Document in which water control objectives and operational guidelines for USACE reservoirs in the ACF Basin are recorded. These manuals include water control plans for each project, as well as a master water control manual for the basin as a whole (see *Master Water Control Manual*).

Withdrawal: The act of removing water from a river system; water so removed from a river system.

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