US Army Corps
of Engineers®
Mobile District

APALACHICOLA-CHATTAHOOCHEE-FLINT (ACF) REMAND MODELING TECHNICAL REPORT

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APALACHICOLA-CHATTAHOOCHEE-FLINT (ACF) REMAND MODELING TECHNICAL REPORT

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APALACHICOLA-CHATTAHOOCHEE-FLINT (ACF) REMAND MODELING TECHNICAL REPORT

SECTION 1 - INTRODUCTION

This report describes the reservoir system modeling activities performed in support of the U.S. Army Corps of Engineers (Corps) response to an 11th Circuit Court of Appeals Tri-State Water Rights decision directing remand in the *Tri-State Water Rights Litigation*.[1]

This report is organized in the following manner. Section 2 provides a general description of the reservoir projects in the Apalachicola-Chattahoochee-Flint (ACF) Basin. Section 3 provides a discussion of the ResSim modeling tool used to perform the technical analysis. Section 4 describes the operations sets incorporated into the ResSim model. Section 5 describes the alternatives that were modeled as part of the technical analysis. Appendix A discusses how the Corps modeled consumptive water usage in the ACF Basin and developed and modeled river and lake return rates. Finally, Appendix B provides a spreadsheet with modeling results for the various alternatives described in Section 5.

The modeling in support of the remand and the Technical Report describing the modeling were subject to review in accordance with the Civil Works Review Policy described in EC 1165-2-209 dated 31 January 2010. This review process includes District Quality Control/Quality Assurance (QC/QA) and Agency Technical Review (ATR) of the work products. The Hydrologic Engineering Center (HEC) performed QC/QA because of the specialized nature of hydrologic modeling. HEC is the designated Center of Expertise for the Corps in the technical areas of surface and groundwater hydrology, river hydraulics and sediment transport, hydrologic statistics and risk analysis, reservoir system analysis, planning analysis, real-time water control management and a number of other closely associated technical subjects. ATR to ensure the quality and credibility of the government's scientific information was conducted by the Corps of Engineers Southwestern Division Planning Center of Expertise for Water Management and Reallocation Studies (WMRS). WMRS is responsible for identifying, monitoring, and maintaining water management expertise and is best capable of understanding and assessing the specifics of the modeling and its Technical Report.

SECTION 2 - OVERVIEW OF RESERVOIR PROJECTS

The Corps operates five dams in the ACF Basin (in downstream order): Buford, West Point, Walter F. George, George W. Andrews, and Jim Woodruff (Woodruff); all but one is entirely on the Chattahoochee River arm of the basin. The exception is the furthest downstream dam, Woodruff, which is immediately below the confluence of the Chattahoochee and Flint Rivers and marks the upstream extent of the Apalachicola

[1] In Re: MDL-1824 *Tri-State Water Rights Litigation*, 644 F. 3d 1160 (11th Cir. 2011)

River. George W. Andrews is a lock and dam without any appreciable water storage behind it, but Buford, West Point, Walter F. George, and Woodruff Dams are reservoirs (Lakes Lanier, West Point, Walter F. George, and Seminole, respectively) with a combined conservation storage capacity (relative to the top of each reservoir's full summer pool) of approximately 1.6 million acre-feet (ac-ft) (Table 1). Because George W. Andrews and Jim Woodruff Dam/Lake Seminole are operated as run-of-river projects, only very limited storage is available to support project purposes.[2] In addition to the five Corps projects, 11 non-Corps dam projects are on the mainstems of the Chattahoochee and Flint Rivers in the ACF Basin. Those non-Corps projects are operated by the Georgia Power Company (GPC) and others. Figure 1 shows the location of the projects in the ACF Basin.[3]

- **Lake Sidney Lanier and Buford Dam**

Lake Sidney Lanier is formed by Buford Dam, which is about 48 miles northeast of Atlanta on the Chattahoochee River. The authorized project provides for a rolled-earth dam 1,630 feet long with crest at elevation 1,106 feet National Geodetic Vertical Datum of 1929 (NGVD29), or about 192 feet above streambed elevation; three earthen saddle dikes with a total length of 5,406 feet; a chute spillway with crest at elevation 1,085 feet; 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.

Lake Lanier has a total storage of 2,554,000 ac-ft, comprised of flood storage (defined as dedicated space within a reservoir that temporarily holds flood waters. Flood storage is normally empty and may vary seasonally), conservation storage (a volume represented by total storage minus inactive storage and flood storage), and inactive storage (dedicated volume within a reservoir to maintain design integrity of the project and serve as a sediment reserve). The minimum conservation pool elevation is 1,035 feet, and the maximum conservation pool elevations are 1,071 feet in the summer and 1,070 feet in the winter. At the top of the conservation pool - elevation 1,071 feet, in summer - the reservoir storage is 1,917,000 ac-ft, of which 1,087,600 ac-ft (in summer) is conservation storage and 867,600 ac-ft is inactive storage. In winter, conservation storage is 1,049,400 ac-ft, between elevations 1035 and 1070. In addition, 637,000 ac-ft (598,800 ac-ft in summer) is reserved for flood storage between elevations 1,071 (1070 in summer) and 1,085. The total usable storage, consisting of flood control and conservation storage, is 1,686,400 ac-ft at all times. Lake Lanier has a surface area of 40,133 acres at elevation 1,071 feet.

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[2] Some run-of-river projects, including George W. Andrews and Jim Woodruff Dam, have a limited amount of storage, called "pondage," in which pool levels may be adjusted by a few feet to reregulate flows to generate power during periods of peak power demand, or for other purposes. Pondage is distinguishable from the greater amount of storage reserved in "storage" projects, where reservoir levels are designed to fluctuate to a greater degree. Other lock-and-dam projects have no storage at all and pass inflows without regulation. See U.S. Army Corps of Engineers, Hydropower: Value to the Nation, available at http://www.iwr.usace.army.mil/docs/VTN/VTNHydropowerBro_loresprd.pdf.

[3] There were 11 non-Federal dams on the ACF System when the Corps began this analysis. In March 2012, the Eagle and Phenix Dam in Columbus, Georgia, was breached as part of a Corps Ecosystem Restoration project. The City Mills Dam is also scheduled to be breached under this same program in late 2012.

TABLE 1
Storage Volumes (ac-ft) at Corps of Engineers Reservoirs on the ACF as Represented in the ACF Basin ResSim Model

Storage	Lanier		West Point		WF George	GA Andrews	Woodruff
	Summer	Winter	Summer	Winter			
Flood	598,800	637,000	170,270	332,500	N/A	N/A	N/A
Conservation	1,087,600	1,049,400	306,130	143,900	244,400	8,200*	100,760*
Inactive	867,600	867,600	298,400	298,400	690,000	9,980	297,633
Total Usable	1,686,400	1,686,400	476,400	476,400	244,400	8,200	100,760
Total	2,554,000	2,554,000	774,800	774,800	934,400	18,180	398,393

*Pondage is a portion of the conservation pool at run of river projects that is used to reregulate hydropower peaking releases.

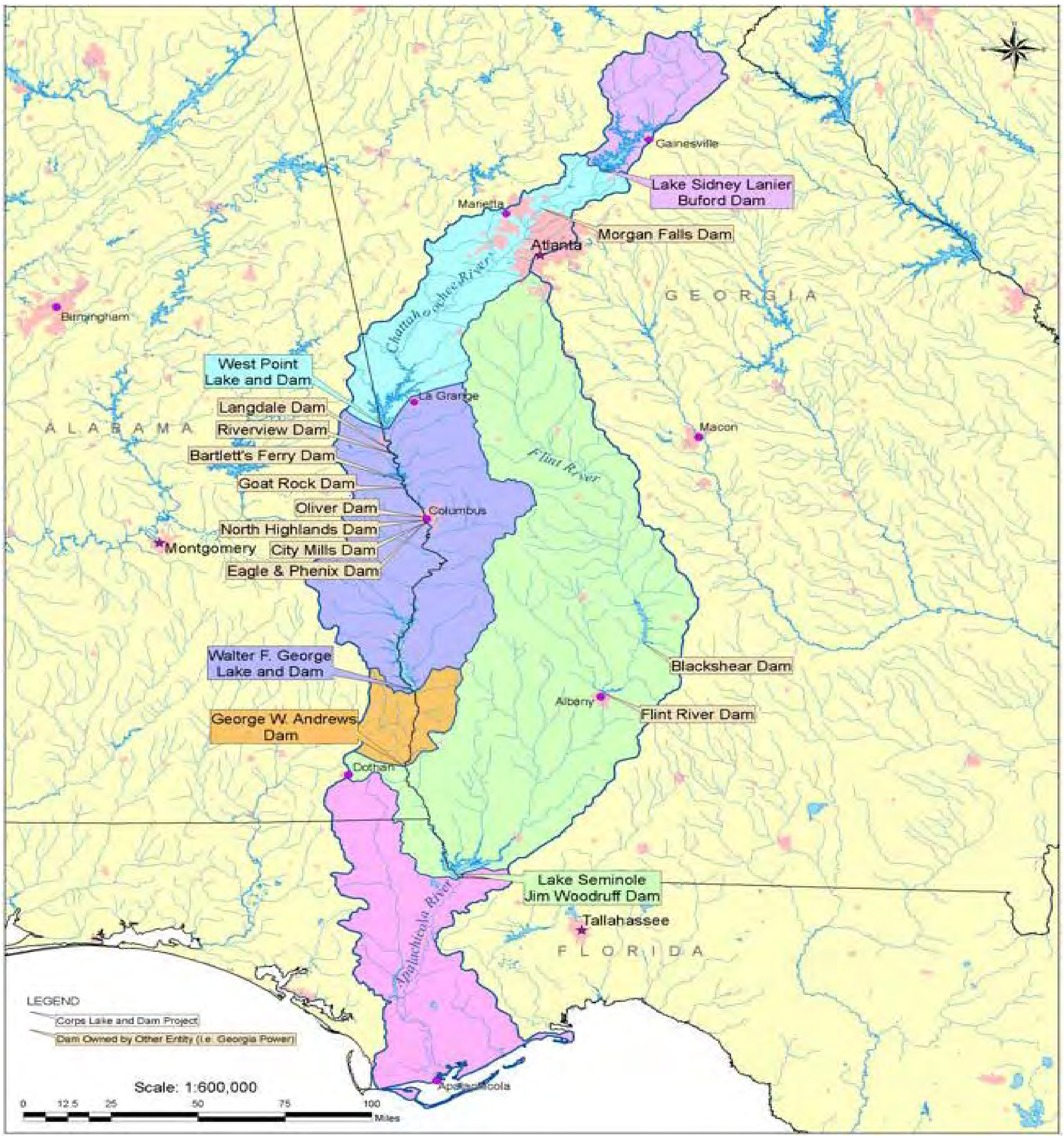

Figure 1. Location map of the projects in the ACF Basin

- **West Point Dam and Lake**

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

At the top of conservation pool (summer elevation of 635 feet; winter elevation of 628 feet), the reservoir provides a total storage of 774,800 ac-ft. Of this total storage, 306,100 ac-ft is available conservation storage (elevation 635 feet to 620 feet) in the summer and 143,900 ac-ft (elevation 628 feet to 620 feet) in the winter. Summer and winter inactive storage volume is 298,400 ac-ft. The total storage at maximum flood pool (elevation 641 feet) is 1,379,320 ac-ft. During the critical flood season, the reservoir is operated with a maximum conservation pool elevation of 628 feet to provide additional flood damage reduction storage. West Point Lake has a surface area of 25,900 acres at elevation of 635 feet.

- **Walter F. George Lock and Dam**

Walter F. George Lake, also known as Lake Eufaula, is created by the Walter F. George Lock and Dam on the Chattahoochee River about 183 miles upstream of Apalachicola Bay. The project is a concrete dam, gated spillway, and single lift lock, with earthen embankments at either side. The non-overflow section of the dam includes a powerhouse and an intake structure. The gated spillway is 708 feet long with a fixed crest at elevation 163 feet. The two earthen embankments, almost equal in length, have a total length of 12,128 feet, with crest elevation at 215 feet and a maximum height of about 68 feet. The non-overflow section of the concrete dam is 200 feet long, with the deck of the powerhouse section at elevation 208 feet. The lock, which has usable chamber dimensions of 82 feet by 450 feet, has a lift of 88 feet with the normal upper pool elevation at 190 feet. Depths are 13 feet over the lower sill and 18 feet over the upper sill at normal pool elevation. At the full pool elevation of 190 feet, the reservoir provides a total storage of 934,400 ac-ft, of which 244,400 ac-ft is conservation storage and 690,000 ac-ft is inactive storage.

No dedicated flood storage is at this project. Walter F. George Lake is the largest reservoir in surface area in the ACF Basin; it has a surface area of 45,180 acres at elevation 190 feet, the top of the conservation pool (May to September). The top of the conservation pool is set at 188 feet during the winter and early spring months (October to April). The bottom of the conservation pool is at 184 feet.

- **George W. Andrews Lock and Dam**

The George W. Andrews Lock and Dam, near Columbia, Alabama, is a navigation project on the Chattahoochee River, 154 miles upstream of Apalachicola Bay and about

28.3 miles below Walter F. George Dam. The project was authorized for navigation and does not include flood control or hydropower generating units. The project consists of a concrete fixed-crest spillway 340 feet long extending into the right bank with crest at elevation 102 feet, a concrete gate spillway adjacent to the lock 280 feet long with crest at elevation 82 feet, a single-lift lock with usable chamber dimensions of 82 feet by 450 feet, and a maximum lift of 25 feet. Depths are 13 feet over the lower sill and 19 feet over the upper sill at a normal pool elevation of 102 feet. The lake has a 9-foot-deep by 100-foot-wide navigation channel extending its entire length. At the full pool elevation of 102 feet, the reservoir provides a total storage of 18,180 ac-ft, of which 8,200 ac-ft is conservation storage and 9,980 ac-ft is inactive storage. Limited recreation facilities are also available at the project. Because of its long, narrow length, the reservoir resembles a large river more than a lake. The George W. Andrews Project reregulates inflows caused by peaking power operations at the Walter F. George Powerhouse.

- **Lake Seminole and Jim Woodruff Dam**

The Jim Woodruff Lock and Dam are located on the Apalachicola River, 107.6 miles above its mouth, about 1,000 feet below the confluence of the Chattahoochee and Flint Rivers and 1.5 miles northwest of Chattahoochee, Florida. The reservoir, Lake Seminole, extends about 46.5 miles upstream along the Chattahoochee River to the vicinity of Columbia, Alabama, and about 47 miles upstream along the Flint River, or 17 miles above Bainbridge, Georgia. The project consists of a concrete open-crest spillway 1,634 feet long on the right bank, with crest at elevation 79 feet; a single-lift lock with usable chamber dimensions of 82 feet by 450 feet constituting a portion of the dam; an earthen section 506 feet long, with a maximum lift of 33 feet and a depth over the sills of 14 feet; a gated spillway 766 feet long with the bridge at elevation 107 feet, or about 67 feet above the streambed elevation; a powerhouse with an intake section constituting a portion of the dam; an earthen section 506 feet long to accommodate the switchyard and substation; and an overflow dike section 2,130 feet long on the left bank, with crest at elevation 85 feet.

At the normal pool elevation of 77 feet, the reservoir has a total storage of 398,393 ac-ft of which 100,760 ac-ft is conservation storage and 297,633 ac-ft is inactive storage. Lake Seminole has a surface area of 37,500 acres. The reservoir level is normally maintained near elevation 77 feet. Pondage of 0.5 feet above and below that elevation is used to reregulate flows into the reservoir from upstream projects that operate as peaking plants. Because no flood damage reduction storage is allocated at this project, the reservoir level is maintained at approximately elevation 77 feet by passing inflows through the spillway gates or through the powerhouse.

- **Non-Corps-Owned Dams**

There are 11 additional dams on mainstem rivers in the ACF Basin that are not owned and operated by the Corps. All of the GPC hydropower generation plants are peaking plants. The project farthest upstream, Morgan Falls Dam (Bull Sluice Lake), is on the Chattahoochee River 30 miles below Buford Dam at River Mile (RM) 312.6. The dam impounds Bull Sluice Lake, a reservoir that has a surface area of 673 acres at elevation 866 feet. The total reservoir storage volume is about 2,450 ac-ft, of which about 2,250 ac-ft is usable. However, GPC operates the Morgan Falls Project as a run-of-river project to reregulate peaking flows from the Corps' upstream Buford Dam for power generation, drinking water supply, and assimilation of treated wastewater in the Atlanta region. The Morgan Falls Dam was constructed in 1904 and has since experienced a significant amount of sediment deposition. That has created broad and shallow pools and wetlands, which are attractive for recreation and fishing in the lake. The lake has low-flow velocities, moderate algal productivity, and dispersed aquatic vegetation.

Below West Point Dam are a series of eight hydroelectric power generation dams along approximately 32 miles of river. Six of those dams are part of Georgia Power's Middle Chattahoochee Hydro Group. The projects operate in a run-of-river-with-pondage mode from the outflow from the Corps' West Point Dam upstream. They are known individually as Langdale, Riverview, Bartlett's Ferry, Goat Rock, Oliver, and North Highlands. The first two, Langdale Dam and Riverview Dam, have very small reservoirs that are unnamed. They are operated as GPC facilities.

Bartlett's Ferry Dam is on the Chattahoochee River upstream of Columbus, Georgia, at RM 178.0. The dam impounds Lake Harding, which has a surface area of 5,850 acres at elevation 521 feet. The project includes a powerhouse composed of six units.

Goat Rock Dam is at river mile 172.2 on the Chattahoochee River. It impounds Goat Rock Lake, which has a surface area of 940 acres at elevation 404 feet. The powerhouse consists of six units. The project provides an instantaneous target minimum flow release of 800 cubic feet per second (cfs), or inflow, whichever is less, downstream of the dam.

Oliver Dam, which impounds Lake Oliver, is at river mile 163.5 on the Chattahoochee River downstream of Goat Rock Dam. The lake has a surface area of 2,150 acres at elevation 337 feet. The powerhouse consists of three large generating units and one small generating unit. The project provides an instantaneous target minimum flow release of 800 cfs, or inflow, whichever is less, downstream of the dam.

The North Highlands Project is at river mile 162.5 on the Chattahoochee River downstream of Oliver Dam. The impoundment has a water surface area of 131 acres at elevation 269 feet. It has four generating units. The project is operated in a run-of-river-with-pondage mode from the outflow from the West Point Dam upstream. In accordance with the Georgia Power Federal Energy Regulatory Commission (FERC) license, 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.

Two small run-of-river dams are at Columbus, Georgia, downstream of the North Highlands Dam. They are the City Mills Dam (RM 161.2), formerly operated by City Mills, and the Eagle and Phenix Dam (RM 160.4), formerly operated by Eagle and Phenix Mill. Both dams have small reservoirs (110 acres and 52 acres, respectively). The City Mills Dam and Eagle and Phenix Dam are inoperative. Columbus, Georgia, owns and operates the two dams. The Eagle and Phenix Dam was breached and City Mills Dam is scheduled to be breached, as part of a Corps Section 206 Ecosystem Restoration project.[4]

Lake Blackshear is the more upstream of two reservoirs on the Flint River. The Lake Blackshear Dam (also known as Warwick Dam), owned and operated by the Crisp County Power Commission, impounds the Flint River near Warwick, Georgia, at Flint RM 134.7. The dam was built in 1930 for hydroelectric power generation. Lake Blackshear borders five counties and covers approximately 8,700 acres. The normal full pool elevation is 237 feet. The power plant consists of four units. The project consists of two 30-foot high earthen dams. The north dam is 3,400 feet long, and the south dam is 650 feet long. The drainage basin is approximately 3,764 square miles and begins at Hartsfield Airport just south of Atlanta, Georgia.

Lake Worth is formed by the Lake Worth Dam (also known as the Flint River Dam) on the Flint River, at the river's confluence with Muckalee Creek and Kinchafoonee Creek. The GPC owns and operates the project, which was constructed in 1908 for hydroelectric power generation. The lake covers 1,400 acres and has 36 miles of shoreline at the normal elevation of 182 feet. Lake Worth is in Dougherty County just upstream of Albany, Georgia.

SECTION 3 – MODEL SELECTION AND DESCRIPTION

Background

The HEC-ResSim (ResSim) reservoir system model performs simulations of project operations for a series of baseline conditions and alternatives operations, and allows comparison of the relative differences among the results. The primary output of the reservoir system modeling activities consists of 70 years (1939-2008) of continuously simulated lake levels and river flows throughout the ACF Basin, for conditions represented by the baselines and alternatives.

Initial work to develop the ACF ResSim model began in May 2008, in conjunction with the development of the Water Control Manual (WCM) update and Environmental Impact Statement (EIS) process. Most of this initial effort went toward refinements to the current baseline model representing basin conditions, using a plan formulation process to ensure results are as realistic as possible and to provide feedback regarding serious and complex questions posed along the way. Throughout the development of the ACF Basin ResSim model, the Corps, Mobile District intended to utilize the model developed as part of that study for other purposes, including other operational uses. Consequently, the baseline reservoir system model eventually grew to include detailed physical characteristics and almost all the operational rules used at each project in the system.

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[4] There were 11 non-Federal dams on the ACF System when the Corps began this analysis. Subsequently the Eagle and Phenix Dam in Columbus, Georgia, has been breached as part of a Corps Ecosystem Restoration project. The City Mills Dam is scheduled to be breached under this same program in late 2012.

The plan formulation process to define new model conditions and ground rules specific to the remand analysis accounted for a significant percentage of the remand modeling activities. To support remand analysis, the ResSim model had to be further modified to include operations in support of water supply and return rates in varying amounts while meeting all other applicable laws and authorities. The outcomes of this formulation process were translated into "ground rules" that were written into the ResSim model, for technical and analytical purposes.[5] Ground rules for the determination of water supply authority that grew from the formulation process included:

- All authorized project purposes must be met at all Federal projects within the ACF Basin.
- Any operational changes that might affect Lake Lanier must ensure that the 10 million gallons per day (mgd) provided for in relocation contracts (executed in the 1950s as compensation for pre-existing water supply facilities that had to be relocated as a result of the Buford Project's construction) is made available.
- Any operational changes that might affect Lake Lanier must ensure that withdrawals of up to 10 mgd expressly authorized by Congress in the 1956 Act is made available.[6]
- No structural changes or other physical alterations to the Buford Project would be considered. By extension, this limits water supply alternatives to those that could be accommodated by operational changes.
- No operational changes considered as part of this process will decrease flood damage reduction from current levels. Thus, no water supply alternatives were included that would reduce flood control storage.
- Some level of peaking hydropower generation must occur at the Buford Dam, West Point, Walter F. George and at Jim Woodruff Dam.
- All applicable laws and regulations, such as the Endangered Species Act (ESA) and current measures adopted pursuant to ESA consultation, must be complied with.
- A minimum of 670 cfs flow will be made available at the foot of West Point Dam to maintain water quality, consistent with comments on the proposed West Point Project from the U.S. Department of Health, Education and Welfare made prior to authorization.[7]
- A minimum of 750 cfs flow will be present at all times in the Chattahoochee River at the Peachtree Creek confluence in Atlanta.

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[5] These "rules" were developed for analytical purposes and do not reflect any final decision by the Corps to operate the ACF System in any particular manner.

[6] Public Law No. 84-841 (July 30, 1956)Although the Corps has never executed a contract pursuant to this authority, the 10 mgd in withdrawals are clearly authorized, subject to the Corps' discretion, and were therefore assumed for analytical purposes.

[7] See H.R. Doc. No. 87-570 at xx-xxvii (Sept. 24, 1962) (letters of James B. Coulter, U.S. Department of Health, Education and Welfare, to Chief of Engineers, July 23, 1962, and Lieutenant General W.K. Wilson, Jr., Chief of Engineers, to Gordon E. McCallum, Chief, Division of Water Supply and Pollution Control, Public Health Service, August 31, 1962).

Many individual changes to operations were implemented and evaluated. These changes primarily consisted of varying amounts of water supply withdrawals (projected and known) from the Chattahoochee River below the Buford Project and upstream of the Buford Project in Lake Lanier; varying amounts of treated water returns (projected and known) to the Chattahoochee River and Lake Lanier, and varying amounts of peaking hydropower generation. The measures underwent iterative refinements, both individually and in conjunction with other changes.

Model Selection

This analysis used HEC-ResSim Version 3.1 “Release Candidate 3, Build 42” (USACE, 2010a). The label “Release Candidate” means that the software is undergoing final testing before distribution as an official version. HEC-ResSim is the Next Generation Graphical User Interface-based reservoir operations simulation software that takes place of its precursor, HEC-5 (USACE, 1998).

Per ECB 2007-6 (USACE, 2007) and EC 1105-2-407 (USACE, 2005b), HEC-ResSim falls under the category of “engineering models used in planning studies”, leaving certification to the Science & Engineering Technology (SET) initiative associated with the Corps Technical Excellence Network (TEN). The Corps Hydrologic Engineering Center (HEC) developed this software, which is now the standard for Corps reservoir operations modeling. As of January 2010, the TEN guidance listed HEC-ResSim as “Community of Practice Preferred” for the purpose of reservoir system analysis.

As the culmination of a three-year model development and verification process, HEC-ResSim is the tool most capable of dependably representing Mobile District Office (SAM) water management practices. In 2006, Mobile District began working with HEC to create ResSim watershed models based on 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” used for analyses concerning the previous Environmental Impact Statement (EIS), the 1990’s Comprehensive Study, and the Revised Interim Operations Plan (RIOP). After ensuring that the corresponding ResSim models could effectively reproduce the HEC-5 results, Mobile District and HEC created another ResSim model that captured the most significant operations as of 2008, including the RIOP rules and head limits constraints. This was generally accepted as the ACF Reservoir System model.

Other considerations factoring into Mobile District’s selection of ResSim include ease of adaptation to other studies or operational use, availability of training, access to software developers for model extensions, opportunity for linkage with water quality models, and ability to share with partners and stakeholders without licensing cost or restriction.

For the purpose of showing a general location map of the study area within the ResSim model, the main window of the Watershed Setup module for the ACF ResSim watershed model named “ACF_WCM-August2010” is shown in Figure 2.

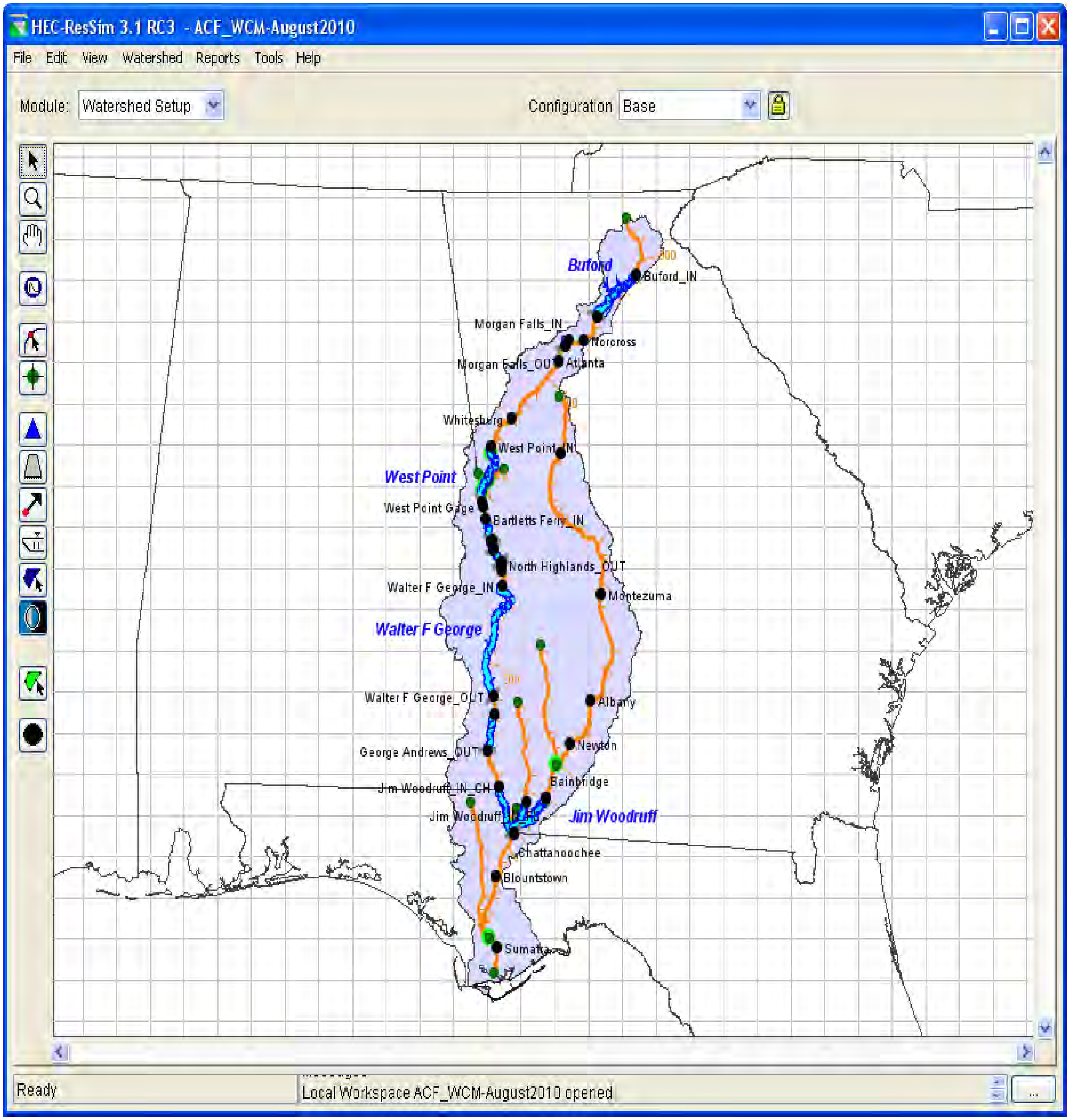

Figure 2. ACF Model – Watershed Setup Module

Peer review of the model yielded several improvements to the ResSim source code that are now available to all users of HEC-ResSim 3.1 (and later versions). These improvements are as follows:

- Allow the specification of both positive and negative diversions amounts
- Allow the null routing method to translate negative flow downstream
- Allow the power plant generating capacity to vary as a function of head (or elevation, storage, or release)

The negative values found in the unimpaired inflows and diversion data sets require that ResSim handle negative diversions and translate (not route) negative flows downstream in order to satisfy the continuity equation.

The variable power capacity feature resembles a HEC-5 capability that allows a better estimate of energy produced as a result of Mobile District's water management operations. The feature allows head vs. energy ratings based on either "best gate" (most efficient flow) or "full gate" (maximum flow) through each unit.

Operations in the ACF System typically reflect the "full gate" situation in order to represent maximizing hydropower production. Mobile District and HEC worked with the Corps' Hydropower Analysis Center to derive updated ratings for each unit at the Corps reservoirs to conform to the ResSim power plant parameter definitions.

Overview of ACF Study Model

This section describes the basic attributes of the ResSim model used to simulate the various alternatives examined with this analysis. Figure 3 shows the location of the reservoirs, junctions, and diversions of the ACF Basin in the "2009" network (used for modeling alternatives).

a. Simulation Time-Step

The ACF model uses a daily time-step to simulate operations. The selection of a daily time-step was made based on previous models, available input data, and compute time considerations. This interval provides consistency with previous HEC-5 modeling activities in the basin and maintains a degree of continuity with previous modeling efforts. The boundary condition data (i.e., diversion amounts and unimpaired inflows) exist only as daily or monthly values, and offer no advantage from a finer time interval. Time constraints precluded development and vetting of sub-daily boundary condition data for period-of-record analysis. Finally, for such a complex effort (many alternatives, complicated operations, and long simulation period), a daily time-step makes it feasible to compute all alternatives in an efficient and timely manner.

b. Routing

The Muskingum Routing Method, which provides an easy means of representing both lag and attenuation, was used in the final model because well calibrated coefficients were available from an HEC-HMS (USACE, 2010b) Model of the ACF Basin and these Muskingum parameters were used in developing the unimpaired inflow data set.

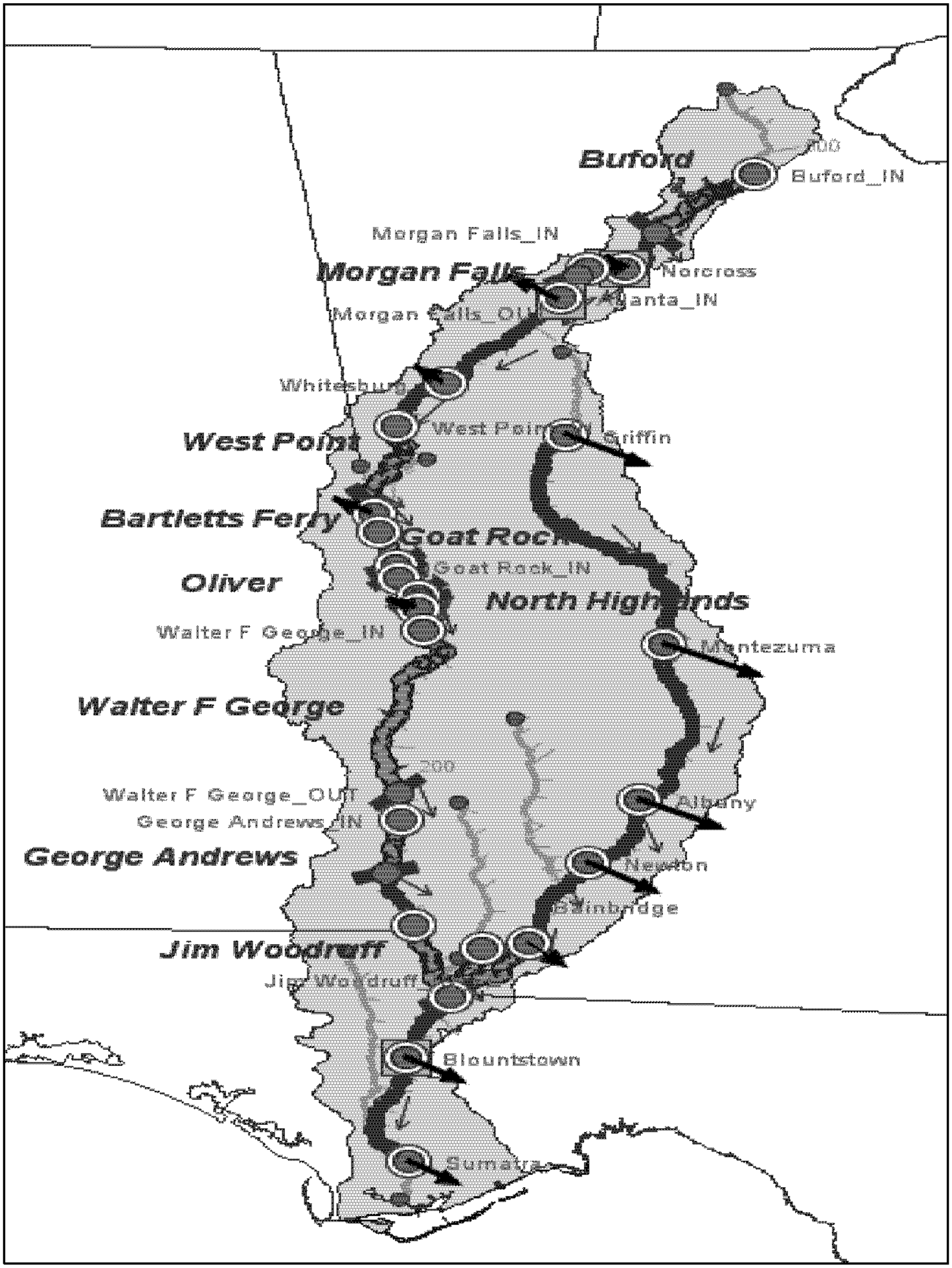

Figure 3. Apalachicola-Chattahoochee-Flint (ACF) River Basin Reservoirs Junctions (represented by red dots) and Diversions (represented by black arrows)

Table 2 lists the routing parameters used in each reach. Reaches with no routings have a travel time of less than one day. *(Note: in the Buford to Norcross reach, the routing parameters were modified to minimize negative impacts on the daily operation for downstream minimum flow requirements at Atlanta that were being caused by the tandem operation and its difficulty in accounting for the attenuation effects in the reaches above the control point. The parameters used are shown in parentheses in Table 2.)*

TABLE 2
Routing Parameters used in the ACF Watershed

River	Reach	Length (mi)	Muskingum K (hrs)	Muskingum X	Steps
Flint	Griffin to Montezuma	124	120	0	5
Flint	Montezuma to Albany	77	48	0	2
Flint	Albany to Newton	34	24	0	1
Flint	Newton to Bainbridge	40	24	0	1
Flint	Bainbridge to Jim Woodruff	29	No Routing Used		
Chattahoochee	Buford to Norcross	18	15 *(24)*	0.20 *(0.50)*	1
Chattahoochee	Norcross to Morgan Falls	18	No Routing Used		
Chattahoochee	Morgan Falls to Atlanta	10	No Routing Used		
Chattahoochee	Atlanta to Whitesburg	43	24	0.20	1
Chattahoochee	Whitesburg to West Point R	61	24	0.50	1
Chattahoochee	West Point R to West Point G	2	No Routing Used		
Chattahoochee	West Point G to Bartletts Ferry	21	No Routing Used		
Chattahoochee	Bartletts Ferry to Goat Rock	5	No Routing Used		
Chattahoochee	Goat Rock to Oliver	9	No Routing Used		
Chattahoochee	Oliver to North Highlands	1	No Routing Used		
Chattahoochee	North Highlands to Columbus	3	No Routing Used		
Chattahoochee	Columbus to W.F. George	85	24	0.30	1
Chattahoochee	W.F. George to George Andrews	29	No Routing Used		
Chattahoochee	George Andrews to Jim Woodruff	47	18	0.25	1
Apalachicola	Jim Woodruff to Chattahoochee	1	No Routing Used		
Apalachicola	Chattahoochee to Blountstown	29	18	0.10	1
Apalachicola	Blountstown to Sumatra	58	90	0.15	4

c. Boundary Conditions

The operational ACF model extends from Buford Dam to the tailwater of the Jim Woodruff Lock and Dam Project (represented by the U.S. Geological Survey (USGS) Chattahoochee Gage 02358000). The complete ACF Watershed model extends from the headwaters of the Chattahoochee River above Lake Lanier to the Apalachicola River at Sumatra (downstream of Lake Seminole).

The 70-year period of record that was modeled with ResSim includes calendar years 1939-2008. The unimpaired incremental local flows, evaporation and diversion data were obtained from SAM. Development of these data sets are described in unimpaired flow reports (USACE, 1997) and (USACE, 2004[2009]). Use of unimpaired inflows allows simulation to capture the natural variability of supplies to the system in terms of flow frequency and volume.

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

These quantities are used to extrapolate diversions. The difference between water withdrawn and water returned is defined as a diversion. Diversions are a net volume or quantity assumed to be permanently lost from the water system.

The original unimpaired flow data set developed as part of the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint (ACT/ACF) River Basins Comprehensive Water Resources Study, ACT/ACF Comprehensive Water Resources Study, Surface Water Availability Volume I: Unimpaired Flow, July 8, 1997 included data at over 50 locations for the 1939 to 1993 period of record. This data set has been extended through 2008.

d. Reservoir Projects

The ACF Basin consists of two main tributaries the Chattahoochee River and the Flint River, which join to form the Apalachicola River as shown in Figure 1. Principal flow regulation capabilities within the basin are restricted to the Chattahoochee River that is impounded at a number of locations. The Flint River has two non-Federal run-of-river projects and is essentially unregulated. The majority of storage for stream regulation in the basin by Federal projects is provided by Lake Lanier (modeled using the dam name Buford), located approximately 50 miles northeast of Atlanta, Georgia. This project provides 65 percent of total conservation storage capacity available in the basin for flow regulation. It is important to note, however, that this project only controls runoff from 5.3 percent of the basin's total drainage area and therefore requires a significant refill period after drought. Lesser, but still significant, amounts of storage and flow regulation are also provided by West Point and Walter F. George, and by the non-Federal projects in the system. George Andrews and Lake Seminole (modeled using the dam name Jim Woodruff) are essentially run-of-river projects, which depend largely upon inflows controlled by upstream impoundments (as stated previously, pondage of 0.5 feet at Jim Woodruff is used to reregulate flows into the reservoir from upstream projects that operate as peaking plants).

Within the ACF model, a number of action zones are consistently defined for the four principal Corps reservoirs (Buford, West Point, Walter F. George, and Jim Woodruff) to provide system-wide balance in using conservation storage[8]. Endangered Species Act (ESA) releases from Jim Woodruff influence system releases due to tandem balancing operations. Tandem balancing are operations to keep the ACF Federal reservoirs

[8] It should be noted that the action zones described in Overview of the ACF Model, Section d. Reservoir Projects are a part of this ACF ResSim model only, and are not the same as the action zones currently utilized in management of the ACF System. The Reservoir Projects action zones for the ResSim model were developed to represent releases made in support of ESA that are calculated based upon system composite storage.

within the same action zones. This is discussed in greater depth in Current Operations, b. Guide Curves and Action Zones. Tandem balancing between Walter F. George and Jim Woodruff means that if Walter F. George is higher in its action zone than Jim Woodruff is in its corresponding action zone, then Walter F. George will release enough water to bring both reservoirs to an equivalent position within their action zones. Since West Point operates in tandem with Walter F. George, the tandem release from Walter F. George for Jim Woodruff may cause a similar release from West Point to find balance with the two downstream projects. Buford also includes a tandem rule for balancing with West Point. Tandem releases are prioritized in the rule stack as the lowest priority.

On the upper and middle Chattahoochee River, there are five projects that are owned and operated by GPC. From upstream to downstream, they are Morgan Falls, Bartletts Ferry, Goat Rock, Oliver, and North Highlands. Because the GPC projects do not have much storage, they are run-of-river projects, and modeled as pass-through (flow-thru) projects in the daily ResSim model. The ResSim model included these projects initially as a carryover from the HEC-5 models, and their utility for modeling consists mainly of providing flow through the project and approximate hydropower generated.

The Corps' George Andrews Project is also represented as a flow-through and has little water management impact within the ResSim model, but is required to perform quality calculations linked to the reservoir simulations.

e. System Operations

The reservoirs in the ACF Watershed are operated as a system in which each reservoir plays a role. Many interests and conditions must be continually considered and balanced when making water control decisions for the basin. 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. In the daily model, a number of state variables are created for the purpose of system operations.

Action zones have been defined for each of the major storage projects (Buford, West Point and Walter F. George). These zones are used to determine minimum hydropower generation at each project, the maximum possible releases for navigation from conservation storage, releases for water supply, and releases for water quality, and to balance the use of system conservation storage based on individual project storage amounts and the ability to refill the reservoirs.

In addition, composite storage is incorporated in the RIOP (described in h. Federally Listed Threatened and Endangered Species Conservation – Revised Interim Operations Plan) in determining the minimum releases from Jim Woodruff Dam. Composite storages are calculated by combining the ordinates for storage action zone curves each day for Buford, West Point Lake, and Walter F. George. Composite storage zones for flood control, conservation, Zone 4, etc, are similarly defined as the sum of the same zone definitions at the three reservoirs, and are used together with basin inflow and seasons to set up minimum release provisions at Jim Woodruff.

The daily model uses tandem rules in balancing conservation storages between upstream and downstream projects. The ResSim model includes an explicit storage balance definition designed to preserve balance across similar zones of the four Corps storage projects. Figure 4 shows the Reservoir System editor where the "Corps Reservoirs" Reservoir System is reflected for the System Storage Balance named "EvenBalance_byZone_Baseline.

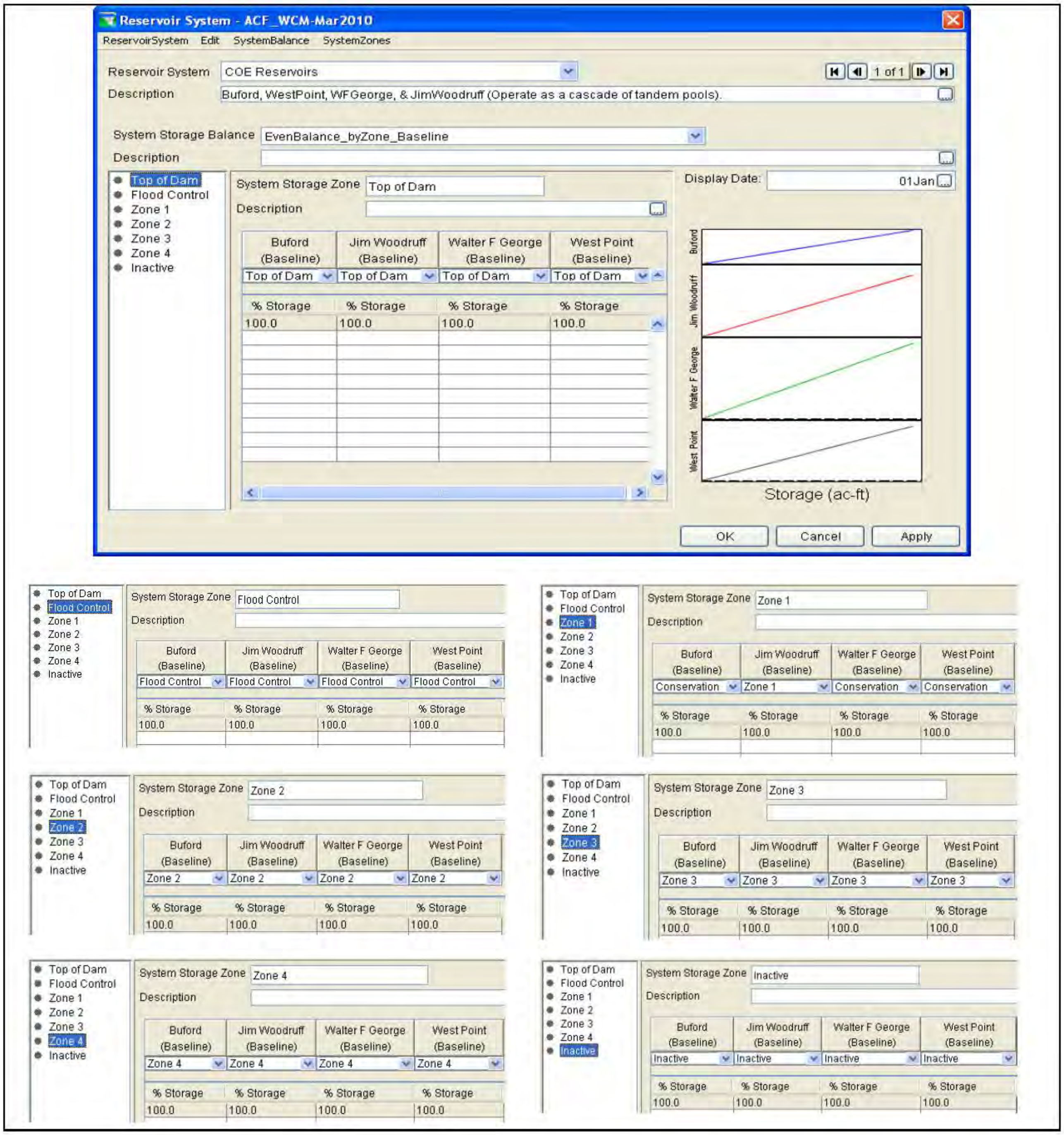

Figure 4. Reservoir System Balancing for Baseline Operations:
Reservoir System = "Corps Reservoirs";
System Storage Balance: "EvenBalance_byZone_Baseline"

f. Diversions

Flow withdrawals and returns occur in the ACF Basin for various purposes. Water is diverted from the Federal and GPC projects as well as from the rivers. Flow withdrawals from the reservoirs and from the rivers are modeled differently using one of the following methods:

1. Withdrawals from a reservoir are modeled at the reservoir inflow junction as a negative local inflow specified as an external time-series, so that a diversion from a reservoir can never be “shorted”.

2. Withdrawals from a river are modeled more flexibly as diversion elements (black arrows) from junctions. These withdrawals might be constant, specified as an external time-series, or represented as a function of a model variable.

For both method 1 (negative local inflow) and method 2 (diversion element), the amount of flow diverted is included in the net inflow calculation. In other words, the net inflow to a reservoir accounts for the flow withdrawal, and is calculated before release decisions from the pool are made. The difference between these two methods is that there is no control on the flow withdrawal for method 1 even if there is insufficient inflow from upstream. Even if the pool is at the bottom of a conservation zone, withdrawal will still take place until the pool is dry (regardless of any outlet elevations). This scenario represents the actual withdrawal conditions occurring in all the Corps and GPC projects. For method 2, if there is shortage in the inflow from upstream, withdrawals will be stopped. This scenario more represents the actual withdrawals from the river reaches. Figure 5 shows examples of both methods being used in the modeling of reservoir and non-reservoir diversions.

Metro-Atlanta returns, as represented in the remand modeling, consist of water that is presumed to have been diverted from the federal projects and the Chattahoochee River and returned to the system. There is a net loss to inflow into a river reach when more water is withdrawn from the reach than is returned to the reach. Conversely, there is a net gain to inflow into a river reach when less water is withdrawn from the reach than is returned to the reach. Several return rate scenarios, reflecting different percentages of withdrawn water is being returned to the ACF System as a treated point source discharge, have been included in this analysis. The return rate scenarios modeled as alternatives are actual river and reservoir return rates as provided by the Georgia Environmental Protection Division (GAEPD); return rates specified in permits; no reservoir or river returns; and the reservoir return rates projected in the Georgia 2000 request. Formulation of return rates is described in Appendix A.

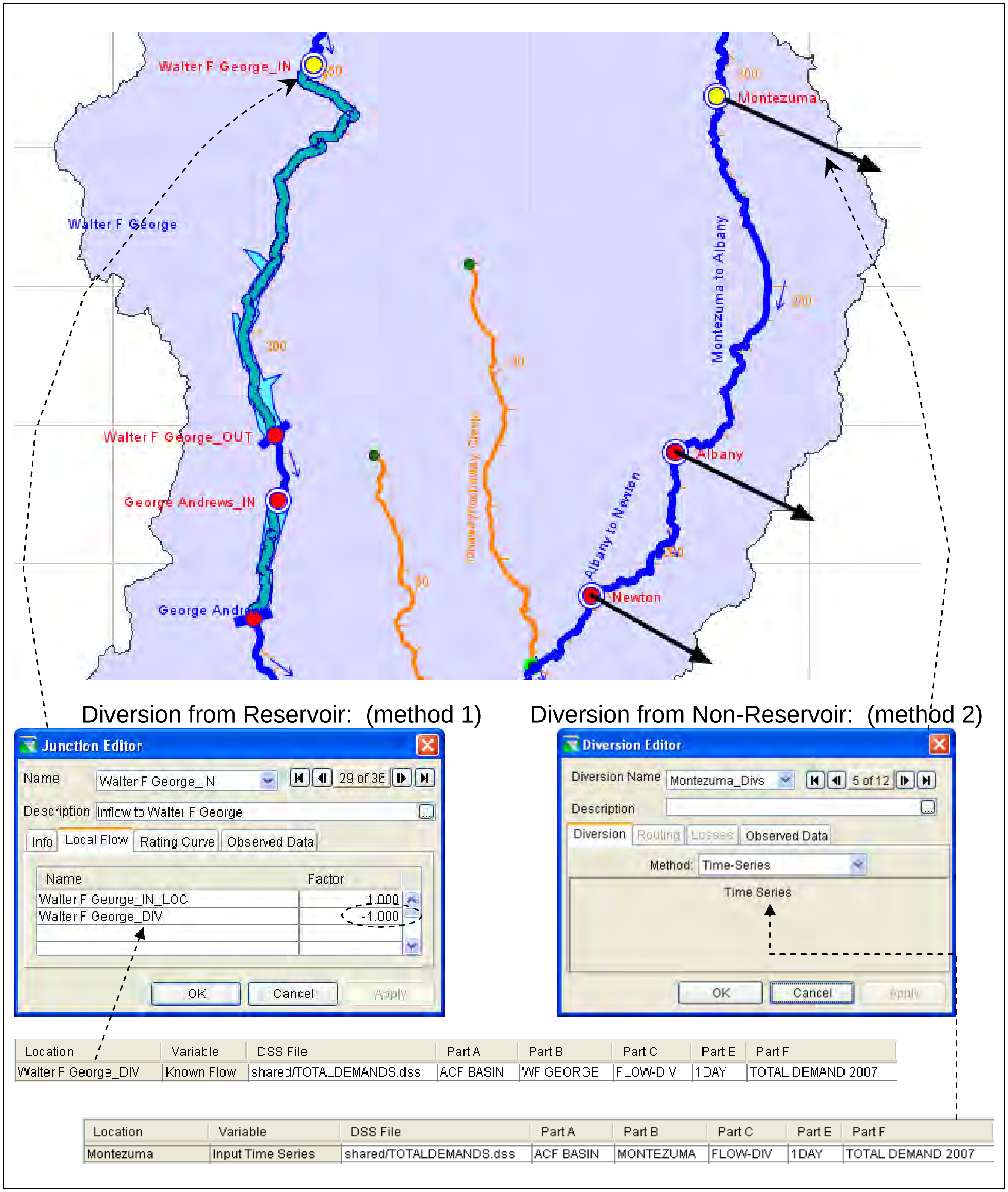

Figure 5. Two Methods Used in Modeling Diversions (for Reservoirs and Non-Reservoirs)

SECTION 4 – OPERATIONS SETS

Background

Operations sets describe the procedures the Corps employs to operate its projects in the ACF Basin in order to achieve the purposes for which they were authorized by Congress. For purposes of this analysis, the Corps modeled two operations sets, Current Operations and Improved Operations. As the name implies, Current Operations reflect the procedures currently in effect throughout the basin. Improved Operations reflect system and project operation improvements that the Corps has identified as potentially more efficient in achieving Congressionally authorized purposes. These improvements were identified based upon more than 50 years of operational experience, and they take into account changes in technology, hydrology, and other factors. Although the Corps has not made any decision whether to implement any of these improvements, they were employed as an operations set for the purpose of modeling hypothetical operations to meet Georgia's future water supply request. The paragraphs below describe both operations sets in detail, explaining general system operations as well operations to accommodate project purposes and operational goals.

Current Operations

a. General System Operations

The Corps operates a series of reservoirs in the ACF Basin together, as a system, to provide for the authorized project purposes of flood damage reduction, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water quality, and water supply. Each of the authorized project purposes is considered when making operational decisions, and these decisions affect how water is stored and released from the projects. In general, to provide for the authorized project purposes, flow must be stored during wetter times of each year and released from storage during drier periods of each year. Based on historic patterns, that means that water is stored in the lakes during winter and spring and released for authorized project purposes in the summer and fall months. However, some benefits are achieved by retaining water in the storage reservoirs, either throughout the year or during specified periods of each year. The flood damage reduction purposes at certain reservoirs require drawing down reservoirs in the fall through winter months to prepare for storing expected flood waters and refilling pools in the spring months to be used for multiple project purposes throughout the remainder of the year.

The multiple water demands in the basin require that the Corps operate the system in a balanced manner in an attempt to meet all authorized 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 balanced water management strategy for the Corps reservoirs in the ACF Basin seeks to balance all authorized project purposes. The intent is to maintain a balanced use of conservation storage among all the reservoirs in the system, which requires fluctuations in pool elevations at the storage reservoirs.

b. Guide Curves and Action Zones

The Corps has defined action zones for each of the three major storage projects on the ACF Basin - Lake Lanier (Figure 6), West Point Lake (Figure 7), and Walter F. George Lake (Figure 8). 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 achieved. As lake levels decline, Zones 2 through 4 define increasingly critical system water shortages and guide the Corps in reducing flow releases, as it becomes increasingly difficult to operate for all purposes. Flow releases are reduced as pool levels drop as a result of 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 purposes such as flood damage reduction, hydroelectric power generation, navigation, fish and wildlife conservation, recreation, water quality, and water supply.

The action zones are basic guidelines for operating the river system; however, other factors and activities might cause the Corps to operate the lakes differently than the zones shown on the charts. Examples of those factors or activities could include exceptional flood damage reduction measures, fish spawn operations, maintenance and repair of turbines, emergency situations such as a drowning and chemical spills, draw-downs because of shoreline maintenance, releases made to free grounded barges, and other circumstances.

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 river system and factors mentioned above, there might be periods when one lake is in a higher or lower zone than another. When that occurs, the Corps makes an effort to bring the lakes back into balance with each other as soon as conditions allow. By doing so, effects on the river basin are distributed equitably among the projects, and adverse effects of low or high flows are mitigated to the extent possible throughout the system. The following definitions apply to the action zones:

Zone 1: When all the lakes are in Zone 1, the ACF system is operated in the normal manner to achieve authorized purposes. Releases can be made for hydroelectric power generation, water supply, and water quality. Releases can be made in support seasonal navigation (when the channel has been adequately maintained).

Zone 2: Hydroelectric power generation is supported at the same or a reduced level. Water supply and water quality releases are met. Minimum flow targets are met. Indicates that releases to support seasonal navigation might be limited.

Zone 3: Hydroelectric power generation is supported at a reduced level. Water supply and water quality releases are met. Minimum flow targets are met. Indicates that releases to support seasonal navigation might be limited.

Zone 4: Hydroelectric power generation demands will be met at a minimum level and might occur only for concurrent uses. Water supply and water quality releases are met. Minimum flow targets are met. Indicates navigation is not supported.

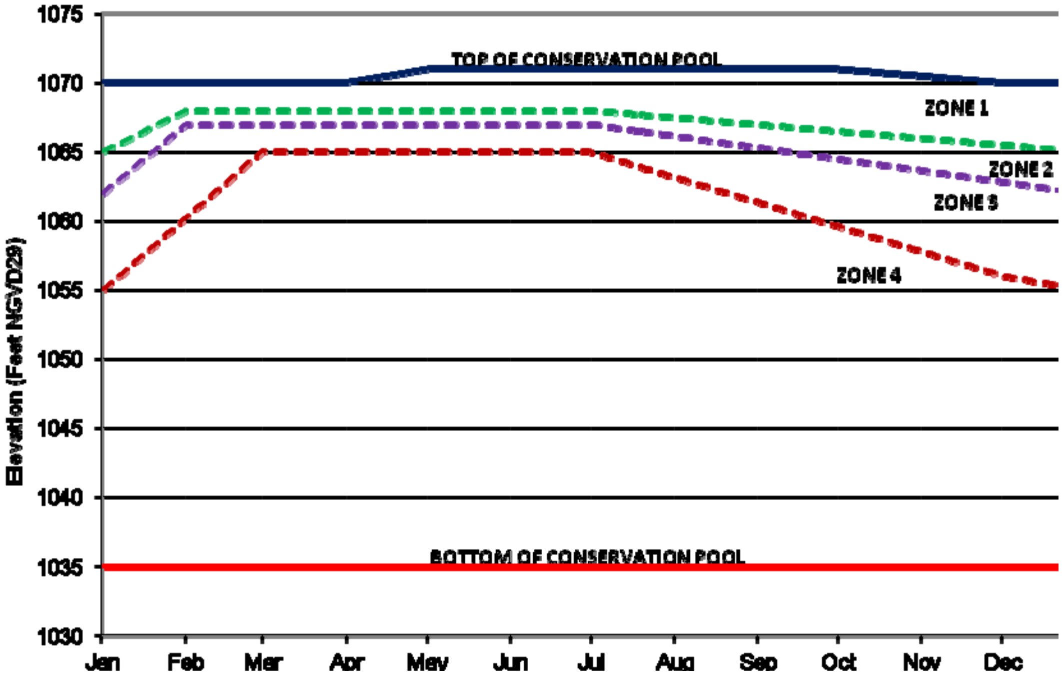

Figure 6. Current Lake Lanier Water Control Action Zones

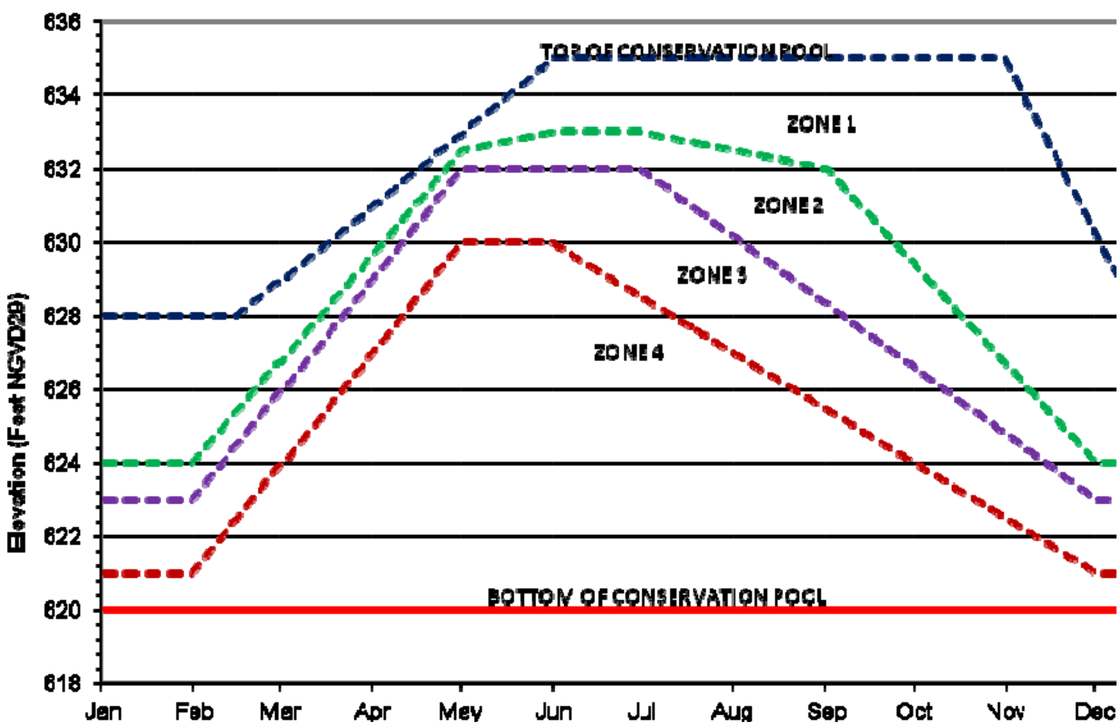

Figure 7. Current West Point Lake Water Control Action Zones

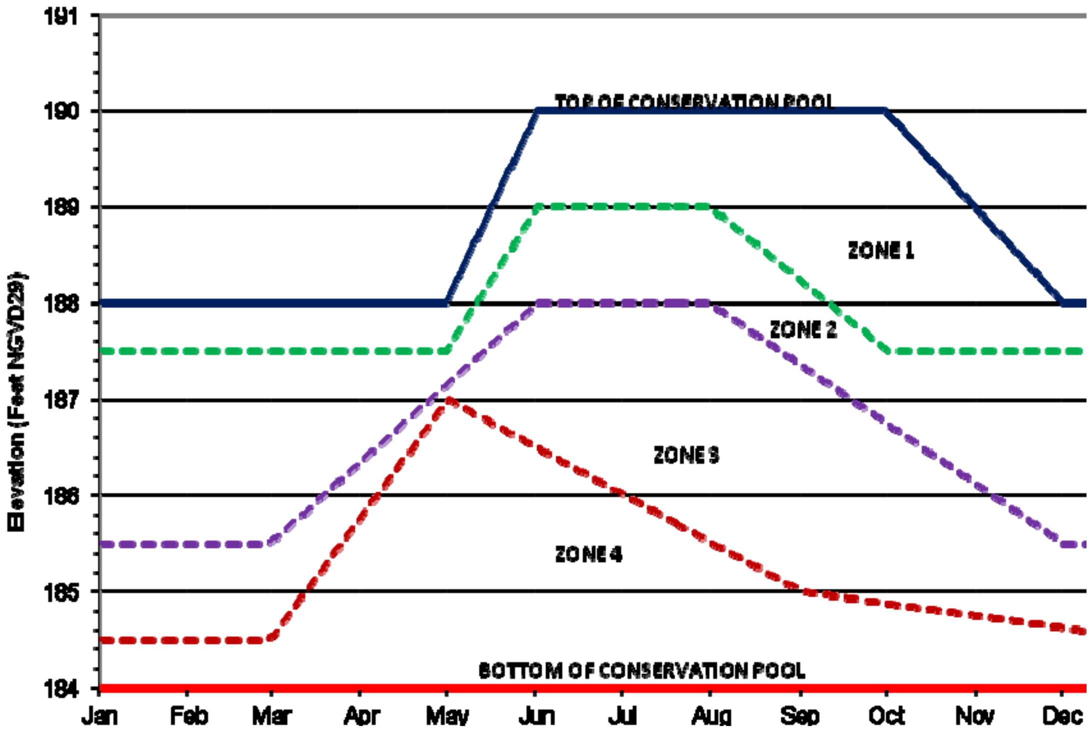

Figure 8. Current Walter F. George Water Control Action Zones

c. Flood Damage Reduction

The objective of flood damage reduction operations in the ACF Basin is storage or reregulation of excess flows, thereby reducing downstream river levels below flood stage. Whenever flood conditions occur, operation to reduce flood damage takes precedence over all other project functions. Flood damage reduction is achieved by storing damaging flood waters, thus reducing downstream river levels below those that would have occurred without the dams in place. Of the five Corps reservoirs, only the Lake Lanier and West Point Lake were designed with space to store flood waters. In addition to providing for space above the conservation pool to hold flood waters throughout the year, Lake Lanier is drawn down one additional foot, and West Point Lake is drawn down at least seven additional feet beginning in the fall, through winter and into the early spring to provide additional capacity to protect life and property in the basin. The George W. Andrews Dam and Jim Woodruff Dam operate to pass inflows, while the Walter F. George Dam operates according to specified schedules for flood damage reduction.

Because flooding usually occurs in the winter and spring when rainfall and runoff are more plentiful and hydroelectric power demands are lower, the *guide curve* operation generally reflects this situation by specifying a lower elevation during such a period. Additional storage for containing flood waters is gained by drawing down the pools in late fall. Those drawdowns can be specifically to reduce flood damage, as at West Point Lake, or coincidentally for other purposes. During the principal flood season, December through April, the regulation plan at Walter F. George Lake provides for lower lake levels to ensure lower reduced peak stages in the reservoir during major floods. The timing of flood peaks in the system is of considerable importance in determining the effectiveness of reservoir flood damage reduction operations and the degree to which such operations can be coordinated. During a flood event, excess water above normal pool elevation, or 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 waters have receded sufficiently so that releases from the reservoirs do not cause flows to exceed bankfull flows capacity. Such 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 dams.

d. Hydroelectric Power Generation

The Buford, West Point, Walter F. George, and Jim Woodruff projects include hydroelectric power generation plants. 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 generation 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 not in Zone 4 of the conservation pool. For example, demand for peak hydroelectric power generation at Buford Dam typically occurs on weekdays from 5:00 a.m. to 9:00 a.m. and from 3:00 p.m. to 10 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. During dry periods, as the lake levels drop below Zone 1,hydroelectric power generation is reduced as pool levels decline to as low as two hours per day generation at each peaking plant project during extreme low-flow conditions. Two-hours of generation at Buford represents releases that normally meet water supply and water quality demands and provide the capacity specified in marketing arrangements. Peak generation could be eliminated or limited to conjunctive releases during severe drought conditions. While hydropower would still be generated, it could not be generated on a regular peaking schedule under severe drought conditions. The typical hours of operation by action zone are presented in Table 3.

TABLE 3

Typical Hours of Peaking Hydroelectric Power Generation by Federal Project under Current Operations

Action zone	Lake Lanier (hours of operation)	West Point (hours of operation)	Walter F. George (hours of operation)
Zone 1	3	4	4
Zone 2	2	2	2
Zone 3	2	2	2
Zone 4*	0*	0*	0*

*While hydropower would still be generated in Zone 4, it could not be generated on a regular peaking schedule under severe drought conditions.

e. Navigation

In the Rivers and Harbors Act of 1946, Congress authorized the Corps to maintain 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. Conditions on the Apalachicola River have been such in recent years that a 9-foot deep channel has not been available for much of the year.

Dredging on the Apalachicola River has been reduced since the 1980s because of a lack of adequate disposal area capacity in certain reaches of the river. No dredging has been conducted since 2001 for a variety of reasons related to flow or funding levels and has been indefinitely deferred because of denial of a section 401 water quality certification from Florida and recent congressional language that limits funding for dredging operations in the ACF Basin.

In the absence of dredging and routine maintenance, depths in the Apalachicola River Navigation Channel have been less than nine feet, 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.

f. Fish and Wildlife Conservation

1. Spawning - The Corps operates the system to provide favorable conditions for annual fish spawning in the reservoirs and the Apalachicola River, in conjunction with other authorized purposes of the system. In most water years (October 1 to September 30) it is not possible to hold both lake levels and river stages at a steady or rising level for the entire spawning period, especially when upstream lakes or the Apalachicola River spawning periods overlap. During the fish spawning period for each waterbody (Table 4), the Corps' 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 four to six weeks during the designated spawning period. When climatic conditions preclude a favorable operation for fish spawn, the Corps consults with the state fishery agencies and the U.S. Fish and Wildlife Service (USFWS) on balancing needs in the system and minimizing the effects of fluctuating lake or river levels.

Table 4
Project-Specific Principal Fish Spawning Period

Project	Fish spawn period
Lake Lanier	April 1 – June 1
West Point	April 1 – June 1
Walter F. George	March 15 – May 15
Lake Seminole	March 1 – May 1
Apalachicola River	April 1 – June 1

Each spring (since 2005), the Corps has operated the lock at Jim Woodruff Dam to facilitate downstream to upstream passage of Alabama shad and other anadromous fishes (those that return from the sea to the rivers where they were born to breed). The timing of these fish passage operations is typically March through May, but operations have begun earlier in the year when conditions indicated this was appropriate. There are slight differences in the locking technique each year. However, in general 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), using attraction flows to entice the fish into the lock (2006 - 2007), or by leaving the lower gate open for a period before a lockage and allowing the fish to move in without an attraction flow (2008). In 2009 no lockages were done, and attraction flows were used again in 2010 - 2012. In each of these methods, once fish have been placed in or have had time to move into the lock, the downstream doors are closed, the lock is filled to the lake elevation, and the upper gates are opened, allowing passage upstream.

g. Federally Listed Threatened and Endangered Species Conservation – Revised Interim Operations Plan (RIOP)

The Corps manages releases from Jim Woodruff Dam to support the federally protected Gulf sturgeon and mussel species (fat threeridge, purple bankclimber, and Chipola slabshell) in the Apalachicola River. That operation is governed by a set of minimum flow and maximum fall rate provisions called the RIOP.

The RIOP specifies two parameters applicable to the daily releases from Jim Woodruff Dam: a minimum discharge (measured in cfs) and a maximum fall rate (measured in ft/d). However, the RIOP also identifies conditions under which maintenance of the maximum fall rate schedule is suspended and more conservative drought operations begin. The RIOP also places limitations on refill but generally does not require a net drawdown of composite conservation storage unless basin inflow is less than 5,000 cfs. The exception to this is when conservation storage is used to manage fall rates in accordance with the maximum fall rate schedule, but at a slower rate than the fall rate of the basin inflow.

h. Minimum Discharge

The RIOP varies minimum discharges from Jim Woodruff Dam by basin inflow, composite conservation storage thresholds, and month. The releases are measured as a daily average flow in cfs at the Chattahoochee, Florida gage.

Table 5 shows minimum releases from Jim Woodruff Dam prescribed by the RIOP and shows when and how much basin inflow is available for increasing reservoir storage. The RIOP defines basin inflow threshold levels that vary by three seasons: spawning season (March - May); non-spawning season (June - November); and winter (December - February), and incorporates composite conservation storage thresholds that factor into minimum release decisions. Composite conservation storage is calculated by combining the conservation storage of Lake Sidney Lanier, West Point Lake, and Walter F. George Lake.

TABLE 5
RIOP Water Releases from Jim Woodruff Dam

Months	Composite conservation storage zone	Basin inflow (BI) (cfs)	Releases from JWLD (cfs)	BI available for storage[a]
March–May	Zones 1 and 2	>= 34,000	>= 25,000	Up to 100% BI > 25,000
		>= 16,000 and < 34,000	>= 16,000 + 50% BI > 16,000	Up to 50% BI > 16,000
		>= 5,000 and < 16,000	>= BI	
		< 5,000	>= 5,000	
	Zone 3	>= 39,000	>= 25,000	Up to 100% BI > 25,000
		>= 11,000 and < 39,000	>= 11,000 + 50% BI > 11,000	Up to 50% BI > 11,000
		>= 5,000 and < 11,000	>= BI	
		< 5,000	>= 5,000	
June–November	Zones 1, 2, and 3	>= 24,000	>= 16,000	Up to 100% BI > 16,000
		>= 8,000 and < 24,000	>= 8,000 + 50% BI > 8,000	Up to 50% BI > 8,000
		>= 5,000 and < 8,000	>= BI	
		< 5,000	>= 5,000	
December–February	Zones 1, 2, and 3	>= 5,000	>= 5,000 (Store all BI > 5,000)	Up to 100% BI > 5,000
		< 5,000	>= 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-control purposes, and equipment capabilities.
b. Once composite conservation storage falls below the top of the Drought Zone, ramp down to 4,500 cfs will occur at a rate of 0.25 ft/d drop.

Each of the individual storage reservoirs consists of four action zones. The composite conservation storage uses the four zone concepts as well; i.e., Zone 1 of the composite conservation storage represents the combined storage available in Zone 1 for each of the three storage reservoirs. During the spawning season, two sets of four basin inflow thresholds and corresponding releases exist according to composite conservation storage. When composite conservation storage is in Zones 1 and 2, a less conservative operation is in place. When composite conservation storage is in Zone 3, a more conservative operation is in place while still avoiding or minimizing effects on listed species and critical habitat in the river. When composite conservation storage falls below the bottom of Zone 3 into Zone 4, the drought operations are *triggered* representing the most conservative operational plan. A detailed description of the drought operations is provided below.

During the spawning season, a daily monitoring plan that tracks composite conservation storage will be implemented to determine water management operations. Recent climatic and hydrological conditions experienced and meteorological forecasts will be used in addition to the composite conservation storage values when determining the appropriate basin inflow thresholds to use in the upcoming days.

During the non-spawning season, one set of four basin inflow 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 the drought operations are triggered.

During the winter season, only one basin inflow threshold and corresponding minimum release (5,000 cfs) exists while in composite conservation storage Zones 1 - 3. No basin inflow storage restrictions are in effect as long as that minimum flow is met under such conditions. When composite conservation storage falls below the bottom of Zone 3 into Zone 4, the drought operations are triggered.

The flow rates included in Table 5 prescribe minimum, and not target, releases for Jim Woodruff Dam. During a given month and basin inflow rate, releases greater than the RIOP minimum release provisions can 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 damage reduction.

i. 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. The fall rates are expressed in units of ft/d and are measured at the Chattahoochee, Florida, USGS gage as the difference between the daily average river stage of consecutive calendar days. Rise rates (e.g., today's average river stage is higher than yesterday's) are not addressed. The RIOP maximum fall rate schedule is provided in Table 6. When composite conservation storage is in Zone 4 and the drought operation described below is implemented, the maximum fall rate schedule is suspended. Unless otherwise noted, fall rates under the drought operation would be managed to match the fall rate of the one-day basin inflow.

j. Drought Operations

Coupled with the action zones defined for the upstream reservoirs, the RIOP incorporates a drought operation (referred to as the drought operations plan) that specifies a minimum release from Jim Woodruff 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 them. The minimum discharge is determined in relation to composite conservation storage and not average basin inflow under the drought operations plan. Volumetric balancing is implemented when conditions dictate. To accomplish volumetric balancing volumes of the basin

TABLE 6
RIOP Maximum Fall Rate Schedule
Composite Conservation Storage Zones 1, 2, and 3[a]

Release range (cfs)	Maximum fall rate, measured at Chattahoochee gage (ft/d)
> 30,000[b]	No ramping restriction[c]
> 20,000 and <= 30,000[a]	1.0 to 2.0
Exceeds powerhouse capacity (~ 16,000) and <= 20,000[a]	0.5 to 1.0
Within powerhouse capacity and > 8,000[a]	0.25 to 0.5
Within powerhouse capacity and <= 8,000[a]	0.25 or less

Notes: a. Maximum fall rate schedule is suspended in Composite Zone 4. b. Consistent with safety requirements, flood-control purposes, and equipment capabilities. 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.

During the spawning period (March to May), the Corps operations releases from Jim Woodruff Dam to avoid Gulf sturgeon take. Potential Gulf sturgeon take is defined as an eight-foot or greater drop in Apalachicola River stage over the last 14-day period (i.e., is today's stage greater than eight feet lower than the stage of any of the previous 14 days) when flows are less than 40,000 cfs.

inflows and releases are computed on a continuous basis. Readjustments are made, as necessary, to assure the required flow releases occur. The drought operations 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 Zone 1 - 3 provisions (seasonal storage limitations, maximum fall rate schedule, and minimum flow thresholds) are suspended, and management decisions are based on the provisions of the drought operations plan. The drought operations plan also includes any combination of (1) 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 or (2) beginning spring refill operations at an earlier date to provide additional conservation storage for future needs and provide for a minimum releases less than 5,000 cfs from Jim Woodruff Dam.

The drought operations 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 9). 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 has been 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 Dam is 5,000 cfs and all basin inflow above 5,000 cfs that is capable of being stored may be stored. Once the composite conservation storage falls below the Drought Zone, the minimum release from Jim Woodruff Dam is 4,500 cfs and all basin inflow 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 will be limited to a 0.25 feet per day (ft/d) drop. The 4,500 cfs minimum release is

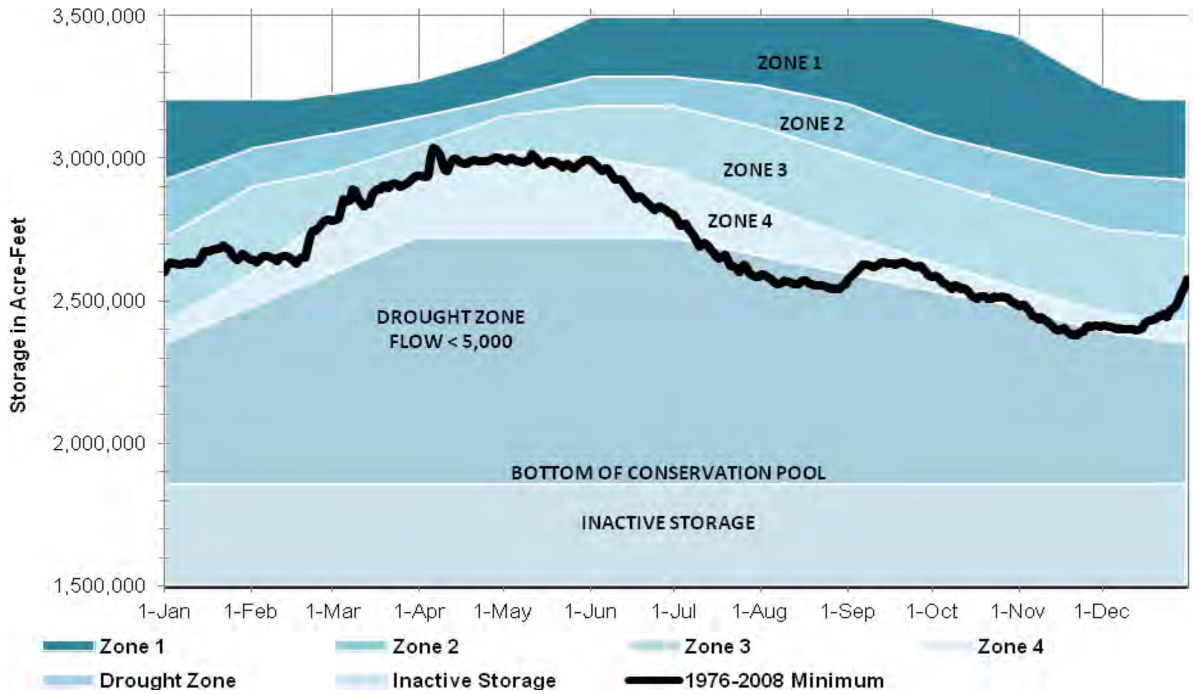

Figure 9. RIOP Drought Composite Conservation Storage Triggers

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 operations plan provisions remain in place until conditions improve such that the composite conservation storage reaches a level above the top of Zone 3 (i.e., in Zone 2). At that time, the temporary drought operations plan provisions would be suspended, and all the other provisions would be reinstated. During the 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. In addition, recent climatic and hydrological conditions experienced and meteorological forecasts would be used when determining the set of operations to use in the upcoming month.

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

k. Recreation

All the Corps lakes have become important recreational resources in the ACF Basin. The Corps is authorized to provide or permit the construction of recreational facilities on the grounds of Corps projects, and to provide water access at reservoirs. A wide variety of recreational opportunities are provided at the lakes including boating, fishing, picnicking, sightseeing, water skiing, and camping, and recreation occurs primarily between May 1 and Labor Day.

Based on current usage patterns, recreation impact levels have been identified for various lake elevations at each of the reservoir projects (Table 7).

TABLE 7
Water Levels Affecting Federal Project Recreation

Corps project	Initial impact level (IIL) (ft NGVD)	Recreation impact level (RIL) (ft NGVD)	Water access limited level (WAL) (ft NGVD)
Lake Lanier	1,066	1,063	1,060
West Point Lake	632.5	629	627
Walter F. George Lake	187	185	184
Lake Seminole	76	NA	NA

The first impact level is generally characterized by marginal effects on designated swimming areas, increased safety awareness regarding navigation hazards, minimal effects on Corps boat ramps, and minimal effects on private marina and dock owners. Additional impacts begin to occur at the second and third impact levels and may affect the quality of the recreational opportunities that are provided.

The primary recreation period corresponds to the dryer months of the year, when inflows decrease and the Corps must release water from storage to meet authorized project purposes throughout the system, according to the ACF system design. Thus, lake levels can and do decline during the primary recreation period, particularly during drier than normal years.

I. Water Quality

Buford, West Point, and Jim Woodruff dams all include water quality operations to provide continuous minimum flow releases. No minimum flow provisions are in place downstream of Walter F. George Dam. However, when low dissolved oxygen values are observed below the dam, water is spilled until the dissolved oxygen readings return to an acceptable level as defined by the *Standard Operating Procedure - Action to Be Taken During Periods of Low Dissolved Oxygen and Fish Distress Downstream of Walter F. George Lock & Dam* (USACE, Mobile District 1993a). Occasional special releases are also made at Buford Dam to ensure adequate dissolved oxygen and water temperature at the Buford Fish Hatchery downstream of the dam. At Buford Dam, the small turbine-generator is run continuously to provide a minimum flow from the dam, which ranges up to approximately 600 cfs. At West Point Dam, a similar small generating unit provides a minimum continuous release of approximately 675 cfs. In addition to those flows, Buford Dam is operated in conjunction with the downstream Georgia Power Dam at Morgan Falls to ensure a minimum in-stream flow of 750 cfs on the Chattahoochee River at Peachtree Creek to meet state water quality commitments.

Although there is no Corps requirement to maintain minimum flows for assimilative capacity at Columbus, Georgia, the GPC projects above Columbus are required in their FERC licenses to provide 1,850 cfs weekly average, 1,350 cfs daily average, and 800 cfs instantaneous minimum flow at Columbus. Releases from the GPC projects are dependent on upstream releases from West Point Dam and, to a limited extent those requirements are considered when making release decisions for West Point Dam.

Georgia Pacific and Farley Nuclear Plant below George W. Andrews Dam have stated a requirement of 2,000 cfs for compliance with permits and to meet their operational needs respectively. Although that is not a Corps requirement, to the extent practicable, the needs are considered in operations at Walter F. George Dam and Jim Woodruff Dam.

m. Water Supply

Various municipal and industry (M&I) entities withdraw water directly from Lake Lanier, the Chattahoochee River downstream of Lake Lanier and the Flint River. The Corps makes releases from Buford Dam that support the downstream withdrawals. Previous water supply contracts issued by the Corps for withdrawals from Lake Lanier expired in or before 1990 and have not been reissued. The Water Supply Act (WSA) of 1958 provides authority for the reallocation of storage within Corps reservoirs for water supply, but no storage within the ACF projects has been formally allocated to water supply under the WSA.

Water management for the water supply/water quality function involves accommodating the use of storage for water supply withdrawals, either directly from the reservoir or through dam releases for downstream interests. Releases from projects in the system are the minimum (capacity) release for hydropower or releases needed for basin-wide water supply/water quality. Releases are made for water supply requirements between Buford Dam and Peachtree Creek. Releases are made for water quality requirements between the Buford project and the Peachtree Creek confluence, at West Point Dam and at Jim Woodruff Lock and Dam.

Currently, downstream water supply withdrawals between Buford Dam and Peachtree Creek are approximately 277 mgd annually.

The current water supply users withdrawing water directly from Lake Lanier and their 2006 net withdrawal amounts are as follows:

Gwinnett County:	92.57 mgd
City of Gainesville:	18.98 mgd (includes 8.0 mgd under a relocation agreement)
City of Cumming:	18.76 mgd[9]
City of Buford:	1.53 mgd (includes 2.0 mgd under a relocation agreement)

Over 40 percent of Lake Lanier’s total water storage capacity is located in the “inactive” storage zone (below elevation 1,035 feet mean sea level (msl). The Lake Lanier reservoir is not designed to support Buford Dam as a peaking hydropower generation plant when Lake Lanier’s levels are below 1,035 feet. This is because maintaining the water elevation at or above 1,035 feet provides optimum head pressure to support hydropower production. All the water supply users have multiple level intakes in Lake Lanier (in the conservation pool and inactive storage), and several withdraw water from the inactive storage.

[9] The City of Cumming withdraws 11.93 mgd for their own municipal use, and an additional 6.83 which is sold to Forsyth County, Georgia.

Releases through Buford Dam to the Chattahoochee River currently draw from the inactive storage zone (releases from the hydropower units and the flood control sluice tunnels), and these waters are released and make up the Chattahoochee River that flows downstream to the Atlanta area municipal water intakes downstream.[10]

In general, Lanier weekly water supply/quality release decisions are made in consideration of the recommended releases per the Chattahoochee River Management System (as recorded in the Apalachicola Basin Reservoir Regulation Manual, Appendix B). In coordination with the Corps and Georgia Power, Atlanta Regional Commission (ARC) calculates the sum of anticipated downstream water supply river withdrawals by DeKalb County, City of Atlanta, Cobb County/Marietta Water Authority and Fulton County, water quality releases to ensure 750 cfs at the Peachtree Creek gaging station, and water returns (minus inflows between Buford Dam and Peachtree Creek). This approach ensures sufficient water is released from Lake Lanier to allow for Chattahoochee River withdrawals while also meeting the 750 cfs requirement at Peachtree Creek, along with generating hydropower and providing flows for fish and wildlife needs. These releases are re-regulated and released through GPC's Morgan Falls project in accordance with the Chattahoochee River Management System and GPC's FERC license. During the winter and spring, releases from Lake Lanier may be reduced due to sufficient downstream tributary flows to meet the Georgia Environmental Protection Division's 750 cfs target water quality flow at Peachtree Creek. To the extent possible, these releases are made in conjunction with peaking power operations in order to maximize the efficiency of releases for both hydropower generation and water supply.

Improved Operations

Many elements of the Improved Operations set are identical to operations under the Current Operations set (General System Operations, Flood Damage Reduction, Spawning and Fish Passage, Recreation, Water Quality, etc.). The following paragraphs describe areas where differences exist between operations under the Current and Improved Operations sets.

a. Guide Curves and Action Zones

Improved Operations use revised guide curves and/or action zones for Lake Lanier, West Point Lake, and Walter F. George Lake as depicted in Figure 10 (Lake Lanier), Figure 11 (West Point Lake), and Figure 12 (Walter F. George Lake). These guide curves and/or action zones are used to manage the lakes at the highest level possible while balancing the needs of all the authorized purposes. The action zones also provide guidance on meeting minimum hydroelectric power generation needs at each project. Other factors or activities might cause the lakes to operate differently than as described in the action zones. Examples of the factors or activities include exceptional flood damage reduction measures, fish spawn operations, maintenance and repair of turbines, emergency situations such as a drowning and chemical spills, draw-downs because of shoreline maintenance, releases made to free grounded barges, and other circumstances.

[10] The penstocks at Buford are at elevation 893 and the invert for the flood control sluice is as elevation 919, both of which are in the reservoir's inactive pool.

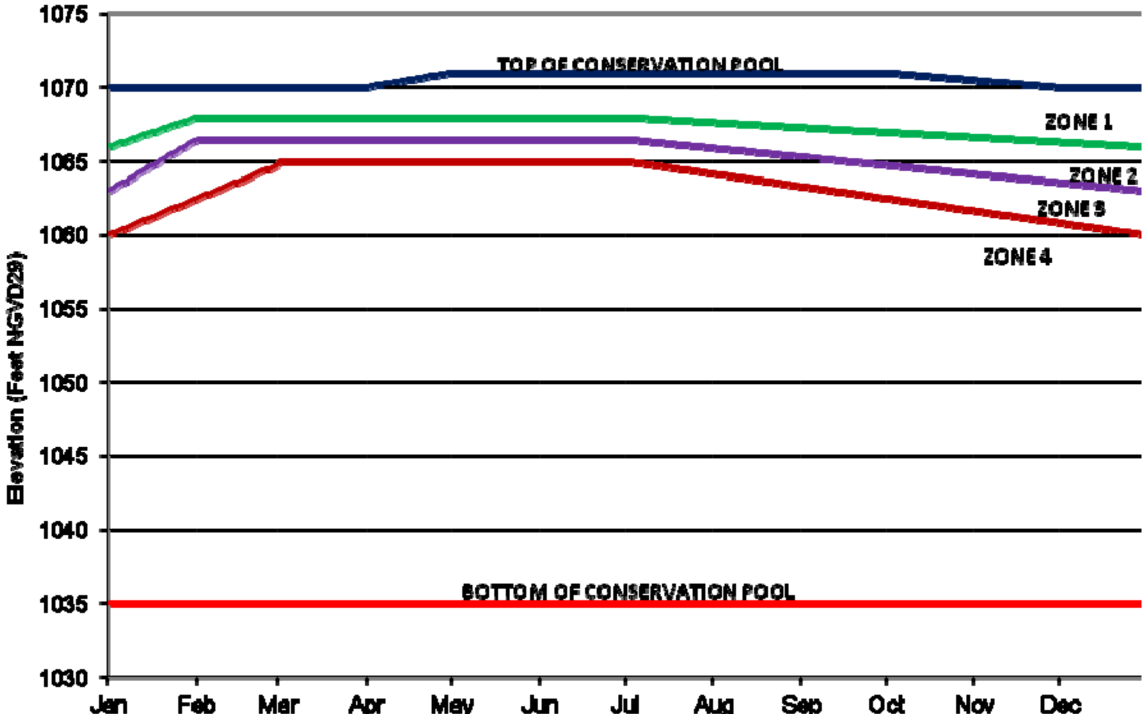

Figure 10. Improved Lake Lanier Water Control Action Zones

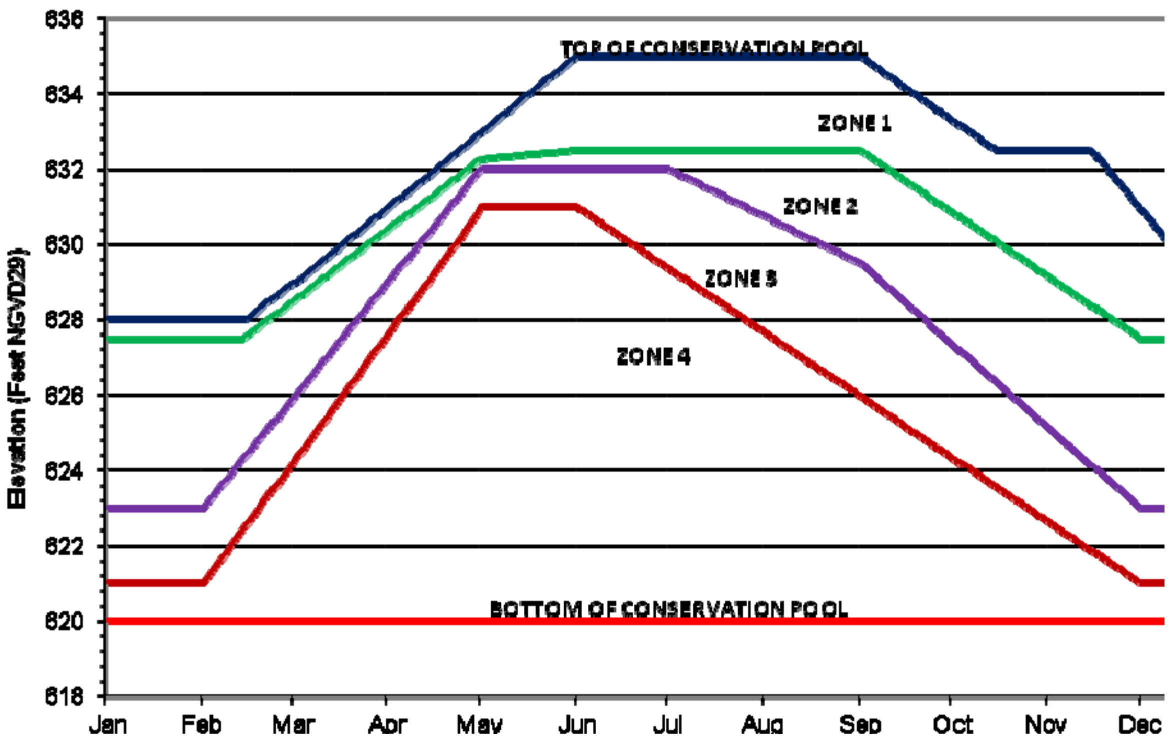

Figure 11. Improved West Point Water Control Action Zones

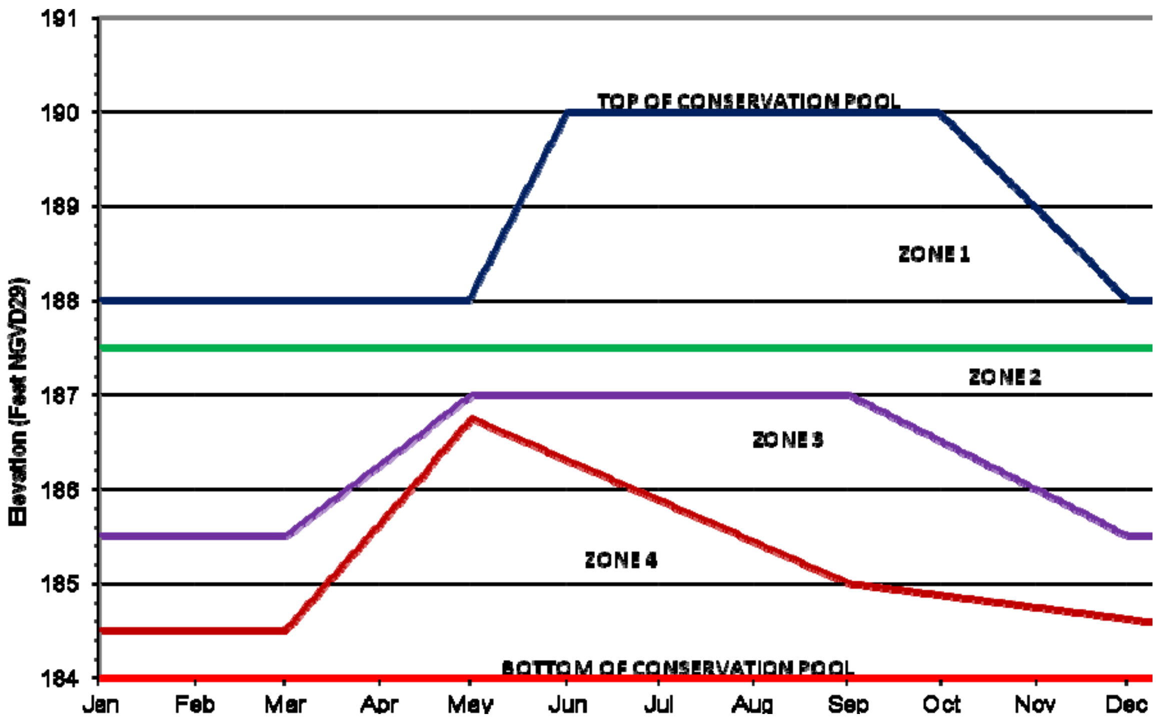

Figure 12. Improved Walter F. George Water Control Action Zones

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 river system and factors mentioned above, there might be periods when one lake is in a higher or lower zone than another. When that occurs, the Corps makes an effort to bring the lakes back into balance with each other as soon as conditions allow. By doing so, effects on the river basin are shared equitably among the projects.

The system-wide regulation of the ACF Basin is accomplished through the concept of composite conservation storage, with the composite storage comprised of four action zones. When composite storage is in Zones 1 and 2, a less conservative operation is in place. When composite storage is in Zone 3, a more conservative operation is in place while still avoiding or minimizing effects on listed species and critical habitat in the river. When composite storage falls below the bottom of Zone 3 into Zone 4, the drought operations are triggered, as described in more detail below.

The following definitions apply to the composite action zones:

Zone 1: If all the lakes are in Zone 1 or above, the river system would operate in a fairly normal manner. Releases can be made for hydroelectric power generation, water supply, and water quality. If system composite conservation storage is in Zone 1, releases can be made in support of a navigation season (January-April or May).

Zone 2: Hydroelectric power generation is supported at the same or a reduced level. Water supply and water quality releases are met. Minimum flow targets are met. If system composite conservation storage is in Zone 2, releases can be made in support of a navigation season (January-April or May).

Zone 3: Hydroelectric power generation is supported at a reduced level. Water supply and water quality releases are met. Minimum flow targets are met. If system composite conservation storage is in Zone 3, navigation is not supported.

Zone 4: Hydroelectric power generation demands will be met at a minimum level and might occur only for concurrent uses. Water supply and water quality releases are met. Minimum flow targets are met. If system composite storage is in Zone 4, navigation is not supported and drought operations are triggered.

The Improved action zones at Lake Lanier facilitate refill and store of water relative to the watershed. By changing the top of Zone 4 from elevation 1,055 feet to 1,060 feet in January, more water is in the reservoir when drought operations go in to effect.

Under the Improved Operation, the West Point Lake guide curve (top of conservation pool) change is maintained at a summer pool level of 635 feet beginning in June and lasting through August. In September, the lake elevation is gradually drawn down to approximately 632.5 feet by October 1. Lake levels are held at 632.5 feet until November. In November, another gradual drawdown to winter pool level of 628.0 feet occurs. Winter pool level is maintained until mid-February. Gradual lake refill begins in mid-February. Winter pool is steadily increased from 628.0 feet through the spring until summer pool elevation of 635.0 feet is achieved in June.

b. Hydroelectric Power Generation

Improved Operations includes hydropower generation that is determined by action zone for Buford Dam, West Point Dam, and Walter F. George Lock and Dam. Typical generation by action zone is depicted in Table 8.

TABLE 8
Typical Hours of Weekday Peaking Hydroelectric Power Generation by Federal Project under Improved Operations

Hydroelectric power generation hours	Hours of Operation		
	Buford Dam	West Point Dam	Walter F. George Dam
Zone 1	3	4	4
Zone 2	2	2	2
Zone 3	2	2	2
Zone 4*	0*	0*	0*

*While hydropower would still be generated in Zone 4, it could not be generated on a regular peaking schedule under severe drought conditions.

c. Navigation

Improved Operations support a reliable navigation season when ACF Basin hydrologic conditions are favorable. 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 four to five consecutive months (January through April or May). During the navigation season, the flows at the Blountstown, Florida, USGS gage should be adequate to provide at least a seven-foot channel. The most recent channel survey and discharge-stage rating was used to determine a flow of 16,200 cfs is required to sustain a minimum navigation depth during the navigation season. The Corps' capacity to support a navigation season will depend on actual and projected system-wide conditions in the ACF Basin before and during January, February, March, April, and May. Those conditions include:

1. A navigation season can be supported only when the ACF Basin composite conservation storage is in Zone 1 or Zone 2 (see Figure 13).
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 2 and is forecast to remain above Zone 3 for a practicable, continuous period.
3. 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.
4. The determination to extend the navigation season beyond April will depend on ACF Basin inflows, recent climatic and hydrological conditions, meteorological forecasts, and basin-wide model forecasts. On the basis of an analysis of those factors, the Corps will determine if the navigation season will continue through part or all of May.
5. Down-ramping of flow releases (regardless of period in the navigation season) will adhere to the Jim Woodruff Dam fall rate schedule (Table 9) for federally listed threatened and endangered species.
6. Releases that augment the flows to provide for the seven-foot 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 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, provided the releases will not significantly affect other project purposes and any fluctuations in reservoir levels or river stages will be minimal. For instance, releases can be requested to achieve up to a nine-foot channel. Those will be evaluated case by case, subject to applicable laws and regulations and the conditions above.

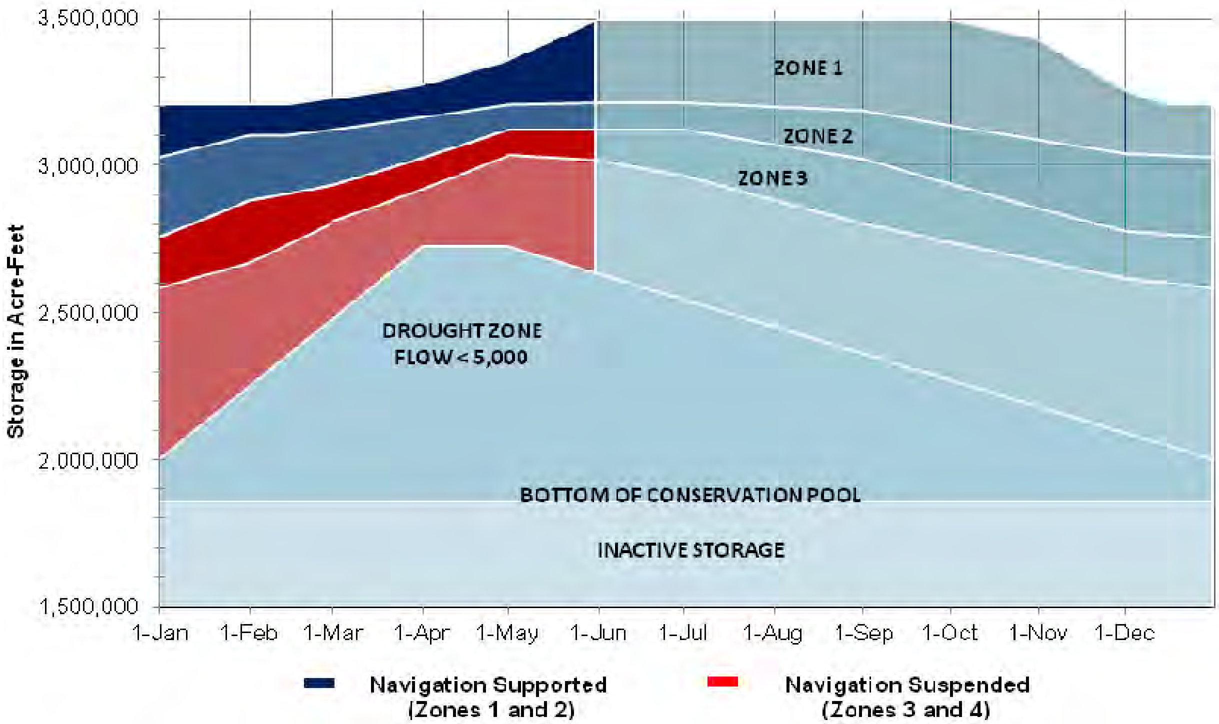

Figure 13. Improved Composite Conservation Storage for Navigation

TABLE 9
Current Maximum Fall Rate Schedule
Composite Conservation Storage Zones 1, 2, and 3[ab]

Release range (cfs)	Maximum fall rate, measured at Chattahoochee gage (ft/d)
> 30,000[c]	No ramping restriction[d]
Exceeds powerhouse capacity (~ 16,000) and <= 30,000[a]	Match 1-day basin inflow fall rate
Within powerhouse capacity and > 8,000[a]	0.25 to 0.5
Within powerhouse capacity and <= 8,000[a]	0.25 or less

Notes:

a. Maximum fall rate schedule is suspended in Composite Zone 4.

b. Any changes to the RIOP minimum flows or maximum fall rate provisions resulting from reinitiation of consultation will be incorporated and evaluated.

c. Consistent with safety requirements, flood-control purposes, and equipment capabilities.

d. 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. Fish and Wildlife Conservation

Under Improved Operations, Spawning and Fish Passage Operations are the same as under Current Operations. Differences concerning operations for Threatened and Endangers Species are discussed below.

Federally Listed Threatened and Endangered Species Conservation - Modified Revised Interim Operating Plan (RIOP)

The modified RIOP specifies two parameters applicable to the daily releases from Jim Woodruff Dam: a minimum discharge and a maximum fall rate. Also like the current RIOP, the modified RIOP places limitations on refill, but does not require a net drawdown of composite storage unless basin inflow is less than 5,000 cfs and maximum fall rate is slower than basin inflow fall rate. However, the modified RIOP includes several changes to the current RIOP. The modifications include 1) elimination of the use of volumetric balancing as described in the May 16, 2007 letter to USFWS; 2) minimum flow releases will match basin inflow when basin inflow is between 5,000 and 10,000 cfs during the months of June through February (this provision is suspended during drought contingency operations)[11]; 3) drought contingency operations are not suspended and normal operations reinstituted until such a time as the composite conservation storage has recovered above Zone 2 into Zone 1; 4) when releases are within powerhouse capacity and less than 10,000 cfs the maximum fall rate is limited to 0.25 ft/d or less; and 5) in accordance with RPM 2008-4 of the RIOP BO (USFWS 2008), formal adoption of an additional Gulf sturgeon spawning season (March-May) provision which ensures that river stage declines of eight feet or more will not occur in less than 14 days when river flows are less than 40,000 cfs (under both normal and drought operations[i])[12].

The modified RIOP does not change the current RIOP basin inflow calculation (seven-day moving average daily basin inflow), use of Chattahoochee gage (USGS number 02358000) to measure releases/river flow, limited hydropower peaking operations at Jim Woodruff Dam, nor conditions under which maintenance of the minimum release and maximum fall rate schedule are suspended and more conservative drought contingency operations begin.

Minimum Discharge - The modified RIOP varies minimum discharges from Jim Woodruff Dam by basin inflow, composite conservation storage level, and by month and the releases are measured as a daily average flow in cfs at the Chattahoochee gage. Table 10 shows minimum releases from Jim Woodruff Dam prescribed by the modified RIOP and shows when and how much basin inflow is available for increasing reservoir storage. Except when basin inflow is less than 5,000 cfs and during some down-ramping periods, the minimum releases are not required to exceed basin inflow.

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[11] On December 13, 2011, at the time the remand modeling was conducted, the Corps was in a revised ESA consultation with the USFWS. The figures cited here represent flows that were modeled as part of the proposal at that time.

[12] The Modified RIOP modeled as part of the technical analysis in response to the remand from the 11th Circuit Court of Appeals includes all the features described in Improved Operations, Section e., Federally Listed Threatened and Endangered Species Conservation – Modified Revised Interim Operating Plan, as well as all other features described as part of the improved operations set.

Table 10. Modified RIOP Releases from Jim Woodruff Dam				
Months	**Composite Storage Zone**	**Basin Inflow (BI) (cfs)**	**Releases from JWLD (cfs)**	**Basin Inflow Available for Storage**[13]
March - May	Zones 1 and 2	>= 34,000	>= 25,000	Up to 100% BI > 25,000
		>= 16,000 and < 34,000	>= 16,000 + 50% BI > 16,000	Up to 50% BI > 16,000
		>= 5,000 and < 16,000	>= BI	None
		< 5,000	>= 5,000	None – Augment releases from storage
	Zone 3	>= 39,000	>= 25,000	Up to 100% BI > 25,000
		>= 11,000 and < 39,000	>= 11,000 + 50% BI > 11,000	Up to 50% BI > 11,000
		>= 5,000 and < 11,000	>= BI	None
		< 5,000	>= 5,000	None – Augment releases from storage
June - November	Zones 1,2, and 3	>= 22,000	>= 16,000	Up to 100% BI > 16,000
		>= 10,000 and < 22,000	>= 10,000 + 50% BI > 10,000	Up to 50% BI > 10,000
		>= 5,000 and < 10,000	>= BI	None
		< 5,000	>= 5,000	None – Augment releases from storage
December - February	Zones 1,2, and 3	=10,000	>=10,000	100% BI > 10,000
		>= 5,000 and <10,000	>= 5,000	None – Augment releases from storage
At all times	Zone 4	NA	>= 5,000	Up to 100% BI > 5,000
At all times	Drought Zone	NA	>= 4,500[14]	Up to 100% BI > 4,500

[13] Consistent with safety requirements, flood control purposes, and equipment capabilities.
[14] Once composite storage falls below the top of the Drought Zone ramp down to 4,500 cfs will occur at a rate no greater than 0.25 ft/d drop.

The modified RIOP defines basin inflow threshold levels that vary by three seasons: spawning season (March-May); non-spawning season (June-November); and winter (December-February). The modified RIOP also incorporates composite conservation storage thresholds that factor into minimum release decisions. Composite conservation storage is calculated by combining the conservation storage of Lake Sidney Lanier, West Point Lake, and Walter F. George Lake. Each of the individual storage reservoirs consists of four zones. These zones are determined by the operational guide curve for each project (reference Section 4). The composite conservation storage utilizes the four zone concepts as well; i.e., Zone 1 of the composite conservation storage represents the combined conservation storage available in Zone 1 for each of the three storage reservoirs.

During the spawning season (March-May), two sets of four basin inflow thresholds and corresponding releases exist based on composite conservation storage. In accordance with RPM 2008-4 of the RIOP BO (USFWS 2008), the spawning season also includes a special fall rate provision in order to avoid take of larval Gulf sturgeon. The provision ensures that river stage declines of eight feet or more do not occur in less than 14 days when river flows are less than 40,000 cfs. When composite conservation storage is in Zones 1 and 2, a less conservative operation is in place. When composite conservation storage is in Zone 3, a more conservative operation is in place while still avoiding or minimizing impacts to listed species and critical habitat in the river. When composite conservation storage falls below the bottom of Zone 3 into Zone 4 the drought contingency operations are “triggered” representing the most conservative operational plan. The spawning season fall rate provision is in place under normal and drought operations. A detailed description of the drought contingency operations is provided below. During the spawning season, a daily monitoring plan that tracks composite storage will be implemented in order to determine water management operations. Recent climatic and hydrological conditions experienced and meteorological forecasts will be used in addition to the composite conservation storage values when determining the appropriate basin inflow thresholds to utilize in the upcoming days.

During the non-spawning season (June-November), one set of four basin inflow thresholds and corresponding releases exists based on composite conservation storage in Zones 1-3. However, the modified RIOP changed basin inflow and minimum release provisions when operating in these composite conservation zones. The modified RIOP further limits storage opportunities when basin inflow is between 5,000 and 10,000 cfs. This change also requires slight adjustments to the basin inflow levels and minimum release provisions at basin inflows greater than 10,000 cfs. Table 10, Modified RIOP Releases from Jim Woodruff describes the modified RIOP, with the changes to the current RIOP. When composite conservation storage falls below the bottom of Zone 3 into Zone 4 the drought contingency operations are “triggered”.

During the winter season (December - February), one set of three basin inflow thresholds and corresponding releases exist based on composite storage in Zones 1-3. The modified RIOP limits storage opportunities when basin inflow is between 5,000 and 10,000 cfs. There are no basin inflow storage restrictions as long as basin inflow is above 10,000 cfs. When basin inflow is 5,000 cfs or less, the corresponding minimum release is 5,000 cfs. When composite storage falls below the bottom of Zone 3 into Zone 4 the drought contingency operations are "triggered".

The flow rates included in Table 9 prescribe minimum, and not target, releases for Jim Woodruff Dam. During a given month and basin inflow rate, releases greater than the Table 10 minimum releases may occur consistent with the maximum fall rate schedule, described below, or as needed to achieve other project purposes, such as hydropower or flood control.

Maximum Fall Rate - Fall rate, also called down-ramping rate, is the vertical drop in river stage (water surface elevation) that occurs over a given period. The fall rates are expressed in units of ft/d, and are measured at the Chattahoochee gage as the difference between the daily average river stage of consecutive calendar days. Rise rates (*e.g.,* today's average river stage is higher than yesterday's) are not addressed. The modified RIOP revises the maximum fall rate schedule (Table 9) prescribed by the current RIOP. The revised maximum fall rate consists of limiting the maximum fall rate to 0.25 ft/d or less when releases are within powerhouse capacity and less than 8,000 cfs. When releases are within powerhouse capacity and greater than 8,000 cfs, the maximum fall rate is limited to 0.25 to 0.50 ft/d. Unless otherwise noted, fall rates under the drought contingency operation would be managed to match the fall rate of the one-day basin inflow to facilitate quicker recovery and a faster return to normal operations.

e. Drought Operations

Drought operations are *triggered* when composite conservation storage of the ACF Basin falls below the bottom of Zone 3 into Zone 4, (See Figure 14). At that time, all the composite conservation storage Zone 1 - 3 provisions (seasonal storage limitations, maximum fall rate schedule, and minimum flow thresholds) are suspended, and management decisions are based on the provisions of the drought operations plan. Under drought operations, the Jim Woodruff Dam minimum discharge is determined in relation to composite conservation storage and not the average basin inflow. The drought operations plan for the ACF Basin specifies a minimum release from Jim Woodruff 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 the minimum releases and maximum fall rates. The drought operations plan also includes 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. There is also an opportunity to begin spring refill operations at an earlier date to provide additional conservation storage for future needs and a provision for minimum releases less than 5,000 cfs from Jim Woodruff Lock and Dam when specific conditions are encountered.

The drought plan prescribes two minimum releases from Jim Woodruff Dam on the basis of composite conservation storage in Zone 4 and the Drought Zone, (See Figure 14). The Drought Zone contains the 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. When the composite conservation storage is within Zone 4 and above the Drought Zone, the minimum release from Jim Woodruff Dam is 5,000 cfs, and all basin

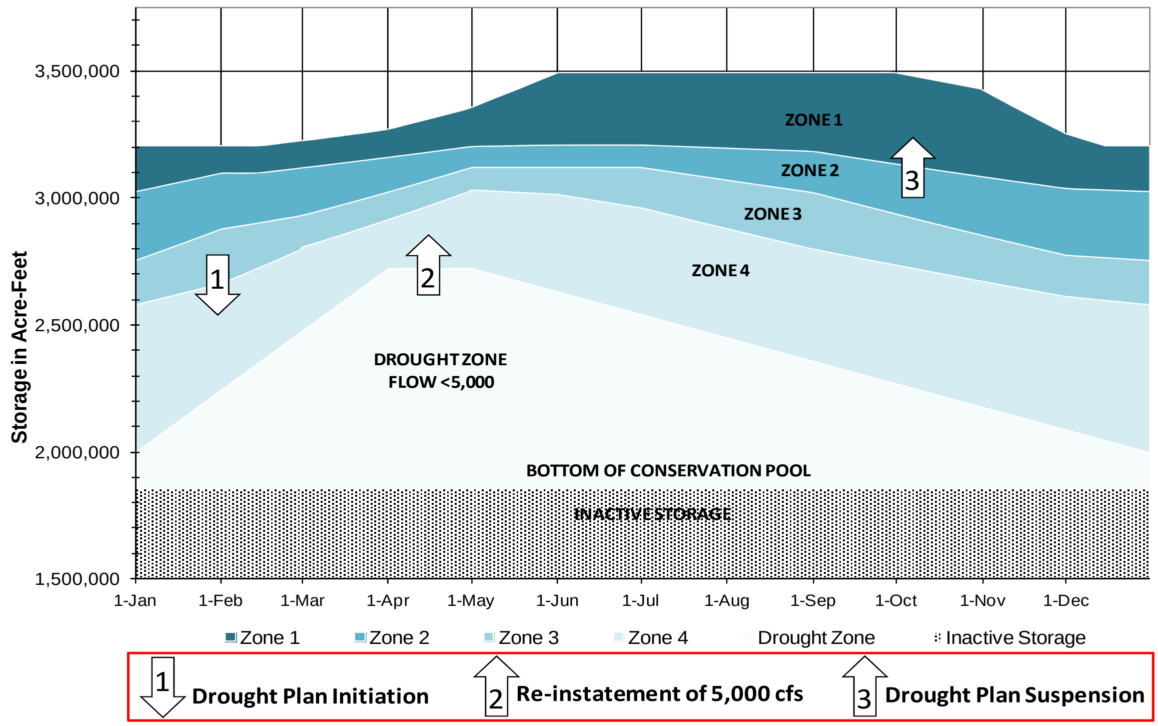


Figure 14. Modified RIOP – Drought Composite Storage Triggers

inflow 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 Dam is 4,500 cfs, and all basin inflow 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 will be limited to a 0.25 ft/d 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 operations plan provisions remain in place until conditions improve such 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 operations plan provisions are suspended, and all the other provisions are reinstated. During the 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) will be implemented to determine which operational triggers are applied. In addition, recent climatic and hydrological conditions experienced and meteorological forecasts will be used when determining the set of operations to use.

f. Water Supply

Assorted water supply demand scenarios were modeled based on the improved operations set. These water supply alternatives (see Section 4), using known and projected water supply withdrawals and known and projected water return rates in Lake Lanier and the Chattahoochee River, were designed to reflect water supply as an authorized purpose rather than incidental to hydropower generation. These alternatives demonstrate management actions in which water supply is an operational objective.

SECTION 5 – ALTERNATIVES

The Corps modeled and evaluated 18 alternatives in this analysis. These alternatives were chosen to represent different assumptions in Lake Lanier withdrawals, Lake Lanier return rates, Chattahoochee River withdrawals, and operating procedures. Table 11, Alternatives Description below provides a brief description of each alternative and the operation set it is based on. Table 12, Baseline Data Sets provides the river and lake water withdrawal amounts for baselines for each data set. Table 13 provides the amount of water to be withdrawn as specified in the Georgia 2000 request (lake and river amounts) as well as the current return rate to the river. Table 14 provides the modeled lake return rates that were used in this analysis.

The objective of a baseline, in the context of this analysis, is to distinguish effects to project purposes, especially hydropower, that are attributable to river withdrawals and that are attributable to lake withdrawals. As used in this analysis, the term “baseline” may reflect different withdrawal amounts from the Chattahoochee River, because the Corps modeled different amounts of river withdrawals pursuant to Georgia’s 2000 request. Therefore, each data set has a “baseline.” The term baseline in each data set always includes an amount of water withdrawn from the river and at least 20 mgd from the Lanier reservoir (reflecting 10 mgd authorized under relocation agreements and 10 mgd expressly authorized under the 1956 Act). For example, the baseline for a Georgia’s 2010 request is 347 mgd from the river and 20 mgd from the reservoir.

TABLE 11
Alternatives Descriptions

Alternative	Description	Operation Set
IMP_Power	Improved operations without downstream water supply, 20 mgd from Lake Lanier, 600 cfs (388 mgd) off-peak release from Buford Dam, 13.5 hrs/weekday of peak generation at Buford Dam	IMProved
Current	Current operations including 2008 Revised Interim Operating Plan with 2007 water use as reported by the State of Georgia	Current
IMPBase	Improved operations with Lake Lanier withdrawals limited to 20 mgd and current Chatthoochee River withdrawals at Atlanta, Georgia	IMProved
IMProved	Improved operations with water supply, current Lake Lanier and Chattahoochee River river withdrawals at Atlanta, Georgia	IMProved
IMPGA2010B	Baseline for evaluating Georgia's 2010 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2010 projected Chattahoochee River withdrawals at Atlanta, Georgia	IMProved
IMPGA2010R	Georgia's 2010 request, with Georgia's 2010 projected lake and river withdrawals and projected lake return rate, improved operations	IMProved
IMPGA2020B	Baseline for evaluating Georgia's 2020 request; Lake Lanier withdrawals limited to 20 mgd, improved operations with 2020 projected Chattahoochee River withdrawals at Atlanta, Georgia	IMProved
IMPGA2020R	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Chattahoochee River withdrawals at Atlanta, Georgia, using Georgia's projected lake return rate, improved operations	IMProved
IMPGA2020P	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Chattahoochee River withdrawals at Atlanta, Georgia, using lake return rate based on current permits, improved operations	IMProved
IMPGA2020C	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Chattahoochee River withdrawals at Atlanta, Georgia, using Lake Lanier return rate based on historic water use, improved operations	IMProved
IR392L125	Georgia's 2020 requested Chattahoochee River withdrawals at Atlanta, Georgia and 2007 Lake Lanier withdrawals as reported by Georgia	IMProved
IMPGA2030B	Baseline for evaluating Georgia's 2030 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2030 projected Chattahoochee River withdrawals at Atlanta, Georgia	IMProved
IMPGA2030R	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Chattahoochee River withdrawals at Atlanta, Georgia, using Georgia's projected Lake Lanier return rate, improved operations	IMProved
IMPGA2030P	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Chattahoochee River withdrawals at Atlanta, Georgia, using lake return rate based on current permits, improved operations	IMProved
IMPGA2030C	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Chattahoochee River withdrawals at Atlanta, Georgia, using Lake Lanier return rate based on historic water use	IMProved
IR408L125	Georgia's 2030 requested Chattahoochee River withdrawals at Atlanta, Georgia, plus Lake withdrawals in 2007 as reported by Georgia, Lake Lanier return rate based on historic water use, improved operations	IMProved
IR408LMAX	Georgia's requested 2030 Chattahoochee River withdrawal at Atlanta, Georgia combined with the maximum amount of Lake Lanier withdrawals that could be made to drain lake storage to, but not below, the bottom of the conservation pool at elevation 1035', improved operations	IMProved
IMPMAXRHA	20mgd withdrawal from Lake Lanier, combined with the maximum amount of Chattahoochee River withdrawal at Atlanta, Georgia that could be made to drain lake storage to, but not below, the bottom of conversation pool at elevation 1035', improved operations	IMProved

TABLE 12
Baseline Data Sets

Name	Lake Lanier Withdrawals (mgd)	Chattahoochee River Withdrawals (mgd)
Improved Operations Baseline	**20**	**277**
2010 Baseline	**20**	**347**
2020 Baseline	**20**	**392**
2030 Baseline	**20**	**408**

TABLE 13
Georgia 2000 Request and Current River Return Rate

	Lake Lanier Withdrawals (mgd)	Chattahoochee River Withdrawals (mgd)	River Return Rate
2010 Request	202	347	76%
2020 Request	256	392	76%
2030 Request	297	408	76%

TABLE 14
Assumed Lake Lanier Withdrawal Return Rates for Studied Alternatives

Source	Lake Lanier Return Rates
2010 Georgia projection	15%
2020 Georgia projection	27%
2030 Georgia projection	36%
2007 Georgia reported	7%
Current Georgia permits	23%*/20%**

*Percentage of Georgia's requested 2020 Lake Lanier water withdrawal volume that would be returned to Lake Lanier using return rates specified in current Georgia water withdrawal permits

**Percentage of Georgia's requested 2030 Lake Lanier water withdrawal volume that would be returned to Lake Lanier calculated using return rates specified in current Georgia water withdrawal permits

APPENDIX A

WATER SUPPLY DETERMINATION METHODOLOGY

WATER SUPPLY DETERMINATION METHODOLOGY

I. Background

The purpose of this appendix is to discuss how the Corps modeled water consumption in the ACF Basin and how it developed and modeled river and lake return rates.

Water use within the ACF Basin influences the operation of the reservoirs. Water availability is reduced by the consumptive use of water. Water is withdrawn from streams and water bodies. In some cases, after the withdrawn water is used, it is treated and returned to the system. The net loss of water is classified as consumptive use and reduces the water available within the basin. Estimates for actual water use were performed using information provided by the States of Georgia, Florida and Alabama. The water use is grouped into four categories: municipal, industrial, power and agricultural. Within ResSim, the net water use is represented as diversions and can occur at a reservoir or non-reservoir node (a node typically represents a reservoir site or a stream gaging station). The diversion can enter the system or leave the system entirely. In this analysis the diversion leaves the system entirely. Therefore, the net water use is represented as loss of water to the system.

II. Methodology

ResSim handles withdrawals and returns at nodes within the model. ResSim defines a reach as the area between two control points. All three affected states -- Alabama, Florida and Georgia -- grouped the municipal, industrial, power and agriculture water use sites from their respective state by reaches according to a ResSim model schematic. Figure A-1 shows Buford and reservoir; the reach between Buford Dam and Norcross gage; the Norcross gage site; and the diversion from Norcross.

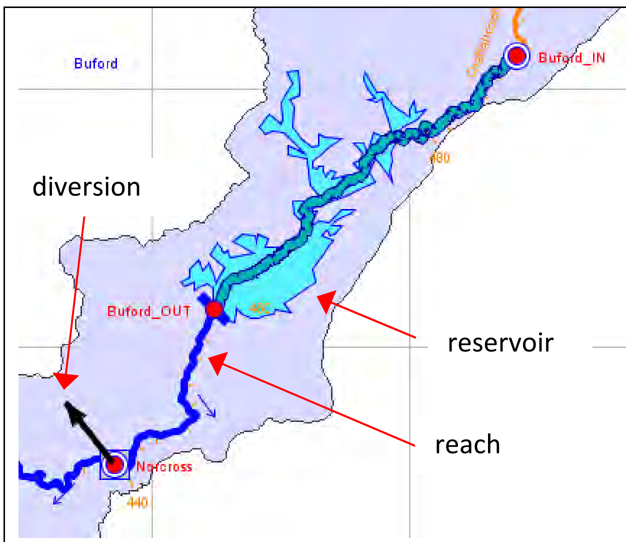


Figure A-1. Buford Dam and reservoir, the reach between Buford Dam and Norcross gage site, and diversion at Norcross

The states only provided data for those municipal, industrial, and thermal flow withdrawals and returns directly to/from surface water. TABLE A-1 lists the state agencies that provided the water use data.

TABLE A-1
Water Use Data Sources

Data Type	Source
Alabama Water Use	Alabama Department of Economic and Community Affairs, Alabama Office of Water Resources (AL OWR)
Georgia Water Use	GA Environmental Protection Division (GAEPD), Department of Natural Resources
Florida Water Use	Florida's Northwest Florida Water Management District (NWFWMD)

The process to gather, reformat, fill-in, and aggregate water use is described below:

- State agencies, GAEPD, AL OWR and NWFWMD were contacted to provide historic water surface water withdrawals and returns within the ACF Basin
- A list of original water users with reach assignment was provided to the states. This original list was developed during the ACT/ACF Comprehensive Study.
- The data provided by the states was reformatted to consistent formats and grouped by withdraws and returns. In this format the data was ready for more efficient review.
- Upon weeks of review and communication with Alabama, Georgia and Florida, missing data, duplicate data, erroneous data and other inconsistencies were discovered and corrected to the best of the Corps' abilities.
- Also during the review, any missing records had to be estimated with the help of the respective state agency.
- As the data set reached a point where major revisions were essentially complete, the data for each user was reorganized according to ResSim model reach.
- The return and withdrawal data for every reach was summed to give total withdrawal and total return by reach.
- Next the net withdrawal (withdrawal minus return) for each reach was computed in mgd and cfs units.
- Final step, import the monthly values into HEC-DSS format and compute daily values.
- The net-withdrawal time series are available for mapping to the appropriate ResSim node.

Flow withdrawals from the reservoirs and from the rivers are modeled differently using one of the following methods:

1. Withdrawals from a reservoir are modeled at the reservoir inflow junction as a negative local inflow specified as an external time-series, so that a diversion from a reservoir can never be "shorted".
2. Withdrawals from a river are modeled more flexibly as diversion elements (black arrows) from junctions. These withdrawals might be constant, specified as an external time-series, or represented as a function of a model variable.

For both method 1 (negative local inflow) and method 2 (diversion element), the amount of flow diverted is included in the net inflow calculation. In other words, the net inflow to a reservoir accounts for the flow withdrawal, and is calculated before release decisions from the pool are made. The difference between these two methods is that there is no control on the flow withdrawal for method 1 even if there's insufficient inflow from upstream. Even if the pool is at the bottom of a conservation zone, withdrawal will still take place until the pool is dry (regardless of any outlet elevations). This scenario represents the actual withdrawal conditions occurring in all of the COE and GPC projects. For method 2, if there is shortage in the inflow from upstream, withdrawals will be stopped. This scenario more represents the actual withdrawals from the river reaches. Figure A-2 shows examples of both methods being used in the modeling of reservoir and non-reservoir diversions.

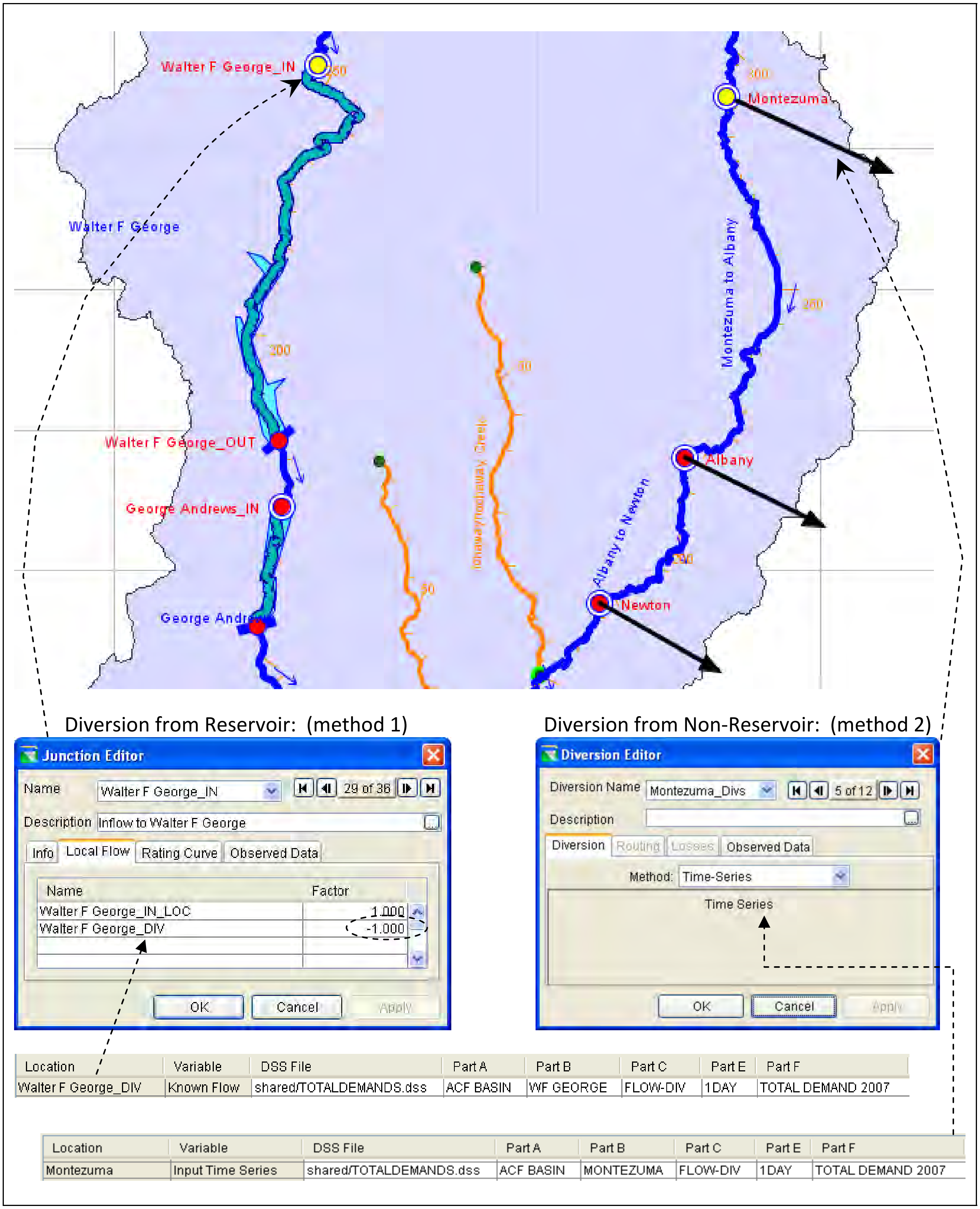


Figure A-2. Two Methods Used in Modeling Diversions (for Reservoirs and Non-Reservoirs)

Monthly water withdrawals and returns of individual entities (users) are summed by model reaches to produce the net withdrawal. Modeled diversions from reservoirs and reaches are listed in Table A-2.

TABLE A-2
List of Diversions Modeled in ResSim

Diversion	Description
Reservoir Diversions (Method 1)	
Metro Atlanta	Diversion from Buford_IN inflow node
10 MGD_Rel Contract	Diversion from Buford_IN inflow node
Morgan Falls_DIV	Diversion from Morgan Falls_IN inflow node
West Point_DIV	Diversion from West Point_IN inflow node
Bartletts Ferry_DIV	Diversion from Bartletts Ferry_IN inflow node
Walter F George_DIV	Diversion from Walter F George_IN inflow node
George Andrews_DIV	Diversion from George Andrews_IN inflow node
Jim Woodruff_DIV	Diversion from Jim Woodruff_IN_SP_IN inflow node
Reach Diversions (Method 2)	
Albany_Divs	Albany diversion
Atlanta Divs_River	Composite of the river withdrawals between Morgan Falls Dam tailrace and Peachtree Creek confluence
Bainbridge_Divs	Bainbridge diversion
Blountstown_Divs	Blountstown diversion
Columbus_Divs	Columbus diversion
Griffin_Divs	Griffin diversion
Montezuma_Divs	Montezuma diversion
Newton_Divs	Newton diversion
Norcross_Divs	Norcross diversion
Sumatra_Divs	Sumatra diversion
West Point Gage_Divs	West Point Gage diversion
Whitesburg_Divs	Whitesburg diversion

A. Data Sources

1. Water Supply M&I Withdrawals and Returns

Various municipal and industry (M&I) entities withdraw water directly from Lake Lanier and others withdraw directly from the Chattahoochee River downstream of Lake Lanier. Operations are also influenced by agricultural water withdrawals on the Flint River. Agricultural demands vary depending on the climatic conditions, but are generally 1.5 to 2 times the withdrawals for M&I. Water withdrawals within the State of Georgia are made pursuant to water withdrawal permits issued by the Georgia Department of Natural Resources. Previous water supply contracts issued by the Corps for withdrawals from Lake Lanier expired by 1990 and have not been re-issued. The Water Supply Act of 1958 provides authority for reallocation or addition of storage within Corps reservoirs for water supply, with the cost of storage and associated facilities to be reimbursed by a non-Federal entity via water storage contracts. No storage within the ACF projects is currently allocated to water supply.

Water management for the water supply/water quality function involves taking water from storage, either directly from the reservoir or through dam releases for downstream interests. These operations ensure that sufficient drinking water is available for municipal and industrial needs and agreements to provide instream flow for water quality are not violated. Releases from projects in the system are the minimum (capacity) release for hydropower or releases needed for basin-wide water supply/water quality. The current (as of 2008) water supply users withdrawing water above Buford Dam and their 2007 average withdrawal amounts are listed in TABLE A-3 and TABLE A-4.

TABLE A-3
Surface Water Withdrawal Facilities above Buford Dam

Facility	mgd	cfs	Directly from Lake Lanier
Baldwin, City of	2.35	3.64	
Birch River, L.P./ Birchriver Chestatee Company, LLC	0.00	0.00	
Buford, City Of (includes 2.0 mgd relocation amount)	1.47	2.27	X
Clarkesville, City Of	0.70	1.08	
Cornelia, City Of	2.62	4.05	
Cumming, City Of	11.63	17.99	X
Dahlonega, City Of - New Plant	0.96	1.49	
Forsyth County Board Of Commissioners (provided by Cumming)	8.44	13.05	X
Gainesville, City Of (includes 8.0 mgd relocation amount)	18.75	29.01	X
Gwinnett County Water & Sewerage Auth	88.19	136.43	X
Habersham Investment & Development Corp. And Birch River, L.P.	0.00	0.00	
Lanier Golf Club	0.04	0.07	
LLI Management Company, LLC	0.02	0.02	X
LLI Management Company, LLC (Pineisle)	0.11	0.17	X
McRae and Stolz, Inc.	0.01	0.02	X
White County Water & Sewer Authority	0.66	1.02	
Total	135.9	210.3	

The current (as of 2008) water supply systems returning water above Buford Dam and their 2007 average discharge amounts are as follows:

TABLE A-4
Facilities that Return/Discharge above Buford Dam

Facility	mgd	cfs	Directly to Lake Lanier
BUFORD SOUTHSIDE WPCP	1.33	2.05	X
CLARKSVILLE WPCP	0.00	0.00	
CLEVELAND WPCP	0.00	0.00	
CORNELIA WPCP	1.96	3.03	
DAHLONEGA WPCP	0.51	0.79	
FLOWERY BRANCH WPCP	0.00	0.00	X
GAINESVILLE FLAT CREEK WPCP	7.22	11.18	X
GAINESVILLE WPCP (Linwood Dr)	1.10	1.71	X
LAKE LANIER ISLAND DEV AUTH WPCP	0.05	0.08	X
SCOVILL FASTENERS, INC.	0.15	0.23	
Total	12.32	19.06	

The total gross M&I water withdrawal above Buford in 2007 was 135.9 mgd (210.3 cfs), total returned was 12.3 mgd (19.1 cfs) and total M&I net withdrawal was 123.6 mgd (191.3)

Generally, Lanier weekly water supply/quality release decisions consider recommended releases from the Chattahoochee River Management System (as recorded in the Apalachicola Basin Reservoir Regulation Manual, Appendix B). On a weekly basis in coordination with Corps and Georgia Power, the Atlanta Regional Commission calculates the sum of anticipated downstream water supply river withdrawals by DeKalb County, City of Atlanta, Cobb County/Marietta Water Authority and Fulton County, water quality releases to ensure 750 cfs at the Peachtree Creek gaging station, and water returns minus inflows between Buford Dam and Peachtree Creek. This approach ensures sufficient water is released from Lake Lanier to allow for Chattahoochee River withdrawals while also meeting the 750 cfs requirement at Peachtree Creek, while generating hydropower and providing flows for fish and wildlife needs. In accordance with the Chattahoochee River Management System and their FERC License Georgia Power Company discharges the ARC recommended releases from the Morgan Falls project. During the winter and spring, releases from Lake Lanier may be reduced due to sufficient downstream tributary flows to meet the Georgia Environmental Protection Division's 750 cfs target water quality flow at Peachtree Creek. To the extent possible, these releases are made in conjunction with peaking power operations in order to maximize the efficiency of releases for both hydropower generation and water supply.

Over 40 percent of Lake Lanier's water is located in the "inactive" storage zone (below elevation 1035 msl). All the water supply users have multiple level intakes in Lake Lanier (in the conservation pool and inactive storage), and several withdraw water from the inactive storage. Gwinnett County has multiple elevation intakes ranging from 1062, 1045, and 1025, and has withdrawn from the 1025 intake (within the inactive storage zone) for many years. The City of Cumming intakes range from elevation 1053 down to elevation 1032. The City of Buford intakes are at elevations 1062, 1052, 1042, and 1032. The City of Gainesville has three intake structures, each with multiple intake ports ranging from elevation 1063 down to elevation 1025. Releases through Buford Dam to the Chattahoochee River currently draw from the inactive storage zone (releases from the hydropower units and the sluice gates), and these release waters make up the Chattahoochee River that flows downstream to the Atlanta area municipal water intakes downstream. Releases from Lake Lanier also support a number of other downstream M&I water supply needs including City of LaGrange, City of West Point, City of Columbus as well as a number of industries.

2. Agricultural Withdrawals

Georgia EPD provided agricultural water use impacting ACF surface waters. Since the late 1990's, the State of Georgia has conducted numerous studies to quantify the amount of water use in agricultural irrigation in the lower Flint and Chattahoochee River Basins. Additionally, the state contracted with USGS to develop a hydrological model quantifying the surface water reduction resulting from groundwater pumpage. The study determined the areas irrigated and application rates for the various regions. The study included application patterns corresponding to monthly statistics of measured values (minimums, medians, and maximums). The amount of surface water used in irrigation is the product of irrigated acreage with surface water as source and the application depth. The volume of water for each month was converted to a daily flow rate. For our modeling purposes, GAEPD provided detailed irrigation distribution by model node.

Groundwater pumpage in portions of the Flint River Basin has a delayed reduction effect on surface water. This effect exists because of reduction of groundwater discharge into streams. To quantify this effect, USGS under contract with GAEPD, developed a groundwater MODEF model reflecting the interactions between the Upper Floridian Aquifer and Flint River. The location of wells and quantities of water pumped from the aquifer can be input to this model, which then computes the reduction in surface water flow at user specified locations along the Flint River and its tributaries. For this analysis, the Corps computed surface water reductions for drought years and normal years. TABLE A-5 and A-6 provide the total surface irrigation and ground water irrigation reduction to surface water for drought and normal years in cfs (Tables A-7 and A-8 provide the same information in mgd). The data is aggregated by ResSim model node.

TABLE A-5
Drought Year Total of Surface Irrigation and GW Irrigation Reduction (cfs)

	Upper Flint (Montezuma)	Albany	Newton	Bainbridge	Buford	Whitesburg	West Point	W.F. George	Woodruff	Total
Jan	0.00	0.00	0.84	0.70	0.00	0.00	0.00	0.00	0.07	1.61
Feb	1.18	11.27	0.00	9.94	0.33	0.99	0.29	0.97	4.22	29.17
Mar	3.53	38.99	15.92	28.28	0.66	1.98	0.57	1.93	24.95	116.81
Apr	8.25	87.93	22.26	72.27	1.64	4.95	1.43	4.83	54.90	258.45
May	14.72	158.61	62.50	234.24	3.28	9.89	2.85	9.65	205.92	701.67
Jun	18.26	201.12	78.09	354.53	5.25	15.83	4.57	15.45	252.00	945.09
Jul	29.45	304.76	74.91	370.04	5.91	17.81	5.14	17.38	242.51	1067.91
Aug	35.34	355.45	75.72	395.63	6.90	20.78	5.99	20.27	235.55	1151.62
Sep	11.19	127.94	81.85	406.50	3.61	10.88	3.14	10.62	172.25	827.98
Oct	0.59	19.94	47.00	160.58	0.33	0.99	0.29	0.97	76.23	306.91
Nov	1.18	22.90	38.12	119.15	0.33	0.99	0.29	0.97	54.01	237.92
Dec	2.94	39.22	28.19	87.60	0.66	1.98	0.57	1.93	44.14	207.22

TABLE A-6

Normal Year Total of Surface Irrigation and GW Irrigation Reduction (cfs)

	Upper Flint (Montezuma)	Albany	Newton	Bainbridge	Buford	Whitesburg	West Point	W.F. George	Woodruff	Total
Jan	0.00	0.00	0.28	0.23	0.00	0.00	0.00	0.00	0.02	0.53
Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar	0.59	7.86	7.99	15.32	0.33	0.99	0.29	0.97	10.58	44.91
Apr	2.94	32.16	9.89	28.32	0.66	1.98	0.57	1.93	34.33	112.79
May	9.42	99.63	26.87	126.60	2.30	6.93	2.00	6.76	116.05	396.55
Jun	10.60	115.45	38.36	165.40	2.63	7.91	2.28	7.72	137.37	487.73
Jul	21.79	222.72	47.16	213.51	4.27	12.86	3.71	12.55	156.35	694.93
Aug	20.02	206.54	48.48	235.13	3.94	11.87	3.42	11.59	146.54	687.54
Sep	5.30	66.12	37.47	165.29	1.64	4.95	1.43	4.83	82.61	369.63
Oct	0.00	8.91	24.22	78.35	0.00	0.00	0.00	0.00	38.27	149.74
Nov	0.00	5.88	15.66	53.14	0.00	0.00	0.00	0.00	25.10	99.78
Dec	0.59	11.44	12.30	37.83	0.33	0.99	0.29	0.97	23.40	88.12

TABLE A-7

Drought Year total of Surface Irrigation and GW Irrigation reduction (mgd)

	Upper Flint (Montezuma)	Albany	Newton	Bainbridge	Buford	Whitesburg	West Point	W.F. George	Woodruff	Total
Jan	0.00	0.00	0.54	0.45	0.00	0.00	0.00	0.00	0.05	1.04
Feb	0.76	7.28	0.00	6.42	0.21	0.64	0.18	0.62	2.73	18.86
Mar	2.28	25.20	10.29	18.28	0.42	1.28	0.37	1.25	16.12	75.51
Apr	5.33	56.84	14.39	46.72	1.06	3.20	0.92	3.12	35.49	167.06
May	9.52	102.53	40.40	151.41	2.12	6.39	1.84	6.24	133.11	453.57
Jun	11.80	130.01	50.48	229.17	3.40	10.23	2.95	9.99	162.90	610.92
Jul	19.04	197.00	48.42	239.20	3.82	11.51	3.32	11.23	156.76	690.31
Aug	22.84	229.77	48.95	255.74	4.46	13.43	3.87	13.11	152.26	744.42
Sep	7.23	82.70	52.91	262.76	2.34	7.03	2.03	6.86	111.34	535.21
Oct	0.38	12.89	30.38	103.80	0.21	0.64	0.18	0.62	49.28	198.39
Nov	0.76	14.80	24.64	77.02	0.21	0.64	0.18	0.62	34.91	153.79
Dec	1.90	25.35	18.22	56.63	0.42	1.28	0.37	1.25	28.53	133.95

TABLE A-8

Normal Year Total of Surface Irrigation and GW Irrigation Reduction (mgd)

	Upper Flint (Montezuma)	Albany	Newton	Bainbridge	Buford	Whitesburg	West Point	W.F. George	Woodruff	Total
Jan	0.00	0.00	0.18	0.15	0.00	0.00	0.00	0.00	0.01	0.35
Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar	0.38	5.08	5.17	9.90	0.21	0.64	0.18	0.62	6.84	29.03
Apr	1.90	20.79	6.39	18.31	0.42	1.28	0.37	1.25	22.19	72.91
May	6.09	64.40	17.37	81.83	1.49	4.48	1.29	4.37	75.02	256.34
Jun	6.85	74.63	24.80	106.92	1.70	5.12	1.48	4.99	88.80	315.27
Jul	14.09	143.97	30.48	138.02	2.76	8.31	2.40	8.11	101.07	449.21
Aug	12.94	133.51	31.34	151.99	2.55	7.67	2.21	7.49	94.73	444.43
Sep	3.43	42.74	24.22	106.85	1.06	3.20	0.92	3.12	53.40	238.93
Oct	0.00	5.76	15.66	50.64	0.00	0.00	0.00	0.00	24.74	96.80
Nov	0.00	3.80	10.12	34.35	0.00	0.00	0.00	0.00	16.22	64.50
Dec	0.38	7.39	7.95	24.45	0.21	0.64	0.18	0.62	15.12	56.96

GAEPD provided the Agricultural surface water reduction data for the period 1970 through 2001. Using historical irrigation trends, the agricultural effect was hindcast from the mid 1990's to 1970. Agricultural water use for years 2002-2008 were estimated using the tables above. Years 2002, 2006 and 2007 were classified as dry; years 2003, 2005 and 2008 as normal.

The agricultural surface water withdrawals for Alabama and Florida are included in the municipal and industrial data provided by the states. TABLE A-9 below lists the month 2007 agricultural surface water withdrawals provided by Alabama.

TABLE A-9
2007 ACF Basin Agricultural Surface Water Withdrawals (mgd)

Month	Jim Woodruff	George Andrews	W.F. George	Columbus	Total
Jan	0.00	0.00	0.00	0.00	0.00
Feb	0.00	0.15	0.00	0.00	0.15
Mar	1.51	1.68	3.00	0.00	6.18
Apr	1.71	2.25	5.50	0.00	9.46
May	3.26	5.34	7.25	0.03	15.88
Jun	2.98	6.28	8.13	0.00	17.39
Jul	2.67	8.59	9.28	0.00	20.54
Aug	2.95	5.94	9.18	0.00	18.06
Sep	2.77	3.41	4.93	0.00	11.10
Oct	1.51	1.81	4.25	0.00	7.56
Nov	0.12	0.66	2.45	0.00	3.23
Dec	0.00	0.05	0.00	0.00	0.05

B. Highest Demand Year

The ACF Basin annual average net withdrawal for years 1994 to 2008 appears in Figure A-3 below. The highest demand year is 2007. Under the Current Alternative, the current water supply operations are assumed to remain in effect based on 2007 withdrawals.

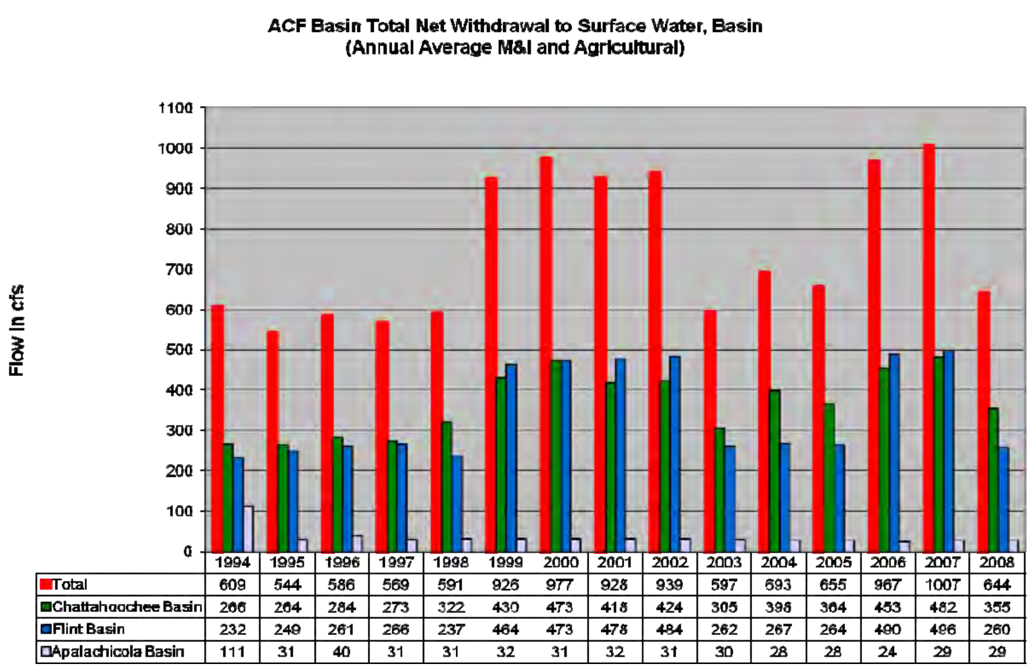


Figure A-3. Average Annual ACF Basin Net Withdrawal Total and Total by Basin

Table A-10 shows the 2007 annual net withdrawal by ResSim reach. The table depicts the distribution of the net water use in the basin.

Table A-10
2007 Average Annual Net Withdrawal by Reach, values in cfs

Reservoir Diversions (Method 1)	**Net Withdrawal (cfs)**	**Net Withdrawal (mgd)**
Metro Atlanta (above Buford Dam)	178.0	115.1
10 MGD_Rel Contract (above Buford	15.7	10.1
Morgan Falls_DIV	106.5	68.8
West Point_DIV	97.0	62.7
Bartletts Ferry_DIV		
Walter F George_DIV	30.9	20.0
George Andrews_DIV	-2.9	-1.9
Jim Woodruff_DIV	129.5	83.7
Reach Diversions (Method 2)		
Albany_Divs	125.4	81.1
Atlanta Divs_River	80.7	52.2
Bainbridge_Divs	185.6	120.0
Blountstown_Divs	10.0	6.5
Columbus_Divs	51.5	33.3
Griffin_Divs	30.7	19.8
Montezuma_Divs	27.2	17.6
Newton_Divs	16.4	10.6
Norcross_Divs	-6.2	-4.0
Sumatra_Divs	18.7	12.1
West Point Gage_Divs	-8.1	-5.2
Whitesburg_Divs	-79.5	-51.4
Total	1007.1	651.0

Figure A-4 below illustrates the monthly distribution of the 2007 average monthly net withdrawals above Buford Dam. The annual average is 193.7 cfs (125.2 mgd).

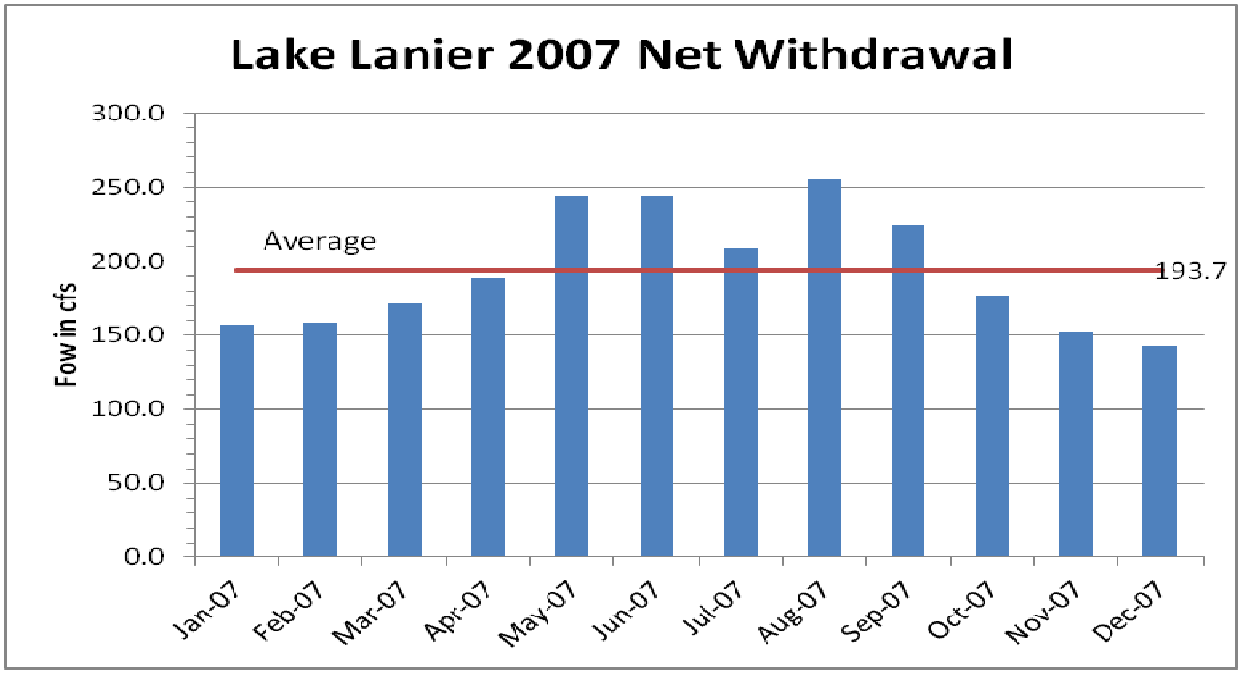


Figure A-4. 2007 Net Withdrawal above Lake Lanier

Figure A-5 illustrates the monthly distribution of the 2007 average monthly net withdrawals below Buford Dam to the Whitesburg gage. The annual average is 101.4 cfs (65.5 mgd). A net value less than zero indicate more water returned than withdrawn through the month.

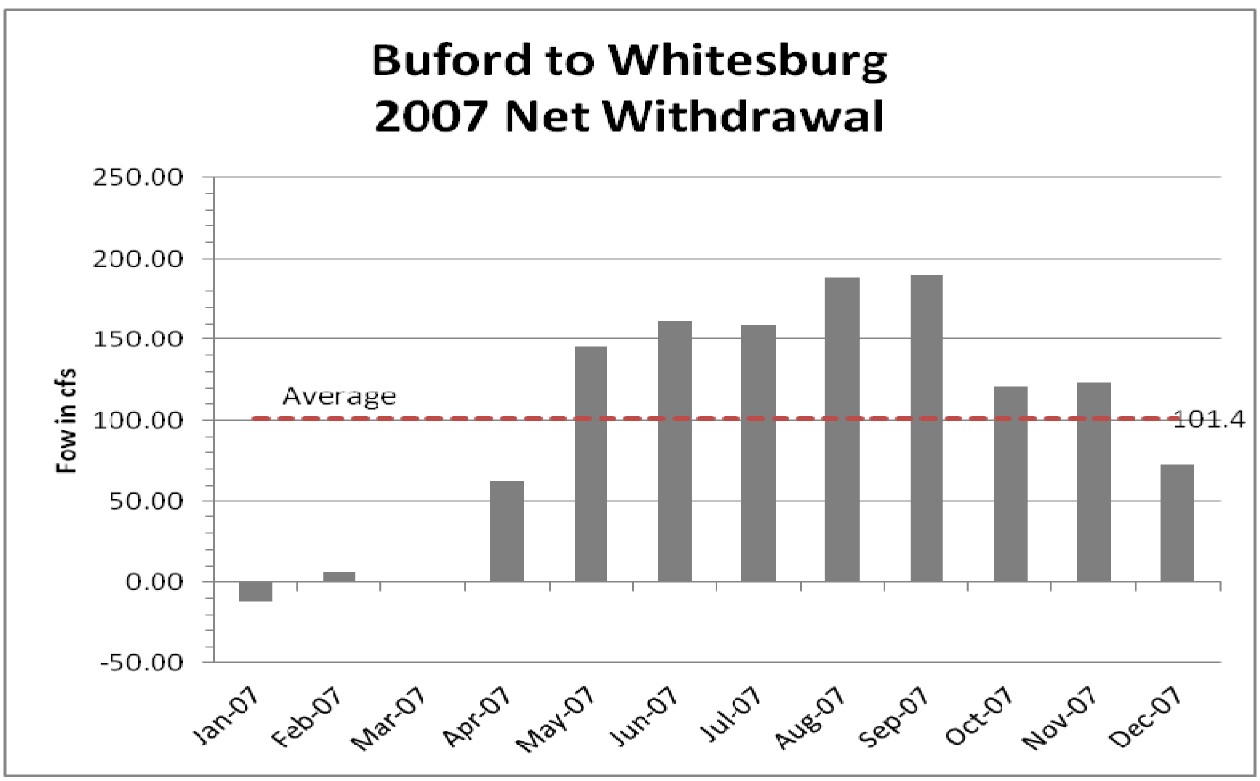


Figure A-5. 2007 Net River Withdrawals from Buford to Whitesburg

C. Projected Metro Atlanta Water Use

The State of Georgia through the office of Governor Roy Barnes submitted a letter dated May 16, 2000 to the Assistant Secretary of the Army (Civil Works) indentifying Georgia's projected Chattahoochee River and Lake Lanier water withdrawals and returns thru the year 2030 (see TABLE A-11 and A-12). This request estimated that annual average withdrawal of 705 mgd would be needed to meet the expected 2030 water use needs from Lake Lanier and the Chattahoochee River below Buford Dam. Of the 2030 total of 705 mgd, 297 mgd would be required to meet the needs directly from Lake Lanier and 408 mgd would be needed in the form of releases from Buford Dam to meet water supply needs of those facilities that withdraw water from the Chattahoochee River between Buford Dam and Peachtree Creek. Withdrawals directly from Lake Lanier are listed in the Buford reach and withdrawals from the Chattahoochee River below Buford Dam are listed in the Atlanta reach. Figure A-6 is a graphical depiction of the two reaches. Georgia also projected that up to 405 mgd would be withdrawn from Lake Lanier, and up to 615 mgd would be withdrawn from the Chattahoochee River to meet **peak day** demands in 2030. Daily, monthly, and annual withdrawal requirements will vary by user, but the maximum monthly withdrawal is typically 30 percent higher than the annual average, and the maximum day is typically 50 percent higher than annual average.

TABLE A-11
Georgia Projected Chattahoochee River and
Lake Lanier Water Withdrawals and Returns (units mgd)

Year	Buford Reach			Atlanta Reach		
	Withdrawal (mgd)	Return (mgd)	Net Withdrawal (mgd)	Withdrawal (mgd)	Return (mgd)	Net Withdrawal (mgd)
1999	131	9	122	278	232	46
2010	202	30	172	347	345	2
2020	256	69	187	392	398	-6
2030	297	107	190	408	450	-42

Total increase in withdrawals Buford Reach 1999 to 2030 = 166 mgd
Total increase in net withdrawals Buford Reach 1999 to 2030 = 68 mgd
Total increase in withdrawals Atlanta Reach 1999 to 2030 = 130 mgd
Total increase in net withdrawals Atlanta Reach 1999 to 2030 = -88 mgd

TABLE A-12
Georgia Projected Chattahoochee River and
Lake Lanier Water Withdrawals and Returns (units cfs)

Year	Buford Reach			Atlanta Reach		
	Withdrawal (cfs)	Return (cfs)	Net Withdrawal (cfs)	Withdrawal (cfs)	Return (cfs)	Net Withdrawal (cfs)
1999	203	14	189	430	359	71
2010	312	46	266	537	534	3
2020	396	107	289	606	616	-9
2030	459	166	294	631	696	-65

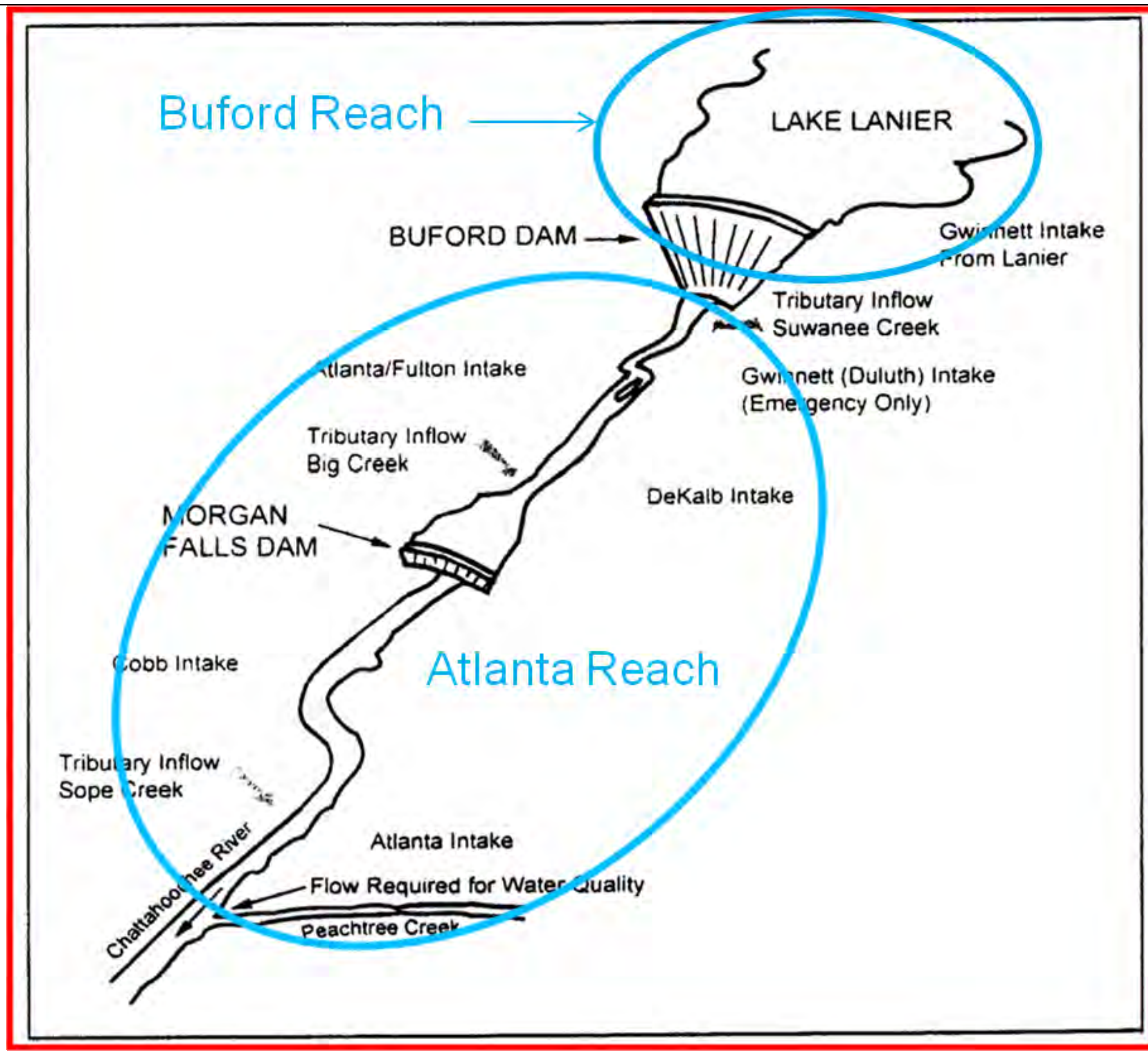


Figure A-6. Buford and Atlanta Reach

The projected annual values provided by Georgia were distributed monthly using year 2000 historical seasonal water use pattern. Separate distribution patterns were developed for the Buford and Atlanta Reaches.

Figures A-7and A-8 plot the monthly distribution patterns for the two reaches. This allowed the modeling effort to capture a seasonal variability expected in the Georgia projected values.

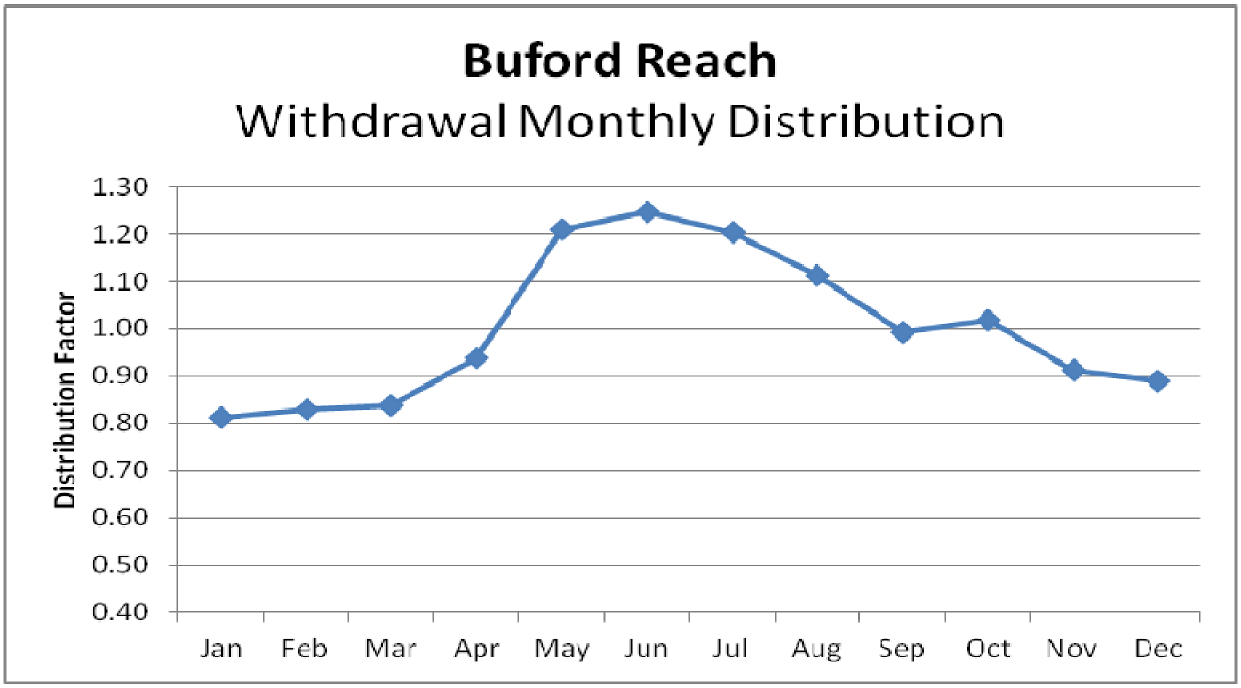


Figure A-7. Buford Reach Withdrawal Monthly Distribution

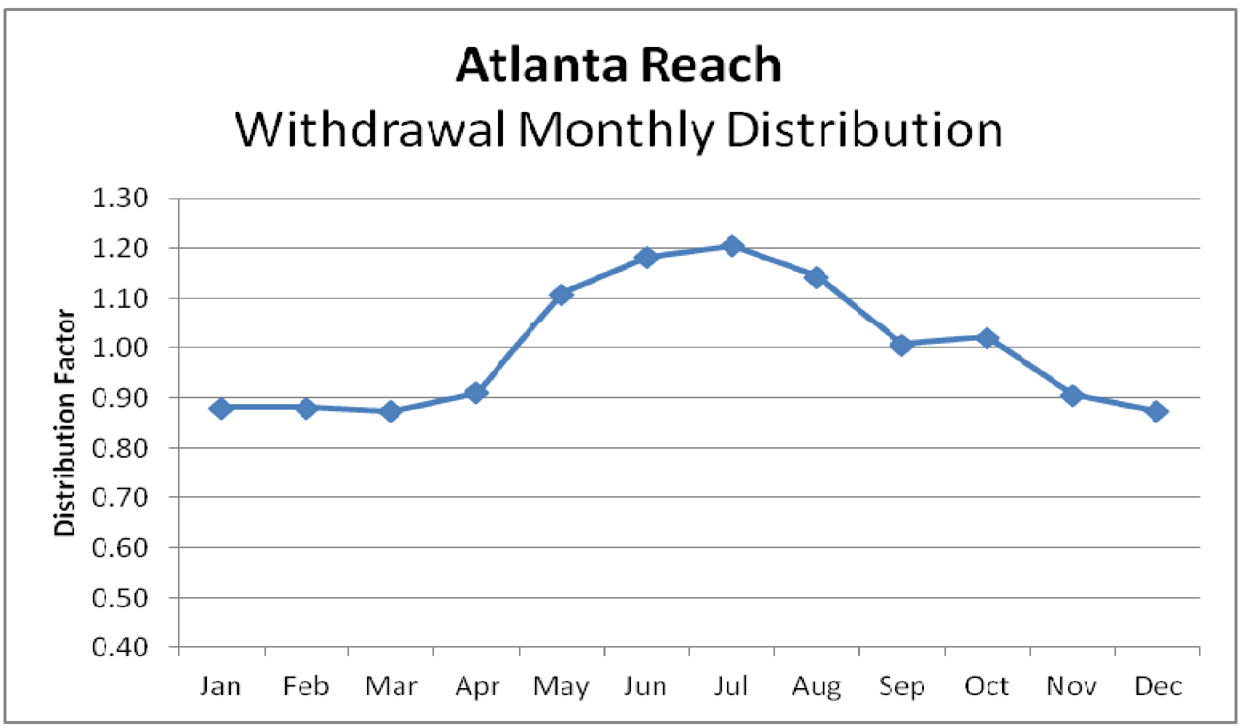


Figure A-8. Atlanta Reach Withdrawal Monthly Distribution

D. River Return Rate

Although not explicitly stated in the Georgia's projected water use values, there is an implied return rate (percentage) associated with each year. Tables A-13 and A-14 include the implied return rates for the lake and river withdrawals. From the table, there is an expectation that the percentage of water returned to the lake and river will increase in the future. Unfortunately, Georgia's 2000 request did not include details on how the expected return rates would be achieved.

TABLE A-13
Projected Chattahoochee River and Lake Lanier Water Withdrawals and Returns with Return Rates (units are mgd)

Year	Buford Reach				Atlanta Reach			
	Withdrawal (mgd)	Return (mgd)	Net Withdrawal (mgd)	**Return Rate**	Withdrawal (mgd)	Return (mgd)	Net Withdrawal (mgd)	**Return Rate**
1999	131	9	122	**7%**	278	232	46	**83%**
2010	202	30	172	**15%**	347	345	2	**99%**
2020	256	69	187	**27%**	392	398	-6	**102%**
2030	297	107	190	**36%**	408	450	-42	**110%**

TABLE A-14
Projected Chattahoochee River and Lake Lanier Water Withdrawals and Returns with Return Rates (units are cfs)

Year	Buford Reach				Atlanta Reach			
	Withdrawal (cfs)	Return (cfs)	Net Withdrawal (cfs)	**Return Rate**	Withdrawal (cfs)	Return (cfs)	Net Withdrawal (cfs)	**Return Rate**
1999	203	14	189	**7%**	430	359	71	**83%**
2010	312	46	266	**15%**	537	534	3	**99%**
2020	396	107	289	**27%**	606	616	-9	**102%**
2030	459	166	294	**36%**	631	696	-65	**110%**

For comparison in this analysis, the Corps computed the return rate based on the water use data provided by GAEPD. Chattahoochee River average annual withdrawals and returns from Buford dam to USGS Whitesburg gage were computed and tabulated. The majority of the withdrawals occur upstream of the Peachtree Creek confluence with the Chattahoochee River and most of the treated water is returned below the same confluence. The rate of return is calculated as the ratio of total returned to total water withdrawn expressed as a percent. TABLE A-15 lists the total withdrawals, returns, and computed return rates for the years 1994-2007. The return rates range from 76 percent to 101 percent through the 14-year period and the lower rates correspond to dry year conditions.

Georgia's projected river demands in its 2000 request have an implied return rate which increases through the years 1999 to 2030, from 83 percent to 110 percent. A return rate of 110 percent means 10 percent more water is returned to the reach than withdrawn. An inter-basin transfer could contribute to returns exceeding withdrawals. This analysis did not evaluate the possibility of increasing inter-basin transfers. Therefore, the river return rates implied by the Georgia 2000 request were not considered in this analysis. In order to replicate the rate at which water was returned to the river, the analysis relied on the analysis of water use data provided by GAEPD (see Table A-15). To ensure conservative estimates, the return rate of 76 percent associated with the highest use year in the reach, 2000, was adopted for the modeling effort.

TABLE A-15
Buford Dam to Whitesburg Average Annual Withdrawals, Returns, Net Use and Computed Return Rate for Period 1994-2007

Annual Average				
	Buford to Whitesburg	**Buford to Whitesburg**		
Year	Total Withdrawals (mgd)	Total Returns (mgd)	Net Use (mgd)	Percent Returned
1994	267	249	18	93%
1995	268	254	14	95%
1996	264	266	-2	101%
1997	272	267	5	98%
1998	293	270	24	92%
1999	308	247	61	80%
2000	315	239	76	76%
2001	301	258	44	86%
2002	300	257	43	86%
2003	284	282	2	99%
2004	295	270	25	91%
2005	302	286	15	95%
2006	310	272	39	88%
2007	304	248	56	82%

E. Lake Return Rate

Lake Lanier return rates were computed in same manner by summing total withdrawals and returns to the lake. Similar to the analysis of river return rates, return rates were computed for the historic lake withdrawals and returns. TABLE A- 16 lists the total withdrawals, returns and computed return rates for years 1994-2008.

TABLE A- 16
Lake Lanier Average Annual Withdrawals, Returns, Net Use and Computed Return Rates for Period 1994 - 2008

Annual Average				
	Lake Lanier			
Year	Total Withdrawals (mgd)	Total Returns (mgd)	Net Use (mgd)	Percent Returned
1994	78	6	71	8%
1995	89	7	82	7%
1996	92	7	85	7%
1997	91	7	85	7%
1998	107	8	100	7%
1999	120	8	112	6%
2000	120	8	112	6%
2001	120	8	113	6%
2002	118	8	110	7%
2003	109	9	100	8%
2004	120	9	111	7%
2005	120	9	111	8%
2006	132	9	123	7%
2007	128	9	120	7%
2008	107	7	100	6%

Georgia's projected lake demands in its 2000 request have an implied return rate that increases through the years 1999 to 2030, from 7 percent to 36 percent. In order to increase the lake return rate, additional facilities would have to be permitted to discharge treated water into Lake Lanier. Consistent with the river return rate methodology, in order to ensure conservative estimates, the Corps adopted a seven percent (corresponding to 2006) return rate for the Buford Reach as part of the modeling analysis.

Table A-17 below lists the permitted facilities that can discharge into Lake Lanier. The total amount permitted to discharge into Lake Lanier was 19 mgd during the period of observed withdraws and returns (1994-2008). The current permitted amount is 59 mgd. Gwinnett County's F. Wayne Hill Wastewater Treatment Plant came on line in May 2010 and is permitted to return 40 mgd.

TABLE A-17
Facilities Permitted to Discharge Water into Lake Lanier

Lake Lanier Facility	Permitted Return (mgd)
Buford Southside WPCP	2
Flowery Branch WPCP	0.4
Gainesville Flat CK WPCP	12
Gainesville WPCP (Linwood Dr)	5
*Gwinnett F. Wayne Hill WRC	40
Cumming Lanier Beach South	0.04
Total	59

*Lake returns began May 2010

For purposes of this analysis, several Lake Lanier return rates were evaluated. This was critical to capture the uncertainty of future treated water return to the lake. The return rates are based on the observed water use data (7%), maximizing permitted withdrawals and the projected return rates implied with Georgia's 2000 request. The demand year, return rates and source of return rate considered in this analysis are listed in Table A-18 below.

TABLE A-18
Demand Year and Lake Lanier Return Rates

Demand Year	Observed (From 1994-2008 records)	Maximized Permitted Amount	Georgia Projection
1999	7%	9%	**7%**
2010	7%	29%	**15%**
2020	7%	23%	**27%**
2030	7%	20%	**36%**

The observed and Georgia's projected return rates are discussed above. The rate of return from the permitted return amount is calculated as the ratio of total permitted returned compared to Georgia's projected Buford Reach water demand expressed as a percent. For example, for year 2030 the return rate is 59 mgd/297 mgd x 100% = 20%.

III. Water Use Alternatives

Various combinations of historic withdrawals, projected demands, and return rates were used to represent different water use alternatives. The projected demands were modeled using the three different return rates discuss above.

- The current Buford Reach demand is represented by the 2007 historic values using the observed 7% return rate.
- The 2010 projected Buford Reach demand is combined with the Georgia projected return rate of 15%. The other return rates of 7% and 29% were not considered for evaluation.
- The 2020 projected Buford Reach demand is combined with historic return rate of 7%, 23% resulting from maximizing permitted returns, and Georgia's projected return rate of 27%.
- The 2030 projected Buford Reach demand is combined with historic return rate of 7%, 20% resulting from maximizing permitted returns, and Georgia's projected return rate of 36%.
- Maximum Buford Reach: the 2030 projected Buford Reach demand combined with the historic rate of 7% resulted in complete exhaustion of the Lake Lanier conservation pool and water supply shortages occurred. A maximum Buford Reach demand of 290.3 mgd could be provided when combined with the historic 7% return rate.
- Maximum Atlanta Reach: when the Buford Reach demand is limited to the 20 mgd authorized under relocation agreements and the 1956 Act, the maximum Atlanta Reach demand that can be supported is 685 mgd.
- A single return rate of 76% is combined with the five Atlanta Reach demand scenarios.
- The highest historic water use year 2007 is used to represent the remainder of the basin.

TABLE A-19 below summarizes the water use alternatives evaluated in the study.

TABLE A-19
Water Use Alternatives Evaluated In the Study

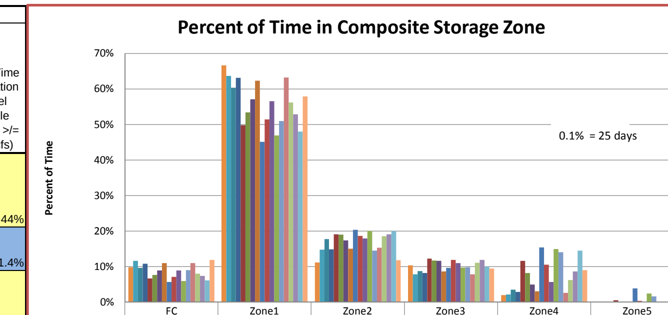
Demand Year /Scenario	Buford Reach Demand (mgd)	Buford Reach Return Rate	Atlanta Reach Demand (mgd)	Atlanta Reach Return Rate	Remainder of Basin
Current (2007)	134.4	7%	277	76%	Year 2007
2010	202	15%	347	76%	Year 2007
2020	256	7%	392	76%	Year 2007
2020	256	23%	392	76%	Year 2007
2020	256	27%	392	76%	Year 2007
2030	297	7%	408	76%	Year 2007
2030	297	20%	408	76%	Year 2007
2030	297	36%	408	76%	Year 2007
2030 (Maximum Buford Reach)	290.3	7%	408	76%	Year 2007
Maximum Atlanta Reach	20	0%	685	76%	Year 2007

APPENDIX B

MODELING OUTPUT SPREADSHEET

System Output Matrix

	A	B	C	D	E	F	G	H	I	J	K	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
2	**Scenario**			**Withdrawals**								**Storage**			**ESA/RIOP/ENV**									**HYD**			**NAV (Jan-May)**	
3	**Alternative**	**Description**	**Operation Set**	**Gross Lake Withdrawal (mgd)**	**Lake Return Rate**	**Lake Net Withdrawal (mgd)**	**Gross River Withdrawal (mgd)**	**River Return Rate**	**River Net Withdrawal (mgd)**	**Total Gross (mgd)**	**Total Net (mgd)**	Percent Time Composite Storage >/= Zone 1	Years in Zone 3 by Dec 1st	Percent Time of Refill from Zone 3 to Zone 1	(Exception Drought Operation) Number of Events, Flows < 5000 cfs Triggered	(Exception Drought Operation) Number of Months Flows < 5000 cfs Triggered	(Exception Drought Operation) Number of Events, Flows < 5000 cfs Released	Percent Time in Drought Operations (%)	Apalachicola River at Chattahoochee Flow = 4500 cfs (Y/N)	Number Events, 22 Consecutive Months >8k cfs releases from Jim Woodruff	Achieves Minimum flow of 670 cfs below West Point Dam (Y/N)	Percent Time, Apalachicola River at Chattahoochee Flow </= 5000 cfs	Percent Time, Chattahoochee River at Peachtree Ck Flow > 750 cfs	Annual Hydropower Generation (MWh)	Annual Weekday Hydropower Generation (MWh)	Percent Reduction	Percent Time 9' Navigation Channel Available (Btown Q >/= 20,050 cfs)	Percent Time 7' Navigation Channel Available (Btown Q >/= 16,200 cfs)
4	IMP_Power	Improved operations without downstream water supply, 20 mgd from Lake Lanier, 600 cfs (388 mgd) off-peak release from Buford Dam, 13.5 hrs/weekday of peak generation at Buford Dam	IMProved	20			incidental			20.0		70%	10	10%	4	15	2	14%	Y	13	Y	1.9%	94%	1,052,719	766,653		4%	44%
5	Current	Current operations including 2008 Revised Interim Operating Plan with 2007 water use as reported by the State of Georgia	Current	134.4	7%	125	277	76%	66	411.4	191.5	76%	6	17%	1	1	1	7%	Y	13	Y	2.0%	81%	1,023,259	759,724		2.9%	21.4%
6	IMPBase	Improved operations with Lake Lanier withdrawals limited to 20 mgd and current withdrawals from the Chattahoochee River at Atlanta	IMProved	20	0%	20	277	76%	66	297.0	86.5	75%	1	0%	0	0	0	4%	N	13	Y	2.3%	82%	1,052,882	778,153		4%	44%
7	IMProved	Improved operations with water supply, current Lake Lanier and Atlanta river withdrawals	IMProved	134.4	7%	125	277	76%	66	411.4	191.5	70%	4	25%	0	0	0	5%	N	14	Y	2.4%	79%	1,022,138	757,366		5.7%	44.3%
8	IMPGA2010B	Baseline for evaluating Georgia's 2010 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2010 projected river withdrawals at Atlanta	IMProved	20	0%	20	347	76%	83	367.0	103.3	74%	1	0%	0	0	0	5%	N	12	Y	2.2%	77%	1,051,821	775,198		4%	46%
9	IMPGA2010R	Georgia's 2010 request, with Georgia's 2010 projected Lake Lanier and Atlanta river withdrawals and projected Lake Lanier return rate, improved operations	IMProved	202	15%	172	347	76%	83	549.0	255.0	64%	10	10%	0	0	0	13%	N	12	Y	2.3%	70%	1,006,948	744,837		2.9%	40.0%
10	IMPGA2020B	Baseline for evaluating Georgia's 2020 request; Lake Lanier withdrawals limited to 20 mgd, improved operations with 2020 projected river withdrawals at Atlanta	IMProved	20	0%	20	392	76%	94	412.0	114.1	74%	1	0%	0	0	0	5%	N	12	Y	2.2%	75%	1,050,576	773,936		4.3%	44.3%
11	IMPGA2020R	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected lake return rate, improved operations	IMProved	256	27%	187	392	76%	94	648.0	281.0	61%	12	17%	1	1	0	16%	N	13	Y	2.2%	66%	1,000,848	740,064		2.9%	38.6%
12	IMPGA2020P	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	256	23%	197	392	76%	94	648.0	291.2	60%	12	17%	1	2	0	19%	N	13	Y	2.2%	65%	998,240	738,401		2.9%	40.0%
13	IMPGA2020C	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use, improved operations	IMProved	256	7%	238	392	76%	94	648.0	332.2	56%	14	14%	3	6	0	21%	N	14	Y	2.2%	63%	987,668	730,690		2.9%	38.6%
14	IR392L125	Georgia's 2020 requested river withdrawals at Atlanta and 2007 Lake Lanier withdrawals as reported by Georgia	IMProved	134.4	7%	125	392	76%	94	526.4	219.1	66%	9	11%	0	0	0	11%	N	12	Y	2.2%	70%	1,020,078	752,490		5.7%	41.4%
15	IMPGA2030B	Baseline for evaluating Georgia's 2030 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2030 projected river withdrawals at Atlanta	IMProved	20	0%	20	408	76%	98	428.0	117.9	73%	1	0%	0	0	0	5%	N	12	Y	2.2%	74%	1,050,151	773,234		4.3%	44.3%
16	IMPGA2030R	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected Lake Lanier return rate, improved operations	IMProved	297	36%	190	408	76%	98	705.0	288.0	59%	13	15%	2	4	0	20%	N	14	Y	2.2%	64%	995,453	736,206		2.9%	38.6%
17	IMPGA2030P	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	297	20%	238	408	76%	98	705.0	335.5	54%	15	7%	7	14	2	22%	Y	14	Y	2.1%	61%	982,244	726,919		2.9%	37.1%
18	IMPGA2030C	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use	IMProved	297	7%	276	408	76%	98	705.0	374.1	51%	17	6%	9	33	3	25%	Y	14	Y	2.0%	58%	971,229	719,166		2.9%	37.1%
19	IR408L125	Georgia's 2030 requested river withdrawals at Atlanta, plus Lake Lanier withdrawals in 2007 as reported by Georgia, Lake Lanier return rate based on historic water use, improved operations	IMProved	134.4	7%	125	408	76%	98	542.4	222.9	65%	10	10%	0	0	0	13%	N	12	Y	2.2%	69%	1,019,551	752,669		5.7%	40.0%
20	IR408LMAX	Georgia's requested 2030 river withdrawals at Atlanta combined with the maximum amount of Lake Lanier withdrawals that could be made to drain lake storage to, but not below, the bottom of the conservation pool at elevation 1035', improved operations	IMProved	290.3	7%	270	408	76%	98	698.3	367.9	53%	15	7%	10	22	3	23%	Y	14	Y	2.1%	59%	978,685	724,532		2.9%	37.1%
21	IMPMAXRHA	20 mgd withdrawals from Lake Lanier, combined with the maximum amount of river withdrawals at Atlanta that could be made to drain lake storage to, but not below, the bottom of conversation pool at elevation 1035', improved operations	IMProved	20	0%	20	685	76%	164	705.0	184.4	60%	15	13%	8	15	2	22%	Y	11	Y	1.8%	52%	1,044,071	765,696		3%	40%
22																												
23	***Improved Comparisons***																											
24	**IMPBase**			**20**	**0%**	**20**	**277**	**76%**	**66**	**297**	**86**	**75%**	**1**	**0%**	**0**	**0**	**0**	**4%**	**N**	**13**	**Y**	**2.3%**	**82%**	**1,052,882**	**778,153**		**4.3%**	**44.3%**
25	IMProved			114	7%	105	-	0%	-	114	105	(5.3%)	3	25.0%	0	0	0	1.9%	N	1	Y	0.1%	(3.5%)	(30,744)	(20,787)	(2.7%)	1.4%	0.0%
26																												
27	***2010 Comparisons***																											
28	**IMPGA2020B**			**20**	**0%**	**20**	**347**	**76%**	**83**	**367**	**103**	**74%**	**1**	**0%**	**0**	**0**	**0**	**5%**	**N**	**12**	**Y**	**2.2%**	**77%**	**1,051,821**	**775,198**		**4.3%**	**45.7%**
29	IMPGA2020R			182	15%	152	-	0%	-	182	152	(10.0%)	9	10.0%	0	0	0	8.0%	N	0	Y	0.1%	(7.2%)	(44,873)	(30,361)	(3.9%)	(1.4%)	(5.7%)
30																												
31	***2020 Comparisons***																											
32	**IMPGA2020B**			**20**	**0%**	**20**	**392**	**76%**	**94**	**412**	**114**	**74%**	**1**	**0%**	**0**	**0**	**0**	**5%**	**N**	**12**	**Y**	**2.2%**	**75%**	**1,050,576**	**773,936**		**4.3%**	**44.3%**
33	IMPGA2020R			236	27%	167	-	0%	-	236	167	(13.0%)	11	16.7%	1	1	0	10.6%	N	1	Y	0.0%	(9.4%)	(49,728)	(33,872)	(4.4%)	(1.4%)	(5.7%)
34	IMPGA2020C			236	7%	218	-	0%	-	236	218	(17.5%)	13	14.3%	3	6	0	15.3%	N	2	Y	0.0%	(11.9%)	(62,908)	(43,246)	(5.6%)	(1.4%)	(5.7%)
35	IR392L125			114	7%	105	-	0%	-	114	105	(8.0%)	8	11.1%	0	0	0	5.1%	N	0	Y	0.0%	(5.2%)	(30,498)	(21,446)	(2.8%)	1.4%	(2.9%)
36																												
37	***2030 Comparisons***																											
38	**IMPGA2030B**			**20**	**0%**	**20**	**408**	**76%**	**98**	**428**	**118**	**73%**	**1**	**0%**	**0**	**0**	**0**	**5%**	**N**	**12**	**Y**	**2.2%**	**74%**	**1,050,151**	**773,234**		**4.3%**	**44.3%**
39	IMPGA2030R			277	36%	170	-	0%	-	277	170	(14.7%)	12	15.4%	2	4	0	14.4%	N	2	Y	0.0%	(10.2%)	(54,699)	(37,028)	(4.8%)	(1.4%)	(5.7%)
40	IMPGA2030C			277	7%	256	-	0%	-	277	256	(22.5%)	16	5.9%	9	33	3	19.5%	Y	2	Y	(0.2%)	(16.2%)	(78,922)	(54,068)	(7.0%)	(1.4%)	(7.1%)
41	IR408L125			114	7%	105	-	0%	-	114	105	(7.8%)	9	10.0%	0	0	0	7.4%	N	0	Y	0.0%	(5.3%)	(30,600)	(20,565)	(2.7%)	1.4%	(4.3%)
42	IR408LMAX			270	7%	250	-	0%	-	270	250	(20.4%)	14	6.7%	10	22	3	18.3%	Y	2	Y	(0.1%)	(14.5%)	(71,466)	(48,702)	(6.3%)	(1.4%)	(7.1%)
43	IMPMAXRHA			-	0%	-	277	0%	66	277	66	(13.3%)	14	13.3%	8	15	2	16.9%	Y	(1)	Y	(0.4%)	(21.7%)	(6,080)	(7,538)	(1.0%)	(1.4%)	(4.3%)
44																												
45																												
46	***Baseline Comparisons***																											
47	**IMP_Power**			**20**	**0%**	**-**	**incidental**	**0%**	**-**	**20**	**-**	**70%**	**10**	**10%**	**4**	**15**	**2**	**14%**	**Y**	**13**	**Y**	**1.9%**	**94%**	**1,052,719**	**766,653**		**4.3%**	**44.3%**
48	IMPMAXRHA			114	7%	125	#VALUE!	76%	66	391	191	6.6%	(4)	6.7%	-3	-14	0	8.1%	Y	(2)	Y	(0.1%)	(41.3%)	(8,648)	(957)	(0.1%)	(1.4%)	(4.3%)
49	IMPBase			-	0%	20	#VALUE!	76%	66	277	86	5.5%	(9)	(10.0%)	-4	-15	-2	(10.4%)	N	0	Y	0.4%	(11.1%)	163	11,500	1.5%	0.0%	0.0%
50	IMPGA2020B			-	0%	20	#VALUE!	76%	94	392	114	4.2%	(9)	(10.0%)	-4	-15	-2	(8.5%)	N	(1)	Y	0.3%	(18.6%)	(2,144)	7,283	0.9%	0.0%	0.0%
51	IMPGA2030B			-	0%	20	#VALUE!	76%	98	408	118	3.5%	(9)	(10.0%)	-4	-15	-2	(8.8%)	N	(1)	Y	0.3%	(19.6%)	(2,568)	6,580	0.0%	0.0%	0.0%



	FC	Zone1	Zone2	Zone3	Zone4	Zone5
BASELINE	0.098082192	0.665949119	0.111898239	0.103248532	0.019843444	0.000978474
IMPBASE	0.116164384	0.636712329	0.147475538	0.078082192	0.021565558	0
IMPROVED	0.096086106	0.603639922	0.177338552	0.087592955	0.035342466	0
IMPGA2020B	0.108454012	0.631624266	0.148962818	0.081800391	0.029158513	0
IMPGA2020C	0.066536204	0.498356164	0.190998043	0.122348337	0.116007828	0.005753425
IMPGA2020R	0.076555773	0.533933464	0.189784736	0.117455969	0.081800391	0.000469667
IR392L125	0.089432485	0.570645793	0.173933464	0.116399217	0.049589041	0
IMPGA2030B	0.109510763	0.623248532	0.150841487	0.086144814	0.030254403	0
IMPGA2030C	0.056438356	0.45146771	0.20332681	0.095968689	0.15444227	0.038356164
IMPGA2030R	0.070919765	0.514637965	0.186497065	0.119021526	0.105401174	0.003522505
IR408R125	0.08888454	0.56555773	0.179373777	0.109745597	0.056438356	0
IR408LMAX	0.05964775	0.469001957	0.200195695	0.097455969	0.14962818	0.02407045
IMPMAXRHA	0.090058708	0.50927593	0.145166341	0.098043053	0.140861057	0.016594912
IMPGA2010B	0.109784736	0.632054795	0.153542074	0.078708415	0.02590998	0
IMPGA2010R	0.080078278	0.561643836	0.185401174	0.110919765	0.061956947	0
IMPGA2020P	0.073620352	0.528454012	0.190684932	0.119138943	0.086927593	0.001174168
IMPGA2030P	0.061252446	0.47964775	0.199726027	0.100234834	0.144618395	0.014520548
IMP_POWER	0.118766169	0.579263682	0.117651741	0.094169154	0.090149254	0.016915423

52
53 NOTES:
54 Current operations include 1989 action zones, hydropower generation, RIOP
55 IMProved operations include revised action zones, hydropower generation, Modified RIOP, and Jan-Apr/May nav ops
56 Compairson values color **(red)** within parenthesis are values less than the compared bas

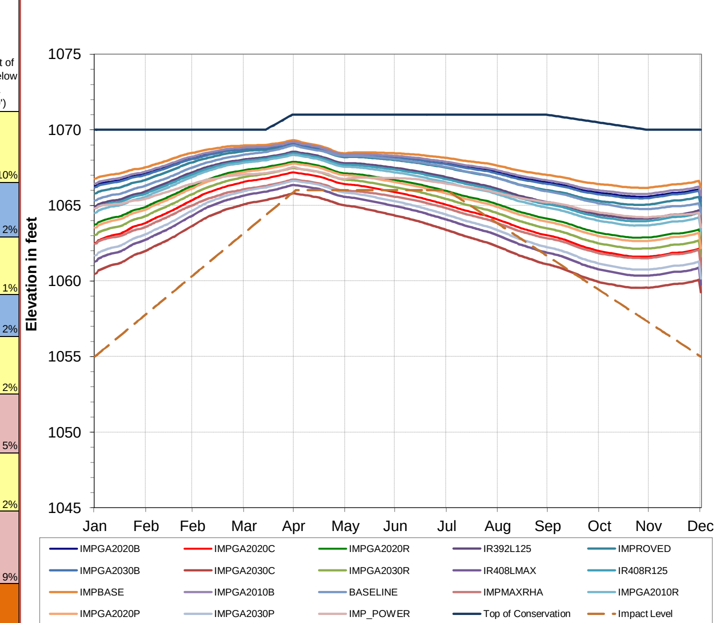
Georgia Projected Chattahoochee River and Lake Lanier Water Withdrawals and Returns
Source: Georgia Governor Roy Barnes May 16, 2000 Letter to ASA for Civil Works Joseph Wesphal

Year	Buford Reach				Atlanta Reach			
	Withdrawal (mgd)	Return (mgd)	Net Withdrawal (mgd)	Return Rate	Withdrawal (mgd)	Return (mgd)	Net Withdrawal (mgd)	Return Rate
1999	131	9	122	**7%**	278	232	46	**83%**
2010	202	30	172	**15%**	347	345	2	**99%**
2020	256	69	187	**27%**	392	398	-6	**102%**
2030	297	107	190	**36%**	408	450	-42	**110%**

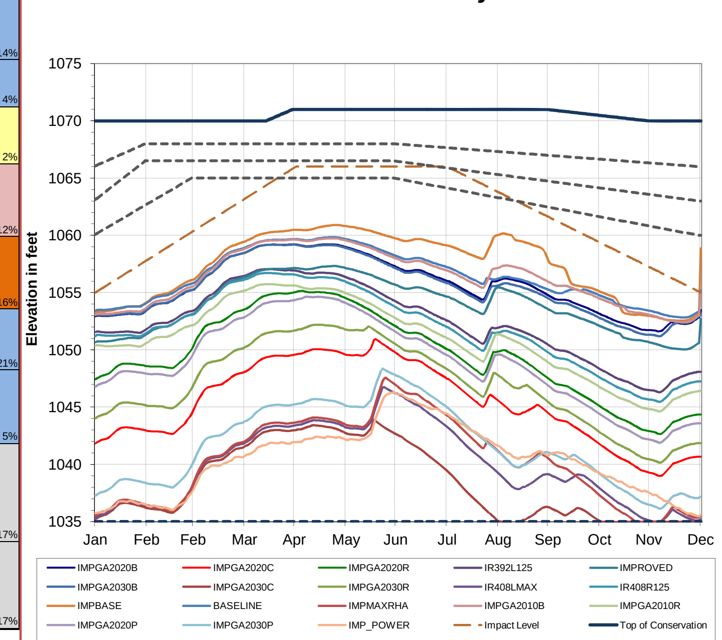
	A	B	C	D	E	F	G	H	I	J	K	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**Buford Output Matrix**																														
2		***Scenario***		***Withdrawals***								***Storage/Lake Levels***							***FRM***		***HYD***					***REC (May-Aug) [Total Number of Weeks = 919]***					
3	**Alternative**	**Description**	**Operation Set**	**Gross Lake Withdrawal (mgd)**	**Lake Return Rate (%)**	**Lake Net Withdrawal (mgd)**	**Gross River Withdrawal (mgd)**	**River Return Rate (%)**	**River Net Withdrawal (mgd)**	**Total Gross (mgd)**	**Total Net (mgd)**	Buford Minimum pool elevation (ft)	Minimum conservation pool elevation 1035 (ft) reached (Y/N)	Buford Percent time Storage >/= Zone 1 (%)	Buford, Years in Zone 3 by Dec 1st	Percent Time Refill from Zone 3 to Zone 1 by May1st the next Year	Buford Percent Time at Full Pool by May 1st (1071)	Percent Time Pool Elevation > 1066' during Period of Record	Dam Safety Impact (Y/N)	Changes to Flood Control Operations (Y/N)	Buford, Annual Hydropower Generation (MWh)	Buford, Annual Weekday Hydropower Generation (MWh)	Percent Reduction	Buford, Lowest Annual Hydropower Capacity (MW) [116.5 MW]	Buford, Weekday/ Weekend Ratio	Number of Weeks below IIL (1066' & 1063') during period of record	Number of Weeks below RIL (1063' & 1060') during period of record	Buford, Number of Weeks below WAL (1060') during period of record	Percent of Time below IIL (1066' & 1063')	Percent of Time below RIL (1063' & 1060')	Percent of Time below WAL (1060')
4	IMP_Power	Improved operations without downstream water supply, 20 mgd from Lake Lanier, 600 cfs (388 mgd) off-peak release from Buford Dam, 13.5 hrs/weekday of peak generation at Buford Dam	IMProved	20	0	0	incidental	0%	0	20	0.0	1035.47	N	63%	18	17%	31%	68%	N	N	137,764	115,467		94.82	1.79	248	147	93	27%	16%	10%
5	Current	Current operations including 2008 Revised Interim Operating Plan with 2007 water use as reported by the State of Georgia	Current	134.4	7%	125	277	0.76	66	411.4	191.5	1052.83	N	58%	15	33%	29%	67%	N	N	121,705	100,040		106.55	1.56	162	57	22	18%	6%	2%
6	IMPBase	Improved operations with Lake Lanier withdrawals limited to 20 mgd and current withdrawals from the Chattahoochee River at Atlanta	IMProved	20	0%	20	277	76%	66	297	86.5	1052.55	N	69%	11	36%	30%	75%	N	N	138,209	111,362		108.34	1.48	171	23	5	19%	3%	1%
7	IMProved	Improved operations with water supply current Lake Lanier and Atlanta river withdrawals	IMProved	134.4	7%	125	277	0.76	66	411.4	191.5	1050.05	N	60%	14	29%	29%	69%	N	N	121,926	99,543		103.63	1.51	196	44	17	22%	5%	2%
8	IMPGA2010B	Baseline for evaluating Georgia's 2010 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2010 projected river withdrawals at Atlanta	IMProved	20	0%	20	347	0.76	83	367	103.3	1052.41	N	67%	13	31%	30%	73%	N	N	138,347	109,280		106.10	1.36	180	41	15	20%	5%	2%
9	IMPGA2010R	Georgia's 2010 request, with Georgia's 2010 projected Lake Lanier and Atlanta river withdrawals and projected Lake Lanier return rate, improved operations	IMProved	202	15%	172	347	0.76	83	549	255.0	1044.63	N	52%	24	46%	24%	60%	N	N	114,194	91,420		100.03	1.38	261	96	49	29%	11%	5%
10	IMPGA2020B	Baseline for evaluating Georgia's 2020 request; Lake Lanier withdrawals limited to 20 mgd, improved operations with 2020 projected river withdrawals at Atlanta	IMProved	20	0%	20	392	0.76	94	412	114.1	1051.61	N	66%	13	31%	30%	73%	N	N	138,388	108,511		105.16	1.32	180	45	17	20%	5%	2%
11	IMPGA2020R	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected lake return rate, improved operations	IMProved	256	27%	187	392	0.76	94	648	281.0	1042.65	N	49%	28	46%	21%	57%	N	N	111,337	88,338		99.32	1.33	283	142	77	31%	16%	9%
12	IMPGA2020P	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	256	23%	197	392	0.76	94	648	291.2	1041.90	N	48%	28	43%	21%	56%	N	N	109,854	87,194		98.89	1.33	288	148	93	32%	16%	10%
13	IMPGA2020C	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use, improved operations	IMProved	256	7%	238	392	0.76	94	648	332.2	1038.99	N	44%	31	35%	21%	51%	N	N	103,871	82,718		97.46	1.33	307	181	128	34%	20%	14%
14	IR392L125	Georgia's 2020 requested river withdrawals at Atlanta and 2007 Lake Lanier withdrawals as reported by Georgia	IMProved	134.4	7%	125	392	0.76	94	526.4	219.1	1046.30	N	56%	20	35%	27%	64%	N	N	121,905	96,191		101.57	1.32	241	92	35	27%	10%	4%
15	IMPGA2030B	Baseline for evaluating Georgia's 2030 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2030 projected river withdrawals at Atlanta	IMProved	20	0%	20	408	0.76	98	428	117.9	1051.19	N	65%	13	31%	30%	72%	N	N	138,370	108,208		104.96	1.31	191	45	18	21%	5%	2%
16	IMPGA2030R	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected Lake Lanier return rate, improved operations	IMProved	297	36%	190	408	0.76	98	705	288.0	1040.15	N	46%	28	39%	21%	54%	N	N	108,483	85,898		97.98	1.31	292	164	113	32%	18%	12%
17	IMPGA2030P	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	297	20%	238	408	0.76	98	705	335.5	1036.13	N	42%	35	40%	21%	49%	N	N	100,964	80,178		96.02	1.31	329	200	145	36%	22%	16%
18	IMPGA2030C	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use	IMProved	297	7%	276	408	0.76	98	705	374.1	1034.77	Y	38%	36	39%	21%	47%	N	N	94,936	75,536		93.48	1.31	351	236	192	39%	26%	21%
19	IR408L125	Georgia's 2030 requested river withdrawals at Atlanta, plus Lake Lanier withdrawals in 2007 as reported by Georgia, Lake Lanier return rate based on historic water use, improved operations	IMProved	134.4	7%	125	408	0.76	98	542.4	222.9	1045.46	N	55%	20	35%	29%	63%	N	N	121,884	95,921		100.97	1.31	249	96	45	28%	11%	5%
20	IR408LMAX	Georgia's requested 2030 river withdrawals at Atlanta combined with the maximum amount of Lake Lanier withdrawals that could be made to drain lake storage to, but not below, the bottom of the conservation pool at elevation 1035', improved operations	IMProved	290.3	7%	**270**	408	0.76	98	698.3	367.9	1035.00	Y	41%	35	40%	21%	48%	N	N	99,000	78,691		94.98	1.31	341	210	150	38%	23%	17%
21	IMPMAXRHA	20 mgd withdrawals from Lake Lanier, combined with the maximum amount of river withdrawals at Atlanta that could be made to drain lake storage to, but not below, the bottom of conversation pool at elevation 1035', improved operations	IMProved	20	0%	20	**685**	0.76	164	705	184.4	1035.00	Y	52%	26	31%	26%	58%	N	N	137,325	102,271		95.47	1.11	306	201	156	33%	22%	17%
22																															
23	***Improved Comparisons***																														
24	**IMPBase**	**0**	**0**	**20**	**0%**	**20**	**277**	**76%**	**66**	**297**	**86**	**1052.55**	**N**	**69%**	**11**	**36%**	**30%**	**75%**	**N**	**N**	**138,209**	**111,362**		**108.34**	**1.48**	**171**	**23**	**5**	**19.1%**	**2.6%**	**0.6%**
25	IMProved	0	0	114	7%	105	-	0%	-	114	105	(2.50)	N	(8.8%)	3	(7.8%)	(1.4%)	(6.6%)	N	N	(16,283)	(11,819)	(10.6%)	(4.71)	0.03	25	21	12	3.1%	2.2%	1.3%
26																															
27	***2010 Comparisons***																														
28	**IMPGA2020B**	**0**	**0**	**20**	**0%**	**20**	**347**	**76%**	**83**	**367**	**103**	**1052.41**	**N**	**67%**	**13**	**31%**	**30%**	**73%**	**N**	**N**	**138,347**	**109,280**		**106.10**	**1.36**	**180**	**41**	**15**	**20.2%**	**4.7%**	**1.7%**
29	IMPGA2020R	0	0	182	15%	152	-	0%	-	182	152	(7.78)	N	(14.4%)	11	15.1%	(5.7%)	(13.1%)	N	N	(24,153)	(17,860)	(16.3%)	(6.07)	0.02	81	55	34	8.9%	6.0%	3.7%
30																															
31																															
32	***2020 Comparisons***																														
33	**IMPGA2020B**	**0**	**0**	**20**	**0%**	**20**	**392**	**76%**	**94**	**412**	**114**	**1051.61**	**N**	**66%**	**13**	**31%**	**30%**	**73%**	**N**	**N**	**138,388**	**108,511**		**105.16**	**1.32**	**180**	**45**	**17**	**20.2%**	**5.0%**	**1.9%**
34	IMPGA2020R	0	0	236	27%	167	-	0%	-	236	167	(8.95)	N	(16.6%)	15	15.7%	(8.6%)	(15.9%)	N	N	(27,051)	(20,173)	(18.6%)	(5.84)	0.01	103	97	60	11.0%	10.7%	6.6%
35	IMPGA2020C	0	0	236	7%	218	-	0%	-	236	218	(12.62)	N	(22.1%)	18	4.7%	(8.6%)	(21.1%)	N	N	(34,518)	(25,793)	(23.8%)	(7.70)	0.01	127	136	111	13.5%	15.0%	12.0%
36	IR392L125	0	0	114	7%	105	-	0%	-	114	105	(5.31)	N	(10.1%)	7	4.2%	(2.9%)	(9.0%)	N	N	(16,483)	(12,321)	(11.4%)	(3.59)	0.01	61	47	18	6.4%	4.9%	2.0%
37																															
38	***2030 Comparisons***																														
39	**IMPGA2030B**	**0**	**0**	**20**	**0%**	**20**	**408**	**76%**	**98**	**428**	**118**	**1051.19**	**N**	**65%**	**13**	**31%**	**30%**	**72%**	**N**	**N**	**138,370**	**108,208**		**104.96**	**1.31**	**191**	**45**	**18**	**21.3%**	**5.2%**	**2.0%**
40	IMPGA2030R	0	0	277	36%	170	-	0%	-	277	170	(11.04)	N	(18.9%)	15	8.5%	(8.6%)	(17.7%)	N	N	(29,887)	(22,310)	(20.6%)	(6.98)	0.01	101	119	95	10.7%	12.9%	10.3%
41	IMPGA2030C	0	0	277	7%	256	-	0%	-	277	256	(16.42)	Y	(26.8%)	23	8.1%	(8.6%)	(25.2%)	N	N	(43,434)	(32,672)	(30.2%)	(11.48)	(0.00)	160	191	174	17.4%	20.7%	18.9%
42	IR408L125	0	0	114	7%	105	-	0%	-	114	105	(5.73)	N	(10.3%)	7	4.2%	(1.4%)	(9.1%)	N	N	(16,486)	(12,287)	(11.4%)	(4.00)	0.00	58	51	27	6.2%	5.3%	3.1%
43	IR408LMAX	0	0	270	7%	250	-	0%	-	270	250	(16.19)	Y	(24.2%)	22	9.2%	(8.6%)	(23.5%)	N	N	(39,370)	(29,518)	(27.3%)	(9.98)	0.01	150	165	132	16.4%	17.8%	14.8%
44	IMPMAXRHA	0	0	-	0%	-	277	0%	66	277	66	(16.19)	Y	(13.5%)	13	0.0%	(4.3%)	(13.9%)	N	N	(1,045)	(5,938)	(5.5%)	(9.50)	(0.19)	115	156	138	12.1%	16.8%	15.4%
45																															
46																															
47	***Baseline Comparisons***																														
48	**IMP_Power**	**0**	**0**	**20**	**0%**	**-**	**incidental**	**0%**	**-**	**20**	**-**	**1035.47**	**N**	**63%**	**18**	**17%**	**31%**	**68%**	**N**	**N**	**137,764**	**115,467**		**94.82**	**1.79**	**248**	**147**	**93**	**27.3%**	**16.1%**	**10.2%**
49	IMPMAXRHA	0	0	114	7%	125	#VALUE!	76%	66	391	191	(0.47)	Y	(11.3%)	8	14.1%	(5.7%)	(10.3%)	N	N	(439)	(13,196)	(11.4%)	0.65	(0.68)	58	54	63	6.1%	5.9%	7.1%
50	IMPBase	0	0	-	0%	20	#VALUE!	76%	66	277	86	17.07	N	6.0%	(7)	19.7%	(1.4%)	7.2%	N	N	445	(4,105)	(3.6%)	13.52	(0.31)	(77)	(124)	(88)	(8.2%)	(13.5%)	(9.6%)
51	IMPGA2020B	0	0	-	0%	20	#VALUE!	76%	94	392	114	16.13	N	2.5%	(5)	14.1%	(1.4%)	4.4%	N	N	625	(6,956)	(6.0%)	10.34	(0.47)	(68)	(102)	(76)	(7.1%)	(11.1%)	(8.3%)
52	IMPGA2030B	0	0	-	0%	20	#VALUE!	76%	98	408	118	16.13	N	2.5%	(5)	14.1%	(1.4%)	4.4%	N	N	625	(6,956)	(6.0%)	10.34	(0.47)	(68)	(102)	(76)	(7.1%)	(11.1%)	(8.3%)

53
54 NOTES:
55 Current operations include 1989 action zones, hydropower generation, RIOP
56 IMProved operations include revised action zones, hydropower generation, Modified RIOP, and Jan-Apr/May nav ops
57 IIL - Recreation Initial Impact Level
58 RIL - Recreation Impact Level
59 WAL - Water Access Limit
60 Compairson values color**(red)** within parenthesis are values less than the compared bas
61

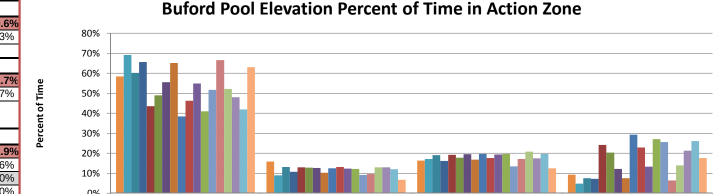
Buford Pool Elevation-Daily Average



Buford Pool Elevation-Daily Minimum



Buford Pool Elevation Percent of Time in Action Zone



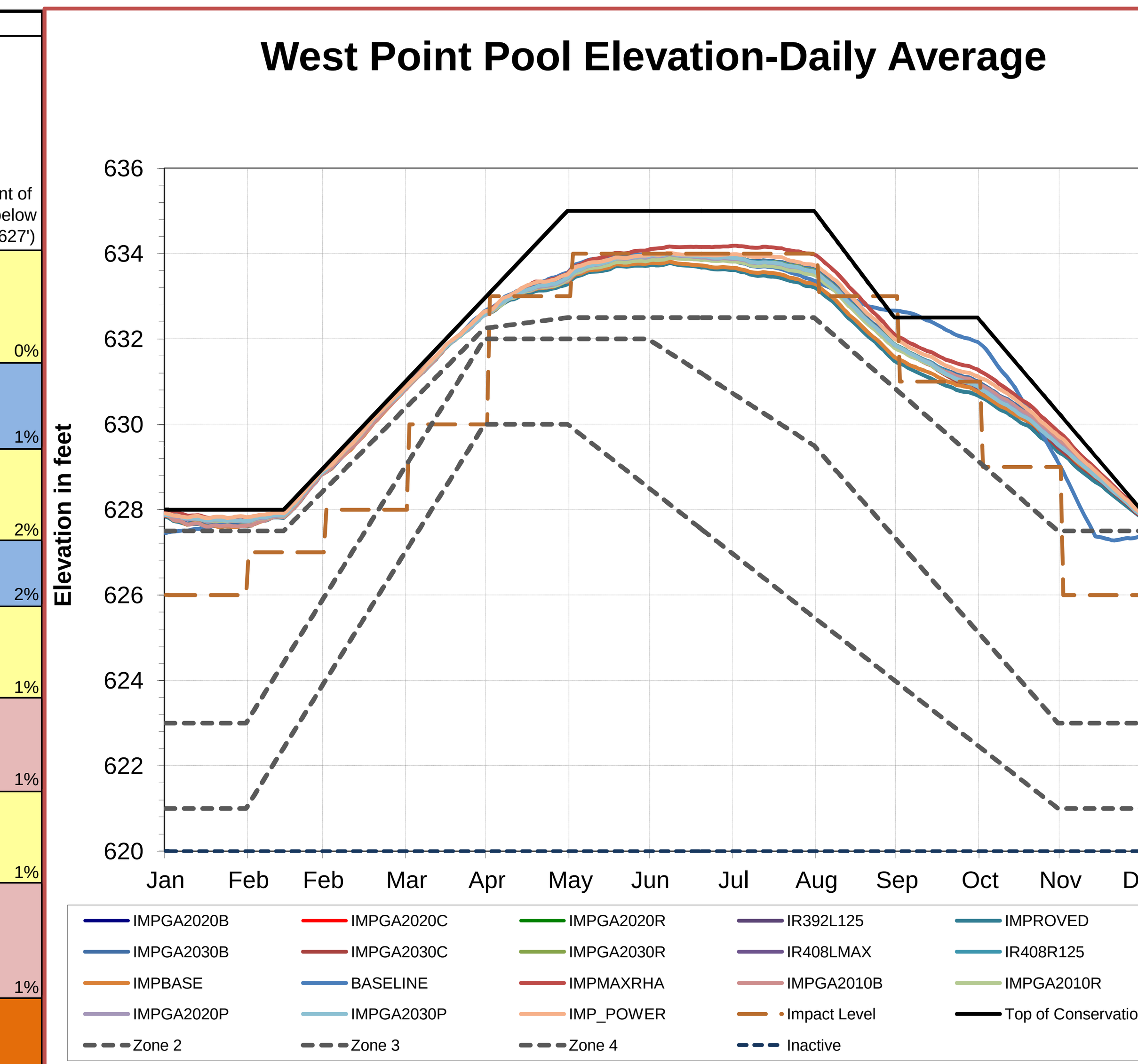
	Zone 1	Zone 2	Zone 3	Zone 4
BASELINE	0.583587577	0.159117578	0.163733083	0.093561762
IMPBASE	0.690956739	0.08941563	0.171477744	0.048149887
IMPROVED	0.602479856	0.131972151	0.190370023	0.075177971
IMPGA2020B	0.656301338	0.108190566	0.162598764	0.072909333
IMPGA2020C	0.435539388	0.130642259	0.192169287	0.241649065
IMPGA2020R	0.490299617	0.127943362	0.17777517	0.203981851
IR392L125	0.555425174	0.126809043	0.195806931	0.121958852
IMPGA2030B	0.651998748	0.102792772	0.169209106	0.075999374
IMPGA2030C	0.383712743	0.125792068	0.197449738	0.293045451
IMPGA2030R	0.463036846	0.131424548	0.176132363	0.229406243
IR408R125	0.548932176	0.123288743	0.194320582	0.1334585
IR408LMAX	0.409841195	0.122702026	0.19694125	0.270515528
IMPMAXRHA	0.51740593	0.092505672	0.134279903	0.255808496
IMPGA2010B	0.666314637	0.096925604	0.172181804	0.064577955
IMPGA2010R	0.522608151	0.129703512	0.208480013	0.139208324
IMPGA2020P	0.480286318	0.130329344	0.175428303	0.213956035
IMPGA2030P	0.419619808	0.121254792	0.197254166	0.261871235
IMP_POWER	0.630837831	0.068450286	0.124657749	0.176054134

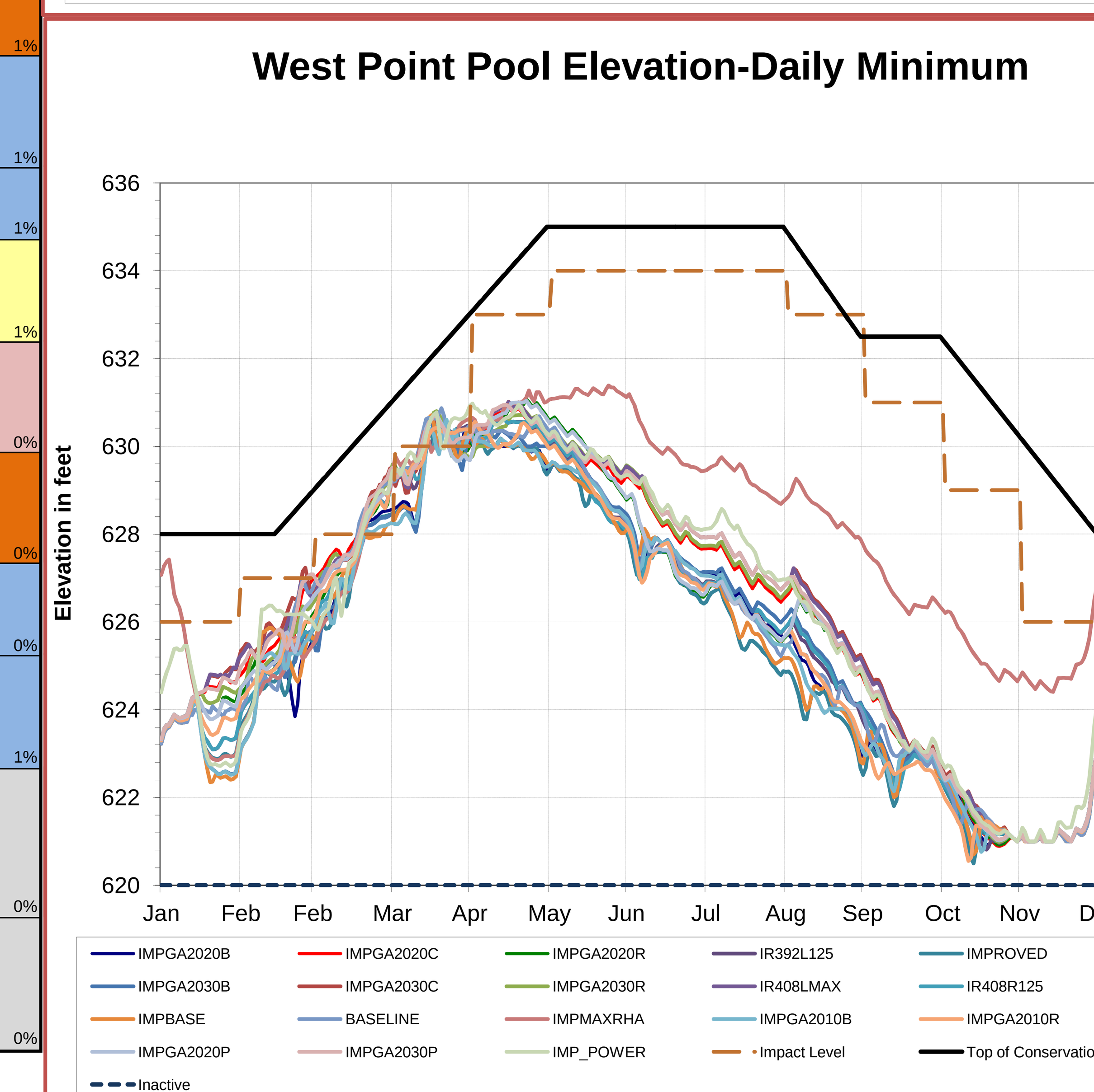
West Point Output Matrix

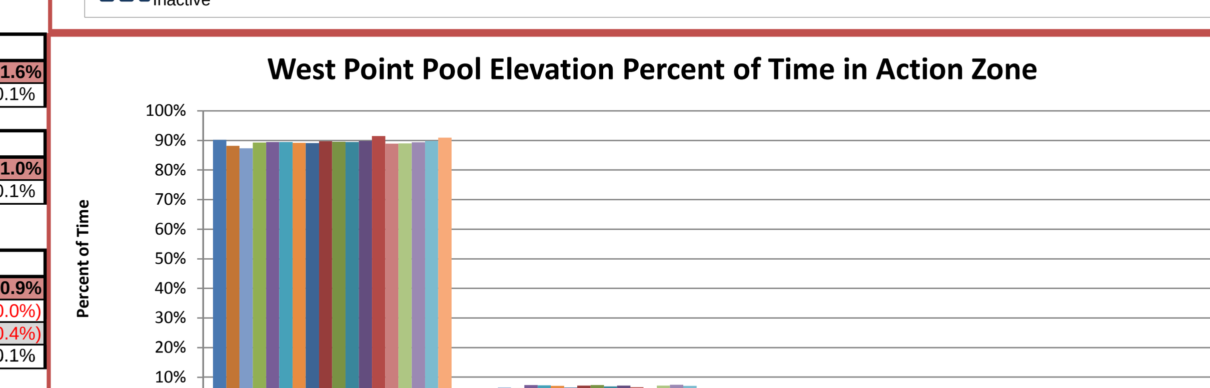
Row	Alternative	Description	Operation Set	Gross Lake Withdrawal (mgd)	Lake Return Rate (%)	Lake Net Withdrawal (mgd)	Gross River Withdrawal (mgd)	River Return Rate (%)	River Net Withdrawal (mgd)	Total Gross (mgd)	Total Net (mgd)
	A	B	C	D	E	F	G	H	I	J	K
2	Scenario			Withdrawals							
4	IMP_Power	Improved operations without downstream water supply, 20 mgd from Lake Lanier, 600 cfs (388 mgd) off-peak release from Buford Dam, 13.5 hrs/weekday of peak generation at Buford Dam	IMProved	20	0	0	incidental	0%	0	20	0.0
5	Current	Current operations including 2008 Revised Interim Operating Plan with 2007 water use as reported by the State of Georgia	Current	134.4	7%	125	277	76%	66	411.4	191.5
6	IMPBase	Improved operations with Lake Lanier withdrawals limited to 20 mgd and current withdrawals from the Chattahoochee River at Atlanta	IMProved	20	0%	20	277	76%	66	297	86.5
7	IMProved	Improved operations with water supply, current Lake Lanier and Atlanta river withdrawals	IMProved	134.4	7%	125	277	76%	66	411.4	191.5
8	IMPGA2010B	Baseline for evaluating Georgia's 2010 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2010 projected river withdrawals at Atlanta	IMProved	20	0%	20	347	0.76	83	367	103.3
9	IMPGA2010R	Georgia's 2010 request, with Georgia's 2010 projected Lake Lanier and Atlanta river withdrawals and projected Lake Lanier return rate, improved operations	IMProved	202	15%	172	347	0.76	83	549	255.0
10	IMPGA2020B	Baseline for evaluating Georgia's 2020 request; Lake Lanier withdrawals limited to 20 mgd, improved operations with 2020 projected river withdrawals at Atlanta	IMProved	20	0%	20	392	76%	94	412	114.1
11	IMPGA2020R	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected lake return rate, improved operations	IMProved	256	27%	187	392	76%	94	648	281.0
12	IMPGA2020P	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	256	23%	197	392	76%	94	648	291.2
13	IMPGA2020C	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use, improved operations	IMProved	256	7%	238	392	76%	94	648	332.2
14	IR392L125	Georgia's 2020 requested river withdrawals at Atlanta and 2007 Lake Lanier withdrawals as reported by Georgia	IMProved	134.4	7%	125	392	76%	94	526.4	219.1
15	IMPGA2030B	Baseline for evaluating Georgia's 2030 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2030 projected river withdrawals at Atlanta	IMProved	20	0%	20	408	76%	98	428	117.9
16	IMPGA2030R	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected Lake Lanier return rate, improved operations	IMProved	297	36%	190	408	76%	98	705	288.0
17	IMPGA2030P	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	297	20%	238	408	76%	98	705	335.5
18	IMPGA2030C	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use	IMProved	297	7%	276	408	76%	98	705	374.1
19	IR408L125	Georgia's 2030 requested river withdrawals at Atlanta, plus Lake Lanier withdrawals in 2007 as reported by Georgia, Lake Lanier return rate based on historic water use, improved operations	IMProved	134.4	7%	125	408	76%	98	542.4	222.9
20	IR408LMAX	Georgia's requested 2030 river withdrawals at Atlanta combined with the maximum amount of Lake Lanier withdrawals that could be made to drain lake storage to, but not below, the bottom of the conservation pool at elevation 1035', improved operations	IMProved	290.3	7%	**270**	408	76%	98	698.3	367.9
21	IMPMAXRHA	20 mgd withdrawals from Lake Lanier, combined with the maximum amount of river withdrawals at Atlanta that could be made to drain lake storage to, but not below, the bottom of conversation pool at elevation 1035', improved operations	IMProved	20	0%	20	**685**	76%	164	705	184.4
22											
23	***Improved Comparisons***										
24	**IMPBase**	**0**	**0**	**20**	**0%**	**20**	**277**	**76%**	**66**	**297**	**86**
25	IMProved	0	0	114	7%	105	-	0%	-	114	105
26											
27	***2010 Comparisons***										
28	**IMPGA2020B**	**0**	**0**	**20**	**0%**	**20**	**347**	**76%**	**83**	**367**	**103**
29	IMPGA2020R	0	0	182	15%	152	-	0%	-	182	152
30											
31											
32	***2020 Comparisons***										
33	**IMPGA2020B**	**0**	**0**	**20**	**0%**	**20**	**392**	**76%**	**94**	**412**	**114**
34	IMPGA2020R	0	0	236	27%	167	-	0%	-	236	167
35	IMPGA2020C	0	0	236	7%	218	-	0%	-	236	218
36	IR392L125	0	0	114	7%	105	-	0%	-	114	105
37											
38	***2030 Comparisons***										
39	**IMPGA2030B**	**0**	**0**	**20**	**0%**	**20**	**408**	**76%**	**98**	**428**	**118**
40	IMPGA2030R	0	0	277	36%	170	-	0%	-	277	170
41	IMPGA2030C	0	0	277	7%	256	-	0%	-	277	256
42	IR408L125	0	0	114	7%	105	-	0%	-	114	105
43	IR408LMAX	0	0	270	7%	250	-	0%	-	270	250
44	IMPMAXRHA	0	0	-	0%	-	277	0%	66	277	66
45											
46											
47	***Baseline Comparisons***										
48	**IMP_Power**	**0**	**0**	**20**	**0%**	**-**	**incidental**	**0%**	**-**	**20**	**-**
49	IMPMAXRHA	0	0	114	7%	125	#VALUE!	76%	66	391	191
50	IMPBase	0	0	-	0%	20	#VALUE!	76%	66	277	86
51	IMPGA2020B	0	0	-	0%	20	#VALUE!	76%	94	392	114
52	IMPGA2030B	0	0	-	0%	20	#VALUE!	76%	98	408	118

Row	Alternative	West Point Minimum pool elevation (ft)	Minimum conservation pool elevation 620 (ft) reached (Y/N)	West Point Percent time Storage >/= Zone 1 (%)	West Point, Years in Zone 3 by Dec 1st	Percent Time Refill from Zone 3 to Zone 1 by May1st the next Year	West Point Percent Time at Full Pool by June 1st (635)	Percent Time Pool Elevation > 632.5' during Period of Record	Dam Safety Impact (Y/N)	Changes to Flood Control Operations (Y/N)	Annual Hydropower Generation (MWh)	West Point Annual Weekday Hydropower Generation (MWh)	Percent Reduction	West Point, Lowest Annual Hydropower Capacity (MW) [85.5 MW]	West Point, Weekday/ Weekend Ratio	Number of Weeks below IIL (632.5' & 629') during period of record	Number of Weeks below RIL (629' & 627') during period of record	West Point, Number of Weeks below WAL (627') during period of record	Percent of Time below IIL (632.5' & 629')	Percent of Time below RIL (629' & 627')	Percent of Time below WAL (627')
		Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2		Storage/Lake Levels							FRM		HYD					REC (May-Aug) [Total Number of Weeks = 1529]					
4	IMP_Power	621.00	N	91%	1	0%	27%	36%	N	N	182,271	137,672		85.06	1.31	261	18	5	21%	1%	0%
5	Current	621.00	N	90%	1	0%	29%	42%	N	N	175,114	134,063		85.01	1.44	291	47	17	20%	3%	1%
6	IMPBase	620.70	N	88%	1	0%	27%	34%	N	N	181,239	136,333		85.03	1.29	350	60	24	25%	4%	2%
7	IMProved	620.50	N	87%	1	0%	26%	33%	N	N	174,923	132,178		85.04	1.31	365	68	24	26%	5%	2%
8	IMPGA2010B	620.76	N	89%	1	0%	27%	34%	N	N	180,572	135,831		85.04	1.28	336	39	14	24%	3%	1%
9	IMPGA2010R	620.55	N	89%	1	0%	23%	34%	N	N	171,394	130,355		85.04	1.33	330	33	15	24%	2%	1%
10	IMPGA2020B	620.92	N	89%	1	0%	27%	35%	N	N	179,975	135,615		85.04	1.28	320	36	13	23%	2%	1%
11	IMPGA2020R	620.92	N	89%	1	0%	23%	34%	N	N	169,857	129,651		85.06	1.35	301	20	13	23%	2%	1%
12	IMPGA2020P	621.00	N	89%	1	0%	23%	34%	N	N	169,317	129,341		85.06	1.36	300	20	12	23%	1%	1%
13	IMPGA2020C	620.89	N	89%	1	0%	24%	34%	N	N	167,225	128,151		85.05	1.38	305	20	7	24%	1%	1%
14	IR392L125	620.81	N	89%	1	0%	26%	34%	N	N	173,756	131,860		85.04	1.32	324	25	14	24%	2%	1%
15	IMPGA2030B	620.80	N	89%	1	0%	27%	34%	N	N	179,790	135,447		85.04	1.28	339	26	12	24%	2%	1%
16	IMPGA2030R	620.99	N	90%	1	0%	23%	34%	N	N	168,677	129,075		85.06	1.37	301	19	6	23%	1%	0%
17	IMPGA2030P	621.00	N	90%	1	0%	23%	34%	N	N	166,087	127,554		85.05	1.39	295	19	4	23%	1%	0%
18	IMPGA2030C	621.00	N	90%	1	0%	21%	34%	N	N	163,859	126,257		85.08	1.41	296	19	4	23%	1%	0%
19	IR408L125	620.78	N	89%	1	0%	24%	34%	N	N	173,544	131,831		85.04	1.40	316	24	14	23%	2%	1%
20	IR408LMAX	621.00	N	90%	1	0%	23%	34%	N	N	165,367	127,174		85.06	1.33	292	19	4	23%	1%	0%
21	IMPMAXRHA	622.85	N	91%	0	#DIV/0!	24%	37%	N	N	177,038	134,644		85.06	1.33	202	4	0	17%	0%	0%
23	***Improved Comparisons***																				
24	**IMPBase**	**620.70**	**N**	**88%**	**1**	**0%**	**27%**	**34%**	**N**	**N**	**181,239**	**136,333**		**85.03**	**1.29**	**350**	**60**	**24**	**25.2%**	**4.1%**	**1.6%**
25	IMProved	(0.20)	N	(0.9%)	0	0.0%	(1.4%)	(0.8%)	N	N	(6,316)	(4,154)	(3.0%)	0.01	0.03	15	8	0	1.2%	0.6%	0.1%
27	***2010 Comparisons***																				
28	**IMPGA2020B**	**620.76**	**N**	**89%**	**1**	**0%**	**27%**	**34%**	**N**	**N**	**180,572**	**135,831**		**85.04**	**1.28**	**336**	**39**	**14**	**24.0%**	**2.7%**	**1.0%**
29	IMPGA2020R	(0.21)	N	0.1%	0	0.0%	(4.3%)	(0.4%)	N	N	(9,177)	(5,476)	(4.0%)	0.01	0.06	-6	-6	1	0.4%	(0.4%)	0.1%
32	***2020 Comparisons***																				
33	**IMPGA2020B**	**620.92**	**N**	**89%**	**1**	**0%**	**27%**	**35%**	**N**	**N**	**179,975**	**135,615**		**85.04**	**1.28**	**320**	**36**	**13**	**23.1%**	**2.5%**	**0.9%**
34	IMPGA2020R	(0.00)	N	0.2%	0	0.0%	(4.3%)	(0.4%)	N	N	(10,119)	(5,964)	(4.4%)	0.02	0.07	(19)	(16)	0	0.3%	(1.0%)	(0.0%)
35	IMPGA2020C	(0.03)	N	0.2%	0	0.0%	(2.9%)	(0.6%)	N	N	(12,751)	(7,464)	(5.5%)	0.01	0.09	(15)	(16)	(6)	0.5%	(1.1%)	(0.4%)
36	IR392L125	(0.11)	N	(0.1%)	0	0.0%	(1.4%)	(0.7%)	N	N	(6,220)	(3,755)	(2.8%)	0.00	0.04	4	(11)	1	1.1%	(0.6%)	0.1%
38	***2030 Comparisons***																				
39	**IMPGA2030B**	**620.80**	**N**	**89%**	**1**	**0%**	**27%**	**34%**	**N**	**N**	**179,790**	**135,447**		**85.04**	**1.28**	**339**	**26**	**12**	**24.0%**	**1.9%**	**0.8%**
40	IMPGA2030R	0.19	N	0.5%	0	0.0%	(4.3%)	0.1%	N	N	(11,114)	(6,372)	(4.7%)	0.02	0.08	(38)	(7)	(6)	(1.0%)	(0.6%)	(0.4%)
41	IMPGA2030C	0.20	N	0.6%	0	0.0%	(5.7%)	0.1%	N	N	(15,931)	(9,190)	(6.8%)	0.04	0.13	(43)	(7)	(8)	(1.1%)	(0.7%)	(0.5%)
42	IR408L125	(0.01)	N	0.4%	0	0.0%	(2.9%)	(0.1%)	N	N	(6,246)	(3,616)	(2.7%)	0.00	0.12	(23)	(2)	2	(0.5%)	(0.2%)	0.2%
43	IR408LMAX	0.20	N	0.7%	0	0.0%	(4.3%)	0.1%	N	N	(14,423)	(8,273)	(6.1%)	0.02	0.04	(47)	(7)	(8)	(1.2%)	(0.6%)	(0.5%)
44	IMPMAXRHA	2.05	N	2.4%	(1)	#DIV/0!	(2.9%)	2.7%	N	N	(2,752)	(803)	(0.6%)	0.02	0.04	(137)	(22)	(12)	(6.8%)	(1.6%)	(0.8%)
47	***Baseline Comparisons***																				
48	**IMP_Power**	**621.00**	**N**	**91%**	**1**	**0%**	**27%**	**36%**	**N**	**N**	**182,271**	**137,672**		**85.06**	**1.31**	**261**	**18**	**5**	**20.9%**	**1.2%**	**0.3%**
49	IMPMAXRHA	(0.00)	N	(0.8%)	0	0.0%	1.4%	6.7%	N	N	(7,158)	(3,609)	(2.6%)	(0.05)	0.13	30	29	12	(0.6%)	1.9%	0.9%
50	IMPBase	(0.30)	N	(2.8%)	0	0.0%	0.0%	(1.8%)	N	N	(1,032)	(1,339)	(1.0%)	(0.02)	(0.02)	89	42	19	4.3%	2.9%	1.3%
51	IMPGA2020B	(0.08)	N	(1.7%)	0	0.0%	0.0%	(0.9%)	N	N	(2,296)	(2,057)	(1.5%)	(0.02)	(0.02)	59	18	8	2.2%	1.2%	0.6%
52	IMPGA2030B	(0.08)	N	(1.7%)	0	0.0%	0.0%	(0.9%)	N	N	(2,296)	(2,057)	(1.5%)	(0.02)	(0.02)	59	18	8	2.2%	1.2%	0.6%

54 NOTES:
55 Current operations include 1989 action zones, hydropower generation, RIOP
56 IMProved operations include revised action zones, hydropower generation, Modified RIOP, and Jan-Apr/May nav ops
57 IIL - Recreation Initial Impact Level
58 RIL - Recreation Impact Level
59 WAL - Water Access Limit
60 Compairson values color (red) within parenthesis are values less than the compared base



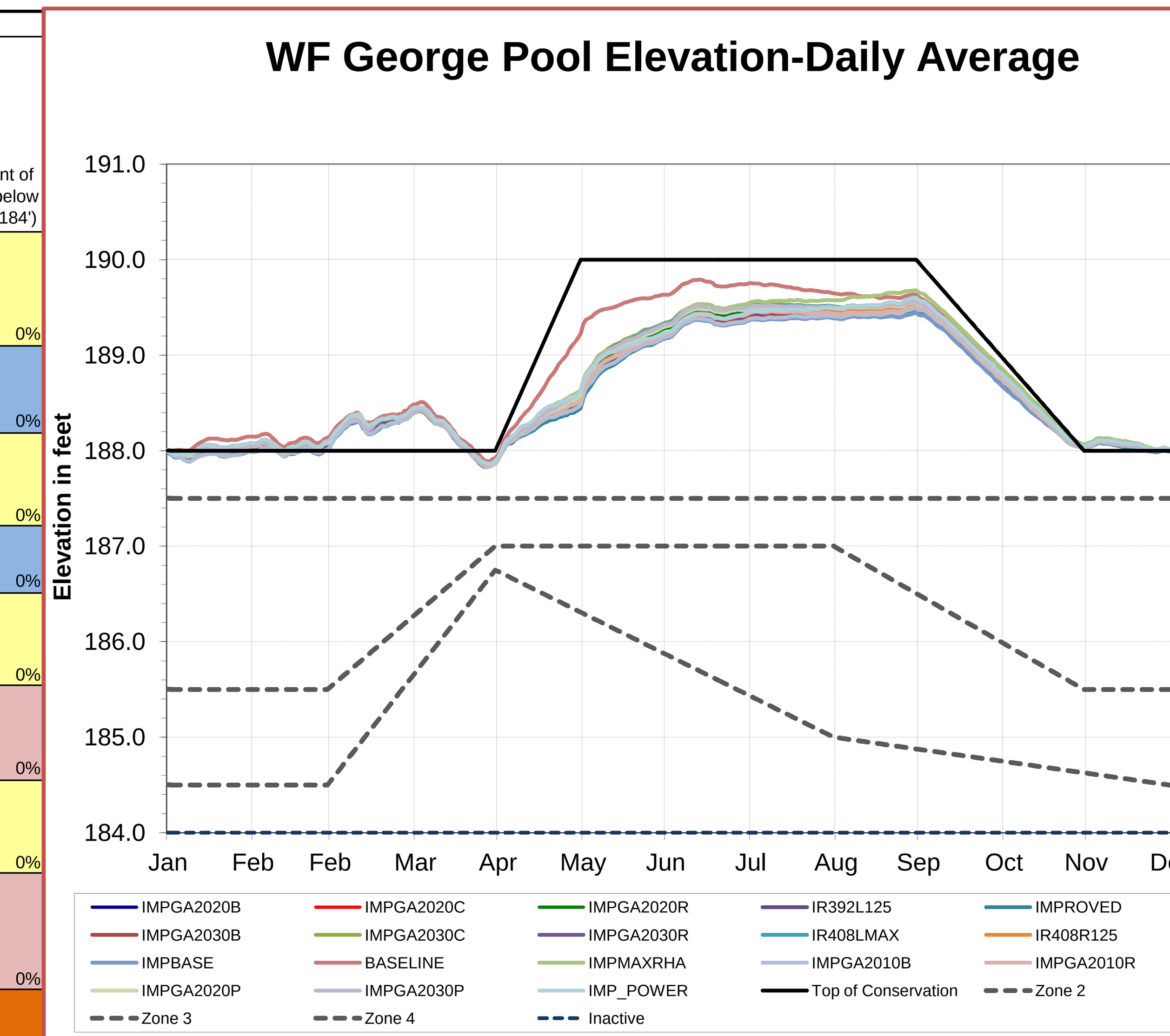


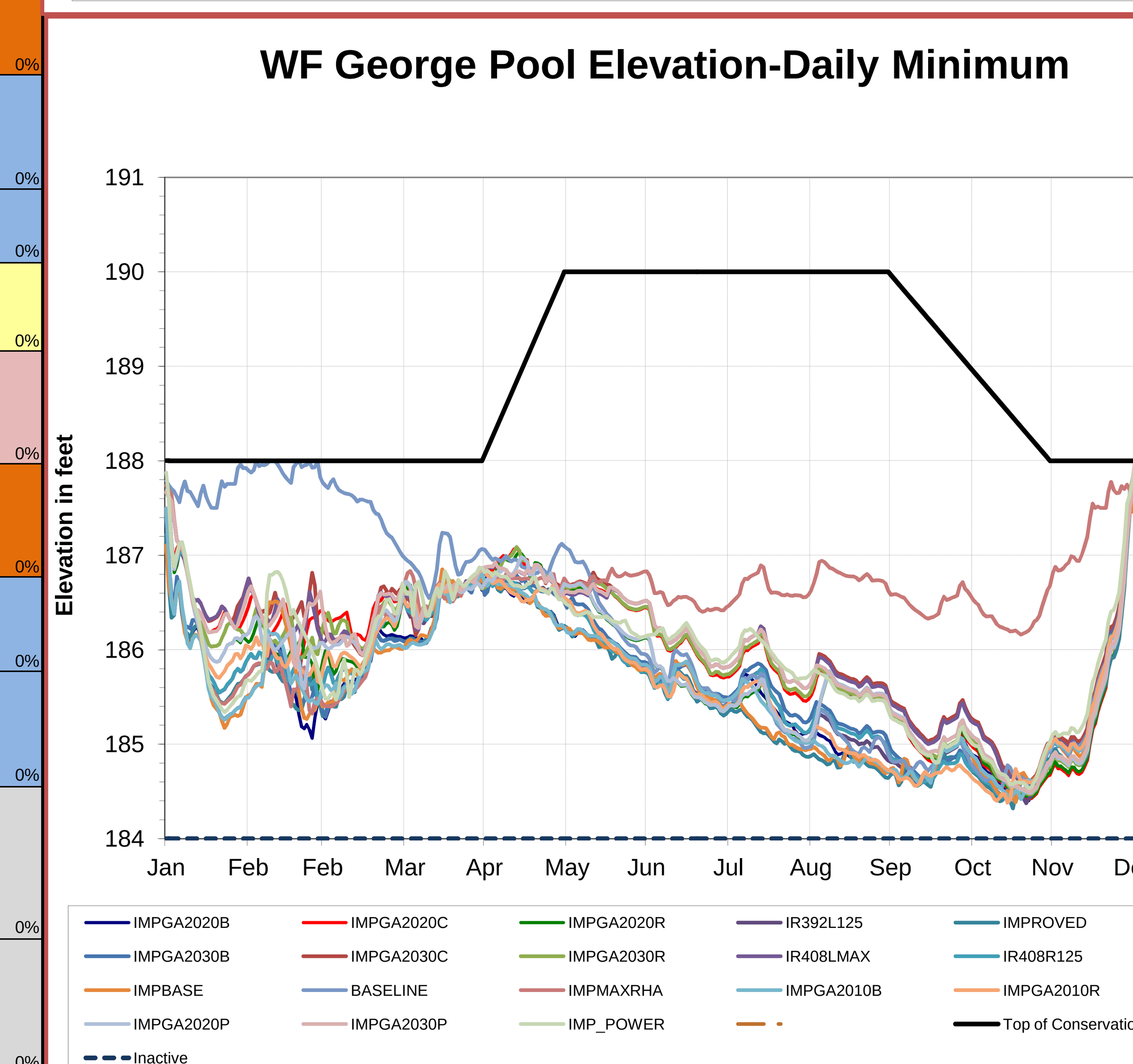


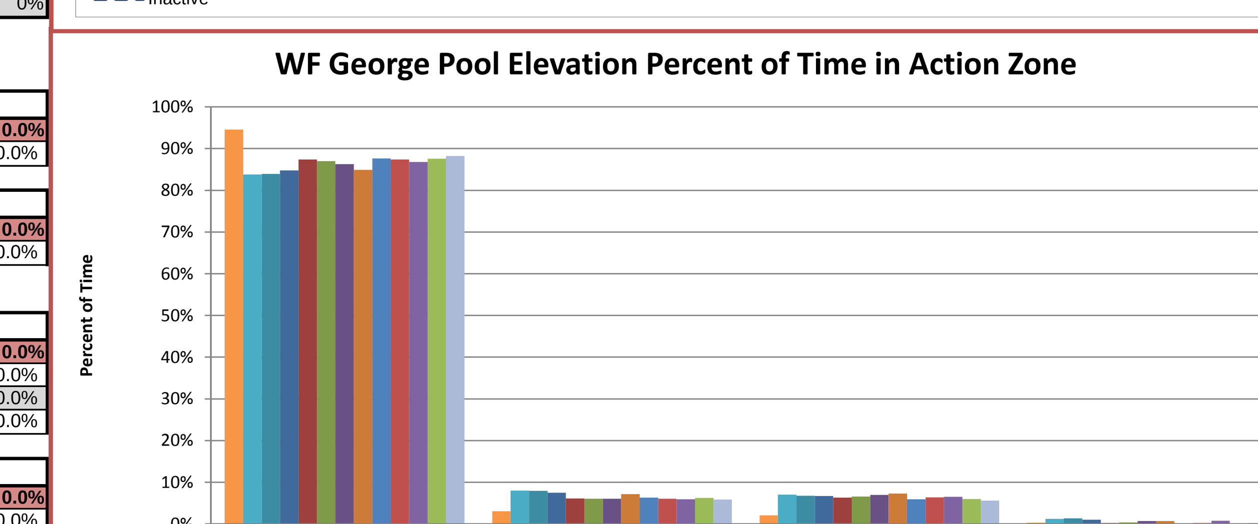
	Zone 1	Zone 2	Zone 3	Zone 4
BASELINE	0.902213878	0.056168349	0.037236955	0.004380818
IMPBASE	0.881991708	0.056559493	0.052452476	0.008996323
IMPROVED	0.873034499	0.065047328	0.0514355	0.010482672
IMPGA2020B	0.892552609	0.063521865	0.038723304	0.005202222
IMPGA2020C	0.894821247	0.073769851	0.030235469	0.001173433
IMPGA2020R	0.894351874	0.072127044	0.031095987	0.002425096
IR392L125	0.891965892	0.070875381	0.033364625	0.003794102
IMPGA2030B	0.891105374	0.064656184	0.040952828	0.003285614
IMPGA2030C	0.897598373	0.071814128	0.029844324	0.000743175
IMPGA2030R	0.89564265	0.073496049	0.029414066	0.001447235
IR408R125	0.894977705	0.068997888	0.031839161	0.004185246
IR408LMAX	0.898067746	0.071227411	0.02980521	0.000899632
IMPMAXRHA	0.91480873	0.066259876	0.018931393	0
IMPGA2010B	0.889540796	0.062465775	0.042048033	0.005945396
IMPGA2010R	0.890049284	0.071344755	0.033129938	0.005476023
IMPGA2020P	0.894078072	0.073926308	0.029414066	0.002581554
IMPGA2030P	0.898576234	0.070366894	0.029922553	0.001134319
IMP_POWER	0.909723852	0.060510052	0.028983807	0.000782289

	A	B	C	D	E	F	G	H	I	J	K	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**Walter F George Output Matrix**																														
2	***Scenario***			***Withdrawals***								***Storage/Lake Levels***							***FRM***		***HYD***					***REC (Jun-Aug) [Total Number of Weeks = 921]***					
3	**Alternative**	**Description**	**Operation Set**	**Gross Lake Withdrawal (mgd)**	**Lake Return Rate (%)**	**Lake Net Withdrawal (mgd)**	**Gross River Withdrawal (mgd)**	**River Return Rate (%)**	**River Net Withdrawal (mgd)**	**Total Gross (mgd)**	**Total Net (mgd)**	WF George Minimum pool elevation (ft)	Minimum conservation pool elevation 184 (ft) reached (Y/N)	WF George Percent time Storage >/= Zone 1 (%)	WFG Years in Zone 3 by Dec 1st	Percent Time Refill from Zone 3 to Zone 1 by May1st the next Year	WF George Percent Time at Full Pool by June 1st (190)	Percent Time Pool Elevation > 632.5' during Period of Record	Dam Safety Impact (Y/N)	Changes to Flood Control Operations (Y/N)	Annual Hydropower Generation (MWh)	WF George Annual Weekday Hydropower Generation (MWh)	Percent Reduction	WFG, Lowest Annual Hydropower Capacity (MW) [167.6 MW]	WFG, Weekday/ Weekend Ratio	Number of Weeks below IIL (187' & 185') during period of record	Number of Weeks below RIL (185' & 184') during period of record	WFG, Number of Weeks below WAL (184') during period of record	Percent of Time below IIL (187' & 185')	Percent of Time below RIL (185' & 184')	Percent of Time below WAL (184')
4	IMP_Power	Improved operations without downstream water supply, 20 mgd from Lake Lanier, 600 cfs (388 mgd) off-peak release from Buford Dam, 13.5 hrs/weekday of peak generation at Buford Dam	IMProved	20	0	0	incidental	0%	0	20	0.0	184.53	N	88%	0	#DIV/0!	30%	97%	N	N	479,259	350,195		167.07	1.12	46	0	0	5%	0%	0%
5	Current	Current operations including 2008 Revised Interim Operating Plan with 2007 water use as reported by the State of Georgia	Current	134.4	7%	125	277	76%	66	411.4	191.5	184.55	N	95%	0	0%	37%	99%	N	N	471,370	344,278		167.13	1.12	25	0	0	3%	0%	0%
6	IMPBase	Improved operations with Lake Lanier withdrawals limited to 20 mgd and current withdrawals from the Chattahoochee River at Atlanta	IMProved	20	0%	20	277	76%	66	297	86.5	184.38	N	84%	0	0%	29%	94%	N	N	478,040	348,620		167.06	1.11	65	1	0	8%	0%	0%
7	IMProved	Improved operations with water supply, current Lake Lanier and Atlanta river withdrawals	IMProved	134.4	7%	125	277	76%	66	411.4	191.5	184.32	N	84%	0	0%	29%	95%	N	N	470,658	344,280		167.10	1.13	63	2	0	7%	0%	0%
8	IMPGA2010B	Baseline for evaluating Georgia's 2010 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2010 projected river withdrawals at Atlanta	IMProved	20	0%	20	347	0.76	83	367	103.3	184.42	N	84%	0	#DIV/0!	30%	95%	N	N	477,272	348,054		167.08	1.11	68	0	0	8%	0%	0%
9	IMPGA2010R	Georgia's 2010 request, with Georgia's 2010 projected Lake Lanier and Atlanta river withdrawals and projected Lake Lanier return rate, improved operations	IMProved	202	15%	172	347	0.76	83	549	255.0	184.38	N	86%	0	#DIV/0!	26%	96%	N	N	466,651	341,916		167.14	1.14	54	0	0	6%	0%	0%
10	IMPGA2020B	Baseline for evaluating Georgia's 2020 request; Lake Lanier withdrawals limited to 20 mgd, improved operations with 2020 projected river withdrawals at Atlanta	IMProved	20	0%	20	392	76%	94	412	114.1	184.40	N	85%	0	0%	30%	95%	N	N	476,569	347,828		167.08	1.12	64	0	0	7%	0%	0%
11	IMPGA2020R	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected lake return rate, improved operations	IMProved	256	27%	187	392	76%	94	648	281.0	184.44	N	87%	0	0%	26%	97%	N	N	464,879	340,963		167.14	1.14	42	0	0	5%	0%	0%
12	IMPGA2020P	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	256	23%	197	392	76%	94	648	291.2	184.48	N	87%	0	#DIV/0!	26%	97%	N	N	464,306	340,738		167.14	1.15	36	0	0	4%	0%	0%
13	IMPGA2020C	Georgia's 2020 request, with Georgia's 2020 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use, improved operations	IMProved	256	7%	238	392	76%	94	648	332.2	184.42	N	87%	0	0%	24%	97%	N	N	461,862	338,978		167.15	1.15	31	0	0	4%	0%	0%
14	IR392L125	Georgia's 2020 requested river withdrawals at Atlanta and 2007 Lake Lanier withdrawals as reported by Georgia	IMProved	134.4	7%	125	392	76%	94	526.4	219.1	184.38	N	86%	0	0%	27%	96%	N	N	469,367	343,508		167.10	1.13	54	0	0	6%	0%	0%
15	IMPGA2030B	Baseline for evaluating Georgia's 2030 request; Lake Lanier withdrawals limited to 20 mgd, Improved operations with 2030 projected river withdrawals at Atlanta	IMProved	20	0%	20	408	76%	98	428	117.9	184.43	N	85%	0	0%	30%	95%	N	N	476,373	347,596		167.08	1.11	66	0	0	8%	0%	0%
16	IMPGA2030R	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Georgia's projected Lake Lanier return rate, improved operations	IMProved	297	36%	190	408	76%	98	705	288.0	184.47	N	87%	0	0%	26%	97%	N	N	463,513	340,115		167.13	1.14	39	0	0	4%	0%	0%
17	IMPGA2030P	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on current permits, improved operations	IMProved	297	20%	238	408	76%	98	705	335.5	184.49	N	87%	0	#DIV/0!	26%	97%	N	N	460,532	338,176		167.17	1.15	32	0	0	4%	0%	0%
18	IMPGA2030C	Georgia's 2030 request, with Georgia's 2030 projected Lake Lanier and Atlanta river withdrawals, using Lake Lanier return rate based on historic water use	IMProved	297	7%	276	408	76%	98	705	374.1	184.61	N	88%	0	0%	27%	97%	N	N	457,926	336,530		167.18	1.15	29	0	0	3%	0%	0%
19	IR408L125	Georgia's 2030 requested river withdrawals at Atlanta, plus Lake Lanier withdrawals in 2007 as reported by Georgia, Lake Lanier return rate based on historic water use, improved operations	IMProved	134.4	7%	125	408	76%	98	542.4	222.9	184.39	N	87%	0	0%	27%	96%	N	N	469,137	343,557		167.10	1.15	52	0	0	6%	0%	0%
20	IR408LMAX	Georgia's requested 2030 river withdrawals at Atlanta combined with the maximum amount of Lake Lanier withdrawals that could be made to drain lake storage to, but not below, the bottom of the conservation pool at elevation 1035', improved operations	IMProved	290.3	7%	**270**	408	76%	98	698.3	367.9	184.58	N	88%	0	0%	26%	97%	N	N	459,705	337,735		167.14	1.13	31	0	0	3%	0%	0%
21	IMPMAXRHA	20 mgd withdrawals from Lake Lanier, combined with the maximum amount of river withdrawals at Atlanta that could be made to drain lake storage to, but not below, the bottom of conversation pool at elevation 1035', improved operations	IMProved	20	0%	20	**685**	76%	164	705	184.4	185.32	N	88%	0	0%	29%	97%	N	N	473,298	346,465		167.10	1.13	33	0	0	4%	0%	0%
22																															
23	***Improved Comparisons***																														
24	**IMPBase**	0	0	20	0%	20	277	76%	66	297	86	184.38	N	84%	0	0%	29%	94%	N	N	478,040	348,620		167.06	1.11	65	1	0	7.7%	0.2%	0.0%
25	IMProved	0	0	114	7%	105	-	0%	-	114	105	(0.07)	N	0.2%	0	0.0%	0.0%	0.6%	N	N	(7,383)	(4,340)	(1.2%)	0.04	0.02	-2	1	0	(0.8%)	0.1%	0.0%
26																															
27	***2010 Comparisons***																														
28	**IMPGA2020B**	0	0	20	0%	20	347	76%	83	367	103	184.42	N	84%	0	#DIV/0!	30%	95%	N	N	477,272	348,054		167.08	1.11	68	0	0	7.5%	0.0%	0.0%
29	IMPGA2020R	0	0	182	15%	152	-	0%	-	182	152	(0.04)	N	2.1%	0	#DIV/0!	(4.3%)	1.5%	N	N	(10,620)	(6,138)	(1.8%)	0.06	0.02	-14	0	0	(1.8%)	0.0%	0.0%
30																															
31																															
32	***2020 Comparisons***																														
33	**IMPGA2020B**	0	0	20	0%	20	392	76%	94	412	114	184.40	N	85%	0	0%	30%	95%	N	N	476,569	347,828		167.08	1.12	64	0	0	7.2%	0.0%	0.0%
34	IMPGA2020R	0	0	236	27%	167	-	0%	-	236	167	0.03	N	2.2%	0	0.0%	(4.3%)	2.1%	N	N	(11,689)	(6,864)	(2.0%)	0.06	0.02	(22)	0	0	(2.7%)	0.0%	0.0%
35	IMPGA2020C	0	0	236	7%	218	-	0%	-	236	218	0.02	N	2.6%	0	0.0%	(5.7%)	2.5%	N	N	(14,706)	(8,850)	(2.5%)	0.07	0.03	(33)	0	0	(3.6%)	0.0%	0.0%
36	IR392L125	0	0	114	7%	105	-	0%	-	114	105	(0.03)	N	1.5%	0	0.0%	(2.9%)	1.3%	N	N	(7,202)	(4,320)	(1.2%)	0.02	0.01	(10)	0	0	(1.4%)	0.0%	0.0%
37																															
38	***2030 Comparisons***																														
39	**IMPGA2030B**	0	0	20	0%	20	408	76%	98	428	118	184.43	N	85%	0	0%	30%	95%	N	N	476,373	347,596		167.08	1.11	66	0	0	7.5%	0.0%	0.0%
40	IMPGA2030R	0	0	277	36%	170	-	0%	-	277	170	0.04	N	2.5%	0	0.0%	(4.3%)	2.4%	N	N	(12,860)	(7,481)	(2.2%)	0.05	0.03	(27)	0	0	(3.3%)	0.0%	0.0%
41	IMPGA2030C	0	0	277	7%	256	-	0%	-	277	256	0.18	N	2.7%	0	0.0%	(2.9%)	2.6%	N	N	(18,446)	(11,066)	(3.2%)	0.10	0.04	(37)	0	0	(4.2%)	0.0%	0.0%
42	IR408L125	0	0	114	7%	105	-	0%	-	114	105	(0.04)	N	1.9%	0	0.0%	(2.9%)	1.5%	N	N	(7,236)	(4,039)	(1.2%)	0.02	0.04	(14)	0	0	(1.9%)	0.0%	0.0%
43	IR408LMAX	0	0	270	7%	250	-	0%	-	270	250	0.15	N	2.7%	0	0.0%	(4.3%)	2.6%	N	N	(16,668)	(9,861)	(2.8%)	0.06	0.02	(35)	0	0	(4.0%)	0.0%	0.0%
44	IMPMAXRHA	0	0	-	0%	-	277	0%	66	277	66	0.90	N	3.4%	0	0.0%	(1.4%)	2.5%	N	N	(3,075)	(1,131)	(0.3%)	0.02	0.01	(33)	0	0	(3.6%)	0.0%	0.0%
45																															
46																															
47	***Baseline Comparisons***																														
48	**IMP_Power**	0	0	20	0%	-	incidental	0%	-	20	-	184.53	N	88%	0	#DIV/0!	30%	97%	N	N	479,259	350,195		167.07	1.12	46	0	0	5.2%	0.0%	0.0%
49	IMPMAXRHA	0	0	114	7%	125	#VALUE!	76%	66	391	191	0.02	N	6.7%	0	#DIV/0!	7.1%	1.6%	N	N	(7,889)	(5,917)	(1.7%)	0.07	0.00	(21)	0	0	(2.5%)	0.1%	0.0%
50	IMPBase	0	0	-	0%	20	#VALUE!	76%	66	277	86	(0.15)	N	(4.1%)	0	#DIV/0!	(1.4%)	(2.6%)	N	N	(1,219)	(1,576)	(0.4%)	(0.00)	(0.01)	19	1	0	2.5%	0.2%	0.0%
51	IMPGA2020B	0	0	-	0%	20	#VALUE!	76%	94	392	114	(0.13)	N	(3.1%)	0	#DIV/0!	0.0%	(2.1%)	N	N	(2,691)	(2,368)	(0.7%)	0.01	(0.01)	18	0	0	2.0%	0.0%	0.0%
52	IMPGA2030B	0	0	-	0%	20	#VALUE!	76%	98	408	118	(0.13)	N	(3.1%)	0	#DIV/0!	0.0%	(2.1%)	N	N	(2,691)	(2,368)	(0.7%)	0.01	(0.01)	18	0	0	2.0%	0.0%	0.0%
53																															

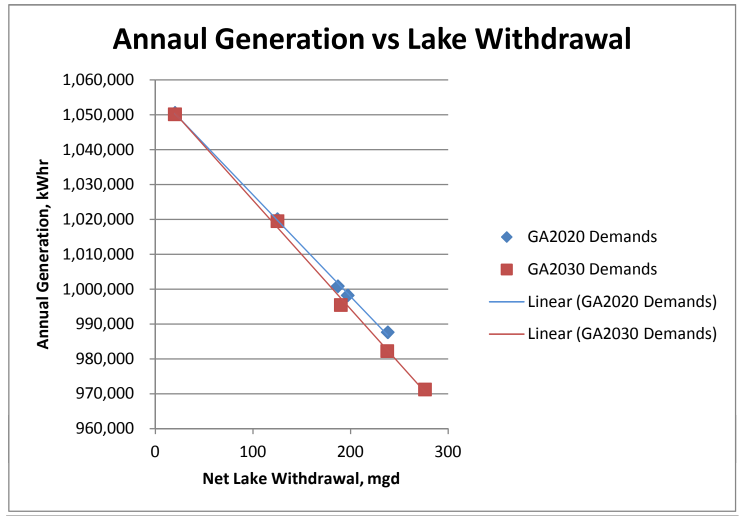
54 NOTES:
55 Current operations include 1989 action zones, hydropower generation, RIOP
56 IMProved operations include revised action zones, hydropower generation, Modified RIOP, and Jan-Apr/May nav ops
57 IIL - Recreation Initial Impact Level
58 RIL - Recreation Impact Level
59 WAL - Water Access Limit
60 Comparison values color (red) within parenthesis are values less than the compared base

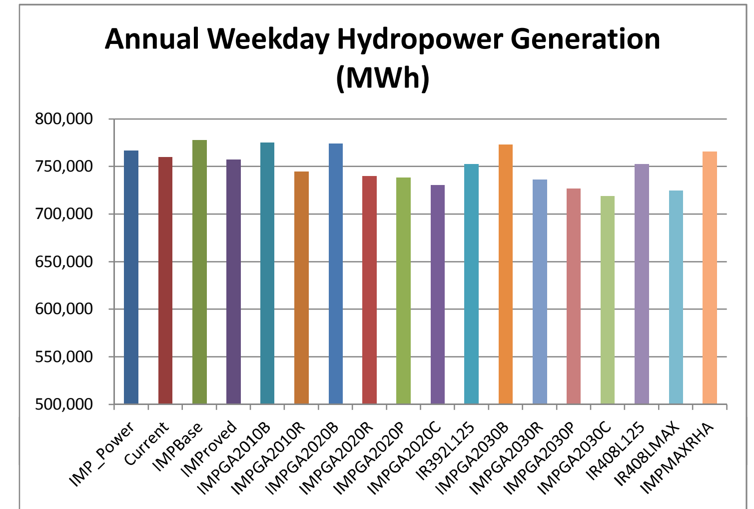


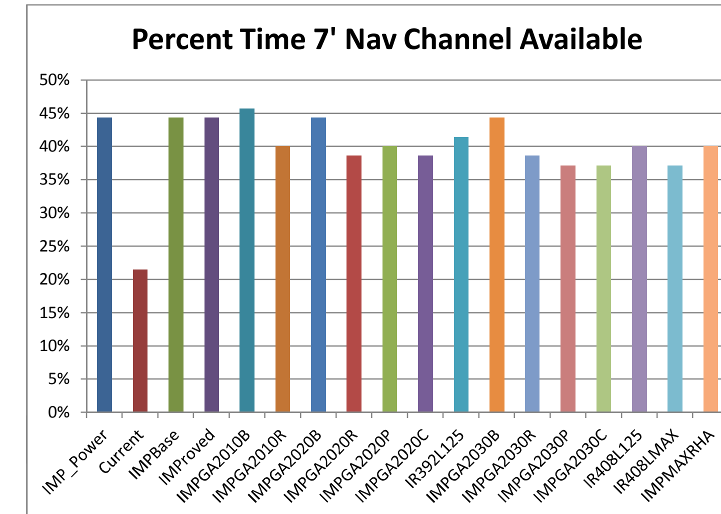


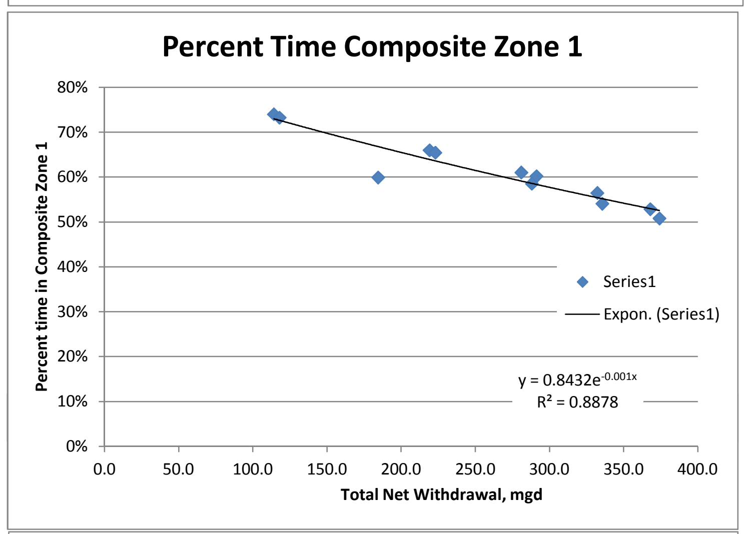


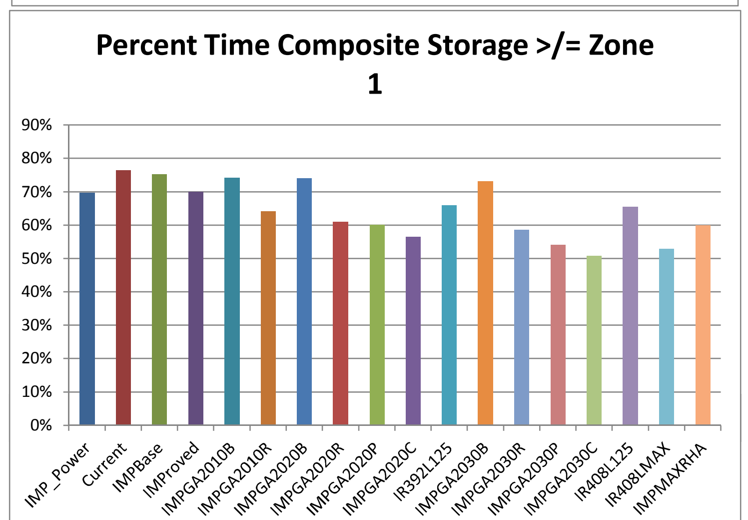
	Zone 1	Zone 2	Zone 3	Zone 4
BASELINE	0.945670031	0.030391927	0.020613315	0.003324728
IMPBASE	0.837675037	0.080028162	0.070210436	0.012086365
IMPROVED	0.839396073	0.079245873	0.067980912	0.013377142
IMPGA2020B	0.847883908	0.074708597	0.067237738	0.010169757
IMPGA2020C	0.873621216	0.061057655	0.062974263	0.002346867
IMPGA2020R	0.869788	0.060862082	0.06567316	0.003676758
IR392L125	0.862708284	0.060862082	0.069389032	0.007040601
IMPGA2030B	0.848744426	0.071383869	0.072870218	0.007001486
IMPGA2030C	0.876202769	0.062935148	0.059023703	0.001838379
IMPGA2030R	0.873934131	0.060353595	0.063560979	0.002151295
IR408R125	0.868184307	0.059062818	0.064929985	0.00782289
IR408LMAX	0.875928968	0.062387546	0.05961042	0.002073066
IMPMAXRHA	0.882500196	0.05890636	0.056285692	0.002307752

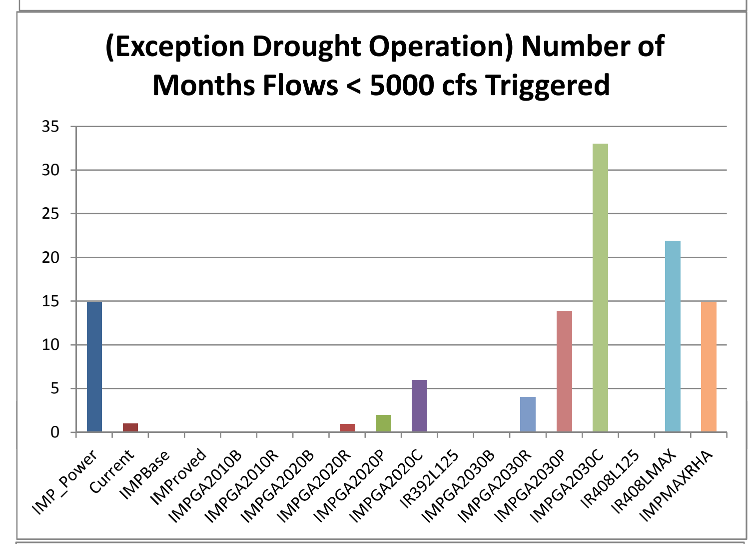

Annaul Generation vs Lake Withdrawal
Annual Generation, kWhr
Net Lake Withdrawal, mgd
GA2020 Demands
GA2030 Demands
Linear (GA2020 Demands)
Linear (GA2030 Demands)

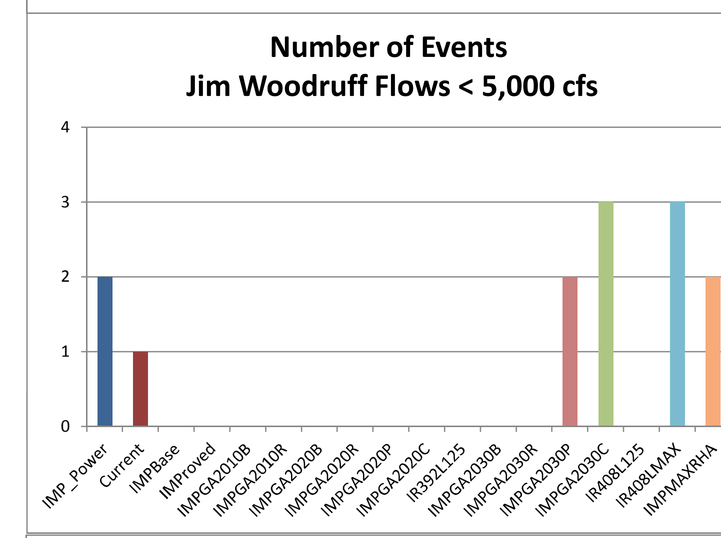

Annual Weekday Hydropower Generation (MWh)
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA

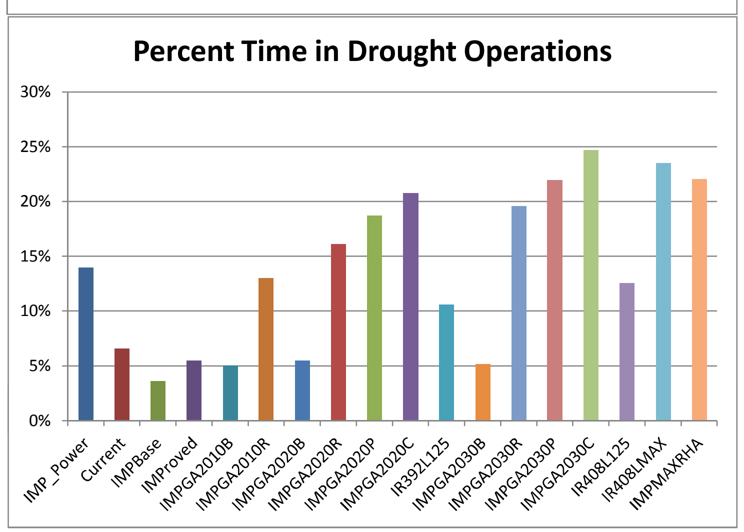

Percent Time 7' Nav Channel Available
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA

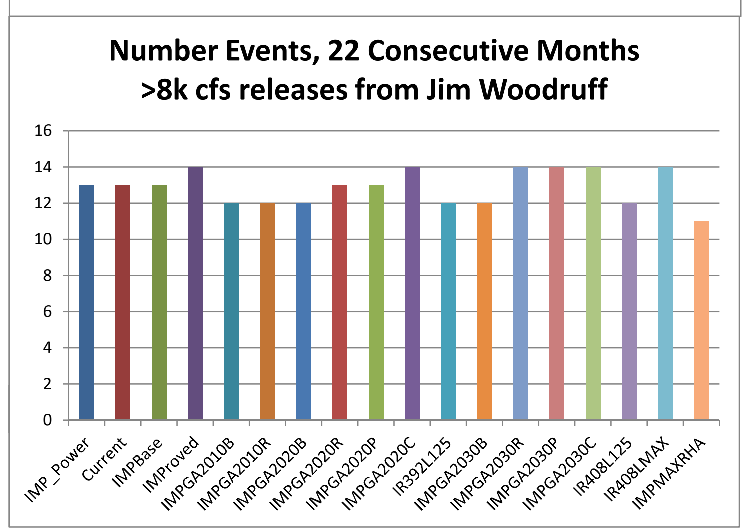

Percent Time Composite Zone 1
Percent time in Composite Zone 1
Total Net Withdrawal, mgd
Series1
Expon. (Series1)
y = 0.8432e^-0.001x
R² = 0.8878

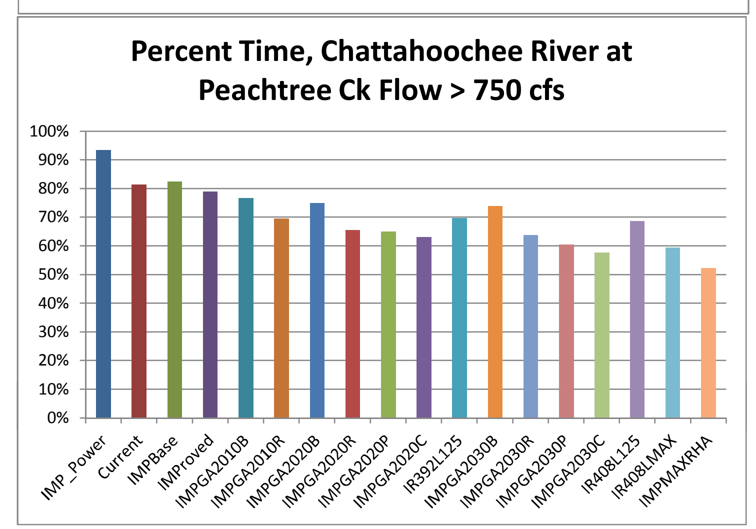

Percent Time Composite Storage >/= Zone 1
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA

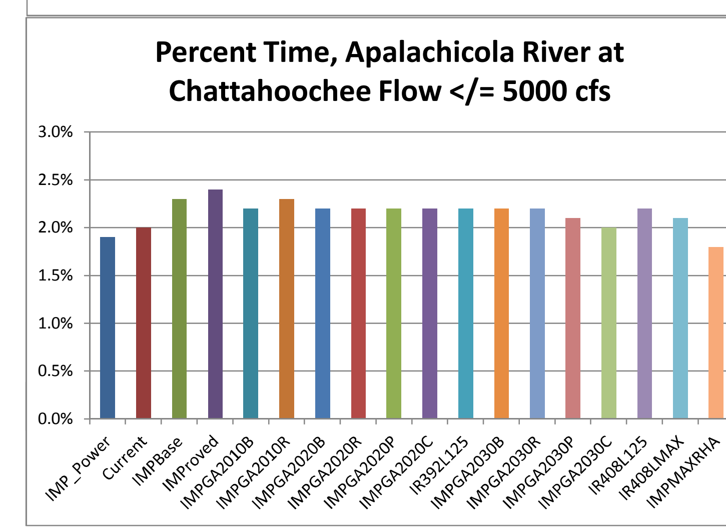

(Exception Drought Operation) Number of Months Flows < 5000 cfs Triggered
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA

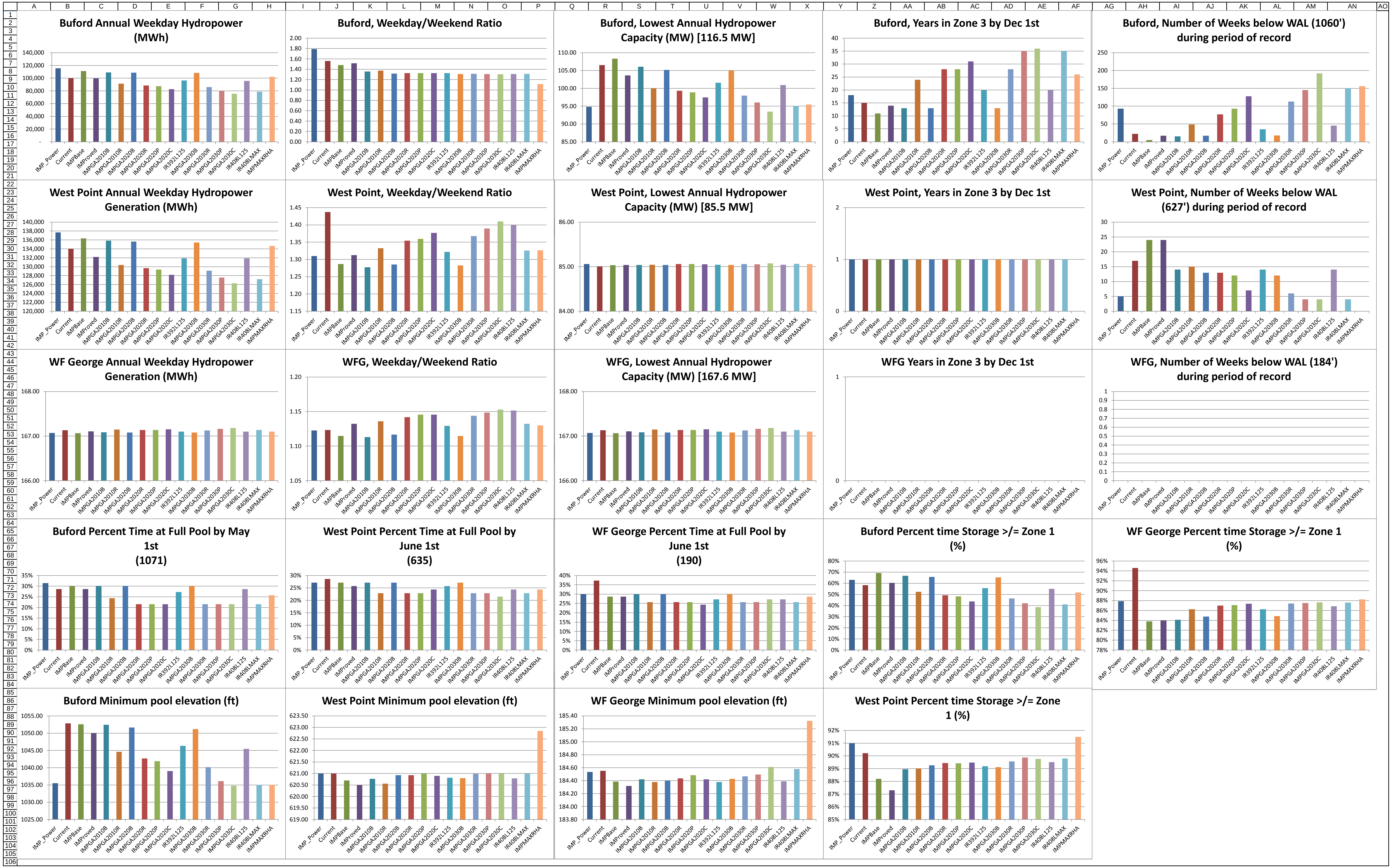

Number of Events
Jim Woodruff Flows < 5,000 cfs
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA


Percent Time in Drought Operations
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA


Number Events, 22 Consecutive Months >8k cfs releases from Jim Woodruff
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA


Percent Time, Chattahoochee River at Peachtree Ck Flow > 750 cfs
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA


Percent Time, Apalachicola River at Chattahoochee Flow </= 5000 cfs
IMP_Power Current IMPBase IMProved IMPGA2010B IMPGA2010R IMPGA2020B IMPGA2020R IMPGA2020P IMPGA2020C IR392L125 IMPGA2030B IMPGA2030R IMPGA2030P IMPGA2030C IR408L125 IR408LMAX IMPMAXRHA


Buford Annual Weekday Hydropower (MWh)
Buford, Weekday/Weekend Ratio
Buford, Lowest Annual Hydropower Capacity (MW) [116.5 MW]
Buford, Years in Zone 3 by Dec 1st
Buford, Number of Weeks below WAL (1060') during period of record
West Point Annual Weekday Hydropower Generation (MWh)
West Point, Weekday/Weekend Ratio
West Point, Lowest Annual Hydropower Capacity (MW) [85.5 MW]
West Point, Years in Zone 3 by Dec 1st
West Point, Number of Weeks below WAL (627') during period of record
WF George Annual Weekday Hydropower Generation (MWh)
WFG, Weekday/Weekend Ratio
WFG, Lowest Annual Hydropower Capacity (MW) [167.6 MW]
WFG Years in Zone 3 by Dec 1st
WFG, Number of Weeks below WAL (184') during period of record
Buford Percent Time at Full Pool by May 1st (1071)
West Point Percent Time at Full Pool by June 1st (635)
WF George Percent Time at Full Pool by June 1st (190)
Buford Percent time Storage >/= Zone 1 (%)
WF George Percent time Storage >/= Zone 1 (%)
Buford Minimum pool elevation (ft)
West Point Minimum pool elevation (ft)
WF George Minimum pool elevation (ft)
West Point Percent time Storage >/= Zone 1 (%)
IMP_Power
Current
IMPBase
IMProved
IMPGA2010B
IMPGA2010R
IMPGA2020B
IMPGA2020R
IMPGA2020P
IMPGA2020C
IR392L125
IMPGA2030B
IMPGA2030R
IMPGA2030P
IMPGA2030C
IR408L125
IR408LMAX
IMPMAXRHA