OUT WITH *the* OLD

Technology and Automation

> *Information technology and business are becoming inextricably interwoven. I don't think anybody can talk meaningfully about one without talking about the other.*
>
> BILL GATES, FOUNDER OF MICROSOFT

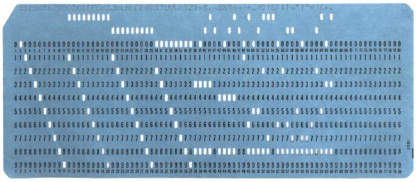
PUNCHING THROUGH THE PAST

When Gus Norwood completed SEPA's first history in 1990, the agency had only recently abandoned the use of punched cards for data compilation. As new desktop computers were purchased during the early 1990s, SEPA held regular workshops to introduce computer operations and programs. Later, the agency interconnected computer terminals through networks, introduced email, and eventually each staff member had their own desktop computer. The hydro projects were virtually connected through remote terminal units for real-time and accurate generation and scheduling information. In two short decades, SEPA transitioned from analog to digital operations. Information Technology (IT) was embraced and woven into all operational and functional aspects of the organization.[1]

Prior to automation, all of the maps, charts, and forms used by SEPA for operations, billing, and hydrology studies, were developed by hand. To develop rates for repaying the Federal Treasury, SEPA had to first determine the energy (MWH) and, more importantly, the dependable capacity (MW) available for sale at the projects. This was accomplished by calculating historic streamflows at each project using a desk calculator (Friden or Marchant) and a desk adding machine.[2]

This cumbersome and time-consuming process changed in 1962. At that time, a number of SEPA employees met with computer personnel at the University of Georgia Computer Center to see if the newly emerging computer era could perform these tedious hand-developed project simulations. As a result, several SEPA engineers, Elbert Rucker, Harold Jones, and Clifford Bond, took computer classes offered at the University.

Left: A SEPA employee uses an IBM key punch machine, late 1960s.



SEPA wrote computer programs on punch cards until the 1980s.

At first, a program language called Symbolic Programming was used. Soon thereafter, two much more sophisticated computer languages became available – FORTRAN and COBOL. Eventually, all of SEPA's simulated project operations were written in FORTRAN, while customer billing was better suited to COBOL. All of these programs used punch cards for program and data entry. Programs integrating many projects required thousands of statements (cards).[3]

During the 1960s, the agency began 'automating' data first with an IBM 1401 (and later an IBM 7094) mainframe computer owned by and housed at the University of Georgia, thirty miles away in Athens. The University's IBM 7094 was a large, bulky machine that monopolized an entire room and was used by the University to run grades and student schedules. In addition to the University and SEPA, other organizations used the machine as well, including the National Aeronautics and Space Administration (NASA) and the Georgia Department of Transportation (GDOT). SEPA had to 'get in line' with everyone else!

The computer itself operated by virtue of programs and data written on punched cards, which were inserted by stacks into the machine. During the 1960s and 1970s, punched cards were the most common method of developing programs and calculating data. The cards, punched on a separate key punch machine, typically included 80 columns and 12 rows of numbers (labeled 1-9). The number combinations were used to develop binary coding for the computer. Writing a program to the cards was tedious and could realistically require hundreds or even thousands of individual cards, but the process represented the latest computer technology at the time.

Prepping data for customer billing, 1970s (pictured: Wade Gaines, Donnie Cordell, Blanche Adams).

Crash Course in Computer Programming

When I came to work here [in 1968], I had never punched a card. I didn't know how to operate a punch machine. About 1969, SEPA's computer programmer left. My boss came in, handed me two books on FORTRAN [programming] and said 'You're it!' I said, 'I don't know this.' He said, 'You've got to learn it.' So, I had to learn computer programming on my own.

Wade Gaines, SEPA's First IT Manager

While the agency had not yet purchased its own primary computer, SEPA did own an IBM key punch machine. Employees wrote all of the computer programs in Elberton, including programs for stream flow studies, billing, and power operations. Once the programs were finalized, the staff drove boxes of cards to Athens and calculated the data on the UGA computer. "Sometimes we'd dump [the cards] out of the seat [of the car] into the floor," Donnie Cordell remembered. "That was a mess." Another employee remembered the cards absorbing moisture from the air when it rained, "and the card reader would sometimes jam and chew up 20 to 30 cards and cause real problems!" Because of the number of users on the one computer system, SEPA might only get two or three opportunities per day. According to Cordell, "Some days you wouldn't get much done. Some days you would. That's just how it was."[4]

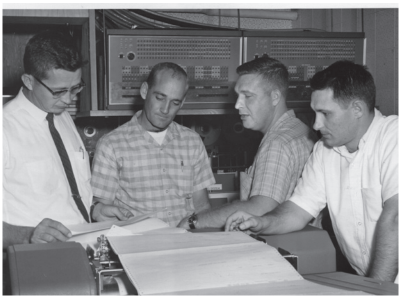
To complicate matters, the University periodically upgraded its computer and users, including SEPA, had to re-learn the system. Each computer upgrade required learning special Job Control Language (JCL), which could prove more difficult to master than the programming language. Also, much like modern computer systems,

Computerized billing operations, 1970s (pictured: Billy Neal, Clifford Bond, Mirtie Clark).

A Tedious Job

Before we came off the punch card system [in the early 1980s], we were up to 12,000 statements [cards] for both power operations and power sales. We took four or five boxes to the University of Georgia several days a week. You would spend all day with it because the University was running other things and had to work us in. We would turn the cards in, the University would run them through the machine, and we would wait for the output. Sometimes you'd get it back and everything would look pretty good except for one little glitch, so you'd have to sit down for an hour or so trying to correct it. It was not too hard to make an error because the machine was real particular – if you punched the wrong thing on the card it made it completely invalid. It was rather tedious.

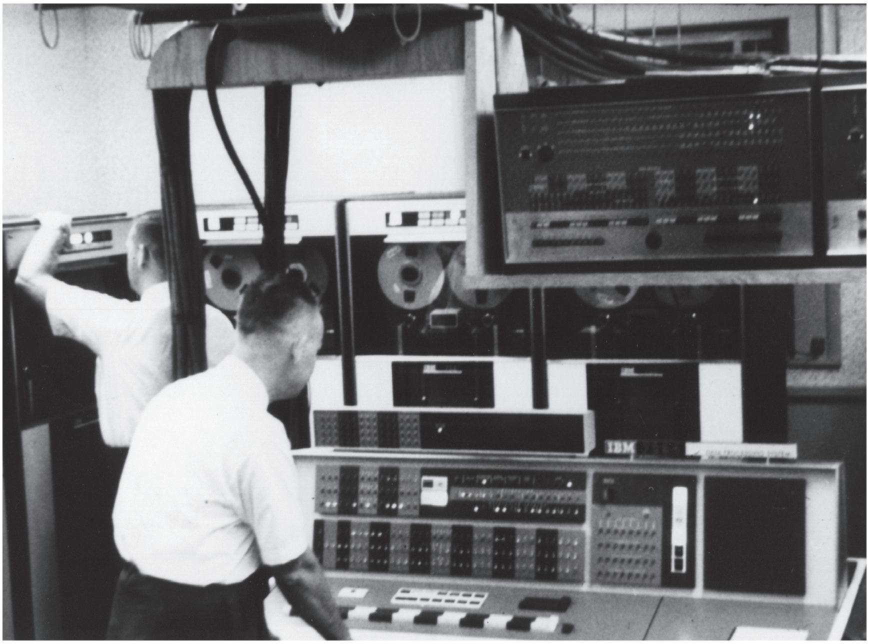
Harold Jones, SEPA (1952-1995)



Waiting on the output from UGA's computer, 1970s.

the early variants were limited to a certain amount of memory. One of the early computers at UGA was limited to 128 kilobytes, a miniscule amount of space compared to gigabytes found on modern computers. Some of SEPA's programs operated on so many kilobytes that the agency used the University's system at night so as to not interfere with other users.[5]

During the early 1980s, SEPA purchased an in-house computer capable of running most programs needed for accounting, power sales, and power operations. This new computer used tapes akin to cassettes or reels. Data was written to the tapes, re-wound, and read back because the memory system was limited.[6] In 1984, the same year that SEPA disposed of using punch cards, the agency purchased a Texas Instruments (TI) 990 that served until a new Prime computer was installed in 1990. During the late 1980s, SEPA purchased two 'desktop' or micro-computers, one for power sales and one for power operations. These included a Macintosh II (heralded as having the new feature of a color monitor) and a Compaq 386 PC, with five megabytes of Random Access Memory (RAM) and a processing speed of 20 megahertz. The new technology required instruction and classes were held in Disk Operating System (DOS), database management, word processing, graphics, spreadsheet, and telecommunications. Some training was conducted internally by SEPA employees, while other courses required bringing in outside experts from Athens Technical College, the University of Georgia, and Clemson University.[7] The agency was entering the IT era, but all administrative work was still largely conducted on calculators and typewriters.



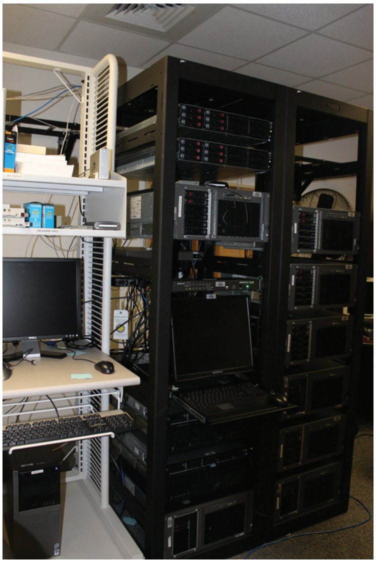
John Mixon and Harold Jones working with the old UGA computer, 1970s.

Training for new computers in the early 1990s (pictured: Blanche Adams, Gail Dickerson, Mirtie Clark, Martha Hewell, and Frances Mixon).

NETWORKING

Billy Neal, Wade Gaines, and Bob Goss led SEPA's IT program in its infancy. With the increasing number of desktop computers, one of their early tasks included developing a server and integrating the machines into a 'network.' SEPA designed the system in addition to laying the required cables for a dedicated server room on the fourth floor of the old Samuel Elbert Hotel, then the agency's headquarters. "There was no looking back," remembered Gaines. "Networks came to be the most popular thing." SEPA installed its first NOVELL operating network in 1990, which interfaced with a Prime mini-computer. In 1994, the agency migrated to a Microsoft Windows network, dominating the market at the time, which was also used by other DOE organizations.[8]

Once the agency's computers were connected internally, SEPA tapped into external networks. During the early 1990s, the City of Elberton had no fiber optic internet capability and SEPA requested a T-1 line from the nearest availability in Athens. Therefore, the agency was connected to the internet before its host city. The external network enabled SEPA to participate in electronic mail (email) systems. During the early 1990s, both SEPA and SWPA connected with WAPA, which had tapped into the DOE network (DOE-Net), for email access. SEPA's first email had wapa.gov tag, but the agency received its own email tags in 1995. At that time, the internet was a dial-up system, accessed through a traditional phone cable. The agency "went online" at regular intervals to retrieve and transmit outside emails, although all internal emails were sent instantaneously. Further, in the early limited email environment at SEPA, employees shared computers for email access. It was a cumbersome, but effective, early system. SEPA even had email capability a full year before the Corps of Engineers.[9]



The new servers at SEPA take up only a few cubic feet of shelf space.

Beyond interconnecting traditional desktop computers, the agency recognized the importance of using the networks to communicate with the hydroelectric projects to obtain instant and accurate information on generation and scheduling. While each of the hydropower plants had computers at the time, none of the computers were connected externally or with each other. By having real-time data, SEPA could better monitor generation at the projects to ensure they met the contractual obligations of the customers.

Internally, SEPA assigned an ad-hoc team (SEPA-Corps Control Area Team [SCCAT]) to issue recommendations on the communication needs of the new Operations Center that would enable communication with six of the Corps' power projects (Hartwell, Thurmond, Russell, Carters, Millers Ferry, and Walter F. George). Because

Top management said, 'What are we going to do with [email]?' Now they couldn't do without it.

Wade Gaines

many of the long-term customer contracts were being re-negotiated at the time, an upgraded operations center became a priority effort to develop a more cost-effective service. The SCCAT provided specific recommendations on the types of connections (T-1 or 56kb) required for each of the six plants and estimated a total of approximately $50,000 for procurement and installation of the equipment.[10]

A Wide Area Network (WAN) was developed to link the projects and the concept was presented to the Corps. "[They] told us it wouldn't work," remembered Gaines, "and it wasn't easy due to the locations of some of the powerhouses." The SEPA IT Team designed the proposed network and set up a prototype mini-network at its headquarters in Elberton to prove the viability of the software. One of the first plants connected through SEPA's network was the Walter F. George project on the Chattahoochee River. Because the local telecommunications system in the nearby town of Fort Gaines, Georgia was so limited at the time, SEPA contracted with Sprint to install a T-1 line to a small building on the Georgia side of the dam. With the T-1 line in place, the IT Team installed the fiber optics in the dam and the powerhouse for the final connection.[11]

After installing computer terminals at the individual plants, SEPA used an early remote access software to link into the computer. "Today, it wouldn't come close to

From one computer to many. All employees have desktop computer stations.

meeting security requirements," Gaines noted, "but at the time nobody knew how to use it." The local Corps operators were instructed to put the generation schedule on their computer screen, and SEPA's operators could see the real-time data on their computers back in Elberton. Operators also used the notepad function to exchange messages.[12]

The remote terminal units were centrally linked to SEPA's Operation Center. When the Operations Center came online in 1994, it was originally located on the Fourth Floor of the old Samuel Elbert Building, and shared a single server with the entire organization. By 2010, SEPA had over seventy-five computers, multiple servers, and an emergency offsite center for continued operations.[13]

IMPROVING BUSINESS THROUGH TECHNOLOGY

When John McAllister arrived at SEPA in 1990, he took charge of an agency, not unlike other federal organizations, that still largely used adding machines and typewriters. SEPA's computers were large, but still able to fit on desktops. Automatic data processing was still in its infancy. "I saw the agency go from an analog entity to a digital entity," he recalled. "[Technology] was fully embraced."

Importantly, technology has allowed, and in some cases facilitated, improved business practices. With the hydro projects now virtually connected to SEPA through an Energy Management System (EMS), operators have access to real-time information in regard to generation, storage, switchyards, and even weather conditions. In scheduling power, SEPA receives a declaration from the Corps, or specifically the amount of energy available for an upcoming week (Saturday-Friday), compiles the capacity by system and estimates a percentage for the customers. With that information in hand, the customers schedule their energy for the week based on estimated peak demands. By 2010, all scheduling takes place electronically in the form of spreadsheets exchanged across the internet, a much quicker process even by 1994 standards when the Control Area went operational.[14]

Technology has become an even more critical asset as more individual preference customers elected to self-schedule their power declarations rather than receiving credits for government power through another parent power company. Since the Operations Center went online, more customers have chosen to schedule power individually, with SEPA providing transmission services. Coordinating additional weekly schedules resulted in an increased workload for SEPA operators, but one that is made far easier with real-time information. Additionally, the e-tagging process, specifically creating point-to-point identifiers for individual power transactions, is conducted entirely through an internet interface. Just as technology allowed for more precise energy storage information, it has also allowed for better accuracy in determining availability on the grid when SEPA requests transmission capability.[15]

In addition to benefitting power operations, the new electronic interfaces have expedited even the more basic tasks associated with power sales. Because of the expanding usage of the internet and availability of electronic interconnections, in 2001, the US Office of Management and Budget launched an "Electronic Government" (E-Government) initiative. An E-Government Task Force identified numerous ways to

We are in a paperless age. At one time we had to coordinate everything through phone calls, print it out on paper, and then fax it to everyone. Now everything is automated. When the schedule is set up, our software emails it to the appropriate people. Technology has really changed the way we access information.

Dee Smith, SEPA Power Operator

use IT to create efficiencies and facilitate citizens' and customers' interaction with the federal government. A variety of individual proposals for all branches of the government resulted from the initiative, including e-dockets for filing official paperwork, online grant submissions, web-based training seminars, and electronic records systems to name just a few. For an agency like SEPA that manages countless individual customer transactions on a daily basis, one of the most beneficial programs was Pay.gov, a web-based electronic funds transfer (EFT) system that allows customers to make payments online, allowing for quicker deposits into the Treasury. In February 2005, SEPA was the first DOE entity to institute the Pay.gov system.[16]

The IT revolution has even made the most mundane of tasks and communication more efficient, reliable, and user-friendly. In 2004, SEPA launched its first website. In addition to providing basic agency information, news releases, hydropower data, and copies of annual reports, the website facilitates procurement processes by directing users to DOE and federal acquisition websites. SEPA also uses the interface to collect Freedom of Information Act (FOIA) requests, information regarding proposed and finalized rate schedules, as well as employment opportunity links.

SECURED AND CONTINUED OPERATIONS

Because SEPA operates within a broader bulk electrical system, the DOE requires the agency to have an offsite Continued Operations (COOP) center should its primary control facility become dysfunctional. From a federal agency standpoint, SEPA also has contractual obligations that must be met on an hourly basis; a default on these obligations would result in substantial financial losses to both the federal government and the preference customers.[17]

COOP standards were established by NERC and compliance is achieved through routine audits and inspections. Each operations backup center must meet minimum standards for data communications, voice communications, physical and cyber security, as well as a source of power supply. According to current NERC standards, backup control areas must be capable of full operation within two hours of a primary system failure.[18]

SEPA established an initial COOP site in 1999. That first backup center was located in a one-room facility in Bogart, Georgia, west of Athens. Then, in 2002, SEPA moved the offsite center to Chase Street in Athens. The COOP center remains unmanned unless there is an emergency, but has all of the essential redundant components to become fully functional within a few hours. The facility has two T-1 data lines, a

Most people do not realize how far technology has come in the last twenty years.

Wade Gaines

conventional (land-based) phone system, generator, and networks to accommodate Doe.net and Corps.net electronic communications.[19] The backup systems are identical to those in the primary control area and are designed to provide replicated information that is immediately available to emergency system staff.

SEPA developed Standard Operating Procedures (SOP) to staff the facility with selected employees. The primary staff would include a power operations manager, power system operators (one or two per shift as needed), and a power operations specialist for accounting. Other staff that might be called in as needed include, a lead power operations specialist, an information technology specialist, contracting specialist, an accountant and an accounting technician. If the offsite center is required for a sustained period, other staff may be required for payroll, billing or supplies.[20]

Maintaining a COOP center is essential to both SEPA operations and ensuring reliability within the larger electrical power supply. SEPA conducts announced and unannounced evacuation drills at least twice per year. As part of the drills, operators are required to prepare a report identifying problems encountered during the mock evacuations as well as provide suggestions for improvement. The SEPA IT staff also conducts weekly equipment and communication checks on the primary systems.[21]

A NEW ERA: CYBER AND PHYSICAL SECURITY

When terrorists launched multiple attacks against homeland assets of the United States on September 11, 2001, the federal government required all of its agencies and organizations to take a fresh look at their procedures for physical security. Further, with the nation and the world more interconnected than ever through computers and the World Wide Web, cyber-attacks remain an imminent threat. Though it is a small organization with few physical assets, SEPA remains vigilant about cyber and physical security.

SEPA operates within a bulk electric power system. Unauthorized access to critical energy information (facilities, equipment, or systems) could have disastrous results. A breach in cyber-security resulting in interference of service could even affect the broader electrical power grid and put other critical infrastructure (military and civil) at further risk. Disruption could also cause the government to default on contractual loads of power to the preference customers. The SEPA IT Team established internal procedures and protocols to follow the applicable cyber-security standards administered by the DOE, NERC, SERC, FRCC, the National Institute of Standards and Technology (NISC), and Federal Information Processing Standards (FIPS). SEPA developed a Program Cyber Security Plan (PCSP) in 2005 to formalize its cyber-

Records Management

SEPA has diligently developed and maintained an electronic records system. Prior to the computer-era, the agency had a “mail log” program which tracked each piece of physical mail that entered the building. Today, logging correspondence is much more challenging as daily communication occurs primarily through email. The agency has also digitized an old manual records system for its archives and legal library. The records system was first digitized using the TI-990 computer and has been updated regularly with new software. Today, SEPA maintains an organized archival repository and comprehensive legal library. Importantly, the agency has also made an effort to scan its historical records, including administrative information, power sales, and power operations.

security policies. Additionally, the agency supplies annual reports to NERC, SERC, and the FRCC, and is audited on a regular basis to check for compliance with security standards. These standards are designed to prevent unwarranted access to data, hardware, software, or any part of the electrical system.[22]

SEPA also instituted additional protections for the physical security of its facilities. Traditional keys were replaced with secured electronic entries, and staff are required to escort approved visitors. The Operations Center, located within the headquarters building, is recognized as “critical energy infrastructure” by the DOE, and has additional security restrictions, limited access, and twenty-four hour monitoring systems.[23]

Ensuring cyber security requires constant vigilance as threats change and become more sophisticated. With the Corps owning the hydropower facilities and SEPA managing the Operations Center, it was critical for the two agencies to develop an agreement supporting the framework for cyber and physical security. In 2005, SEPA and the Corps signed an MOA in regard to hybrid system communications between SEPA’s Operations Center and the Savannah and Mobile districts’ Supervisory Control and Data Acquisition (SCADA) System. The document specified roles and responsibilities for each agency for security patch management, intrusion detection systems, network security (firewalls), physical access and clearance for personnel, software protection (spyware, anti-virus, and malware), and general system support.[24]

The Legal Library at SEPA

SEPA's Record Archive

ENDNOTES

[1] McAllister interview.
[2] Information provided by Harold Jones via email, September 13, 2012.
[3] Jones email, September 13, 2012.
[4] Cordell interview; also, personal communication via email with Wade Gaines, July 25, 2012.
[5] Interview with Wade Gaines (SEPA-Retired), March 4, 2010.
[6] Gaines interview; Jones interview.
[7] *SEPA Newsletter*, December 1988; also Gaines interview.
[8] Gaines interview.
[9] John Sewell, the IT Manager at WAPA, designed the email system that covered SEPA, SWPA, and WAPA; Gaines interview.
[10] August 1995 Memoranda in "Telecommunications: SEPA Operations Center," RG5301, SEPA Archives.
[11] Gaines interview.
[12] Ibid.
[13] Gaines interview; Seymour interview. For a detailed discussion of the creation of the Operations Center, see Chapter 5.
[14] Heard interview.
[15] Interview with Dee Smith, February 25, 2010. Also, SEPA, *Annual Reports*, 2000-2005. See Chapter 5 for a discussion of the e-tagging process.
[16] SEPA, *Annual Report*, 2005.
[17] "Emergency Plan," in SEPA Archives, RG4335, "Facilities Management: Building Security."
[18] Seymour interview. The current NERC standards for operations center backup systems are outlined in "Standard EOP-008-1: Loss of Control Center Functionality." Internet online at *www.ferc.gov/whats-new/comm-meet/2011/042111/E-7.pdf.*
[19] Gaines interview.
[20] "Emergency Plan," SEPA Archives; also Seymour interview.
[21] Gaines interview. See also North American Electric Reliability Corporation (NERC), "Readiness Audit: Southeastern Power Administration. September 29-30, 2004, Elberton, Georgia;" and NERC, "Balancing Authority/Transmission Operator Reliability Readiness Evaluation Report for the Southeastern Power Administration, Elberton, Georgia. February 26-March 1, 2007."
[22] Facility Security Plans, 1992-2007, in "Facilities Management: Building Security," RG4335, SEPA Archives. Also, "Southeastern Power Administration, Program Cyber Security Plan, August 2005," in "Data Processing Management: Cyber Security," RG1360, SEPA Archives.
[23] Gaines interview.
[24] SCADA systems monitor conditions and provide information for distributed networks of infrastructure or processes. See "Memorandum of Agreement Between US Army Corps of Engineers and the Southeastern Power Administration," 2005.

BIBLIOGRAPHY

A Note on Sources

In conducting the archival research for this history, the Southeastern Power Administration Public Affairs Office proved instrumental in gathering existing information, including files, briefings, news releases, fact sheets, and photographs. These materials are organized by record groups in the general SEPA archives housed in Elberton, Georgia. Unless noted in the text, all photographs were provided through the Public Affairs Office.

List of Interviews

Borchardt, Charles (SEPA-Retired). Interview by Patricia Stallings. Tulsa, OK, September 15, 2010.

Cordell, Donnie (SEPA-Retired). Interview by Patricia Stallings. Elberton, GA, March 10, 2010.

Gaines, Wade (SEPA-Retired). Interview by Patricia Stallings. Elberton, GA, March 4, 2010

Heard, Darlene (SEPA). Interview by Patricia Stallings. Elberton, GA, March 4, 2010.

Jones, Harold (SEPA-Retired). Interview by Patricia Stallings. Elberton, GA, March 4, 2010.

Jourolmon, Leon (SEPA). Interview by Patricia Stallings. Elberton, GA, February 25, 2010. Follow-up phone interview, October 1, 2012.

Legg, Ken (SEPA). Interview by Patricia Stallings. Elberton, GA, February 25, 2010.

Lloyd, Jim (SEPA-Retired). Interview by Patricia Stallings. Elberton, GA, March 4, 2010

McAllister, John A. Jr. (SEPA-Retired). Interview by Patricia Stallings. Columbia, SC March 29, 2011.

Nadler, Herb (SEPA). Interview by Patricia Stallings. Elberton, GA, March 4, 2010.

Prince, Bob (SAD). Interview by Patricia Stallings. Atlanta, GA, January 19, 2011.

Rampey, Denver “Lee” (SEPA). Interview by Patricia Stallings. Elberton, GA, February 25, 2010.

Seymour, Joel (SEPA). Interview by Patricia Stallings. Elberton, GA, February 25, 2010.

Smith, Dee (SEPA). Interview by Patricia Stallings. Elberton, GA, February 25, 2010.

Smith, J.W. (SEPA). Interview by Patricia Stallings. Elberton, GA, March 10, 2010.

Spencer, Douglas (SEPA). Interview by Patricia Stallings. Elberton, GA, February 25, 2010.

Worthington, Jon (SEPA-SWPA). Interview by Patricia Stallings. Tulsa, OK, September 15, 2010.

Works Cited

American Society of Civil Engineers. *Civil Works for Hydroelectric Facilities: Guidelines for Life Expansion and Upgrade*. Reston, Virginia: American Society of Civil Engineers, 2007.

Adams, Clifford, Jr., Clinton A. Vince, and Alan I. Robbins, “Federal Electric Preference Power Marketing in the 1980s: Developing Legal Trends.”*Energy Law Journal* 4, no. 1 (1983): 1-57.

Apt, Jay, Lester B. Lave, Sarosh Talukdar, M. Granger Morgan, and Marija Ilic. "Electrical Blackouts: A Systemic Problem." *Issues in Science and Technology* (Summer 2004).

Arsenault, Raymond. "The End of the Long Hot Summer: The Air Conditioner and Southern Culture." *The Journal of Southern History* 50, no.43 (November 1984): 597-628.

Bailey, Ralph, Jr. and Charles F. Philips, Jr. *"As Mobile Goes, So Goes the Corps" A Look at Change Inside a Government Agency. The US Army Corps of Engineers Mobile District, 1985-2003*. Mobile, Alabama: U.S. Army Corps of Engineers, 2006.

Barber, Henry E. and Allen R. Gann. *A History of the Savannah District US Army Corps of Engineers, 1829-1989.* Savannah, Georgia: US Army Corps of Engineers, 1989.

Beck, Bill. *PP&L: 75 Years of Powering the Future. An Illustrated History of Pennsylvania Power and Light Company*. Eden, Prairie, Minnesota: Viking Press, Inc., 1995.

Billington, David P. and Donald C. Jackson. *Big Dams of the New Deal Era: A Confluence of Engineering and Politics*. Norman: University of Oklahoma Press, 2006.

Billington, David P., Donald C. Jackson, and Martin V. Melosi. *The History of Large Federal Dams: Planning, Design, and Construction in the Era of Big Dams*. Denver, Colorado: US Department of the Interior Bureau of Reclamation, 2005.

Brockington and Associates, Inc. *History of the South Atlantic Division US Army Corps of Engineers, 1945-2011*. Atlanta: U.S. Army Corps of Engineers, 2012.

Brudney, Jeffrey L., F. Ted Hebert, and Deil S. Wright. "Reinventing Government in the American States: Measuring and Explaining Administrative Reform," *Public Administration Review* 59, no. 1 (January-February 1999): 19-30.

Cobb, James C.. *The Selling of the South: The Southern Crusade for Industrial Development, 1936-1990.* 2nd ed. Urbana: University of Illinois Press, 1993.

Coleman, Lori I. "Our Whole Future is Bound up in this Project: The Making of Buford Dam." Master's Thesis, Georgia State University, Atlanta, 2008.

Congressional Budget Office. *Should the Federal Government Sell Electricity?* Washington, D.C.: Congressional Budget Office, November 1997.

Congressional Research Service. *CRS Report for Congress. Aging Infrastructure: Dam Safety*. March 25, 2008.

Davis, Joyce M. *Images of America: Historic Elberton.* Charleston: Arcadia Publishing, 2002.

Dellapenna, Joseph W. "Interstate Struggles over Rivers: The Southeastern States and the Struggle over the 'Hooch," *New York University Environmental Law Journal* 12 (2005): 828-866.

de Luna, Phyllis Komarek. *Public versus Private Power during the Truman Administration: A Study of Fair Deal Liberalism*. New York: Peter Lang Publishing, 1997.

DuMars, Charles T. and David Seeley. "The Failure of the Apalachicola-Chattahoochee-Flint River Basin and the Alabama-Coosa-Tallapoosa River Basin Compacts and a Guide to the Successful Establishment of Interstate Water Compacts." *Georgia State University Law Review* 21, no.2 (2004): 373-400.

Durden, Robert F. *Electrifying the Piedmont Carolinas: The Duke Power Company, 1904-1997.* Durham, NC: Carolina Academic Press, 2001.

Energy Information Administration. *The Changing Structure of the Electric Power Industry, 1970-1911*. Washington, DC: US Department of Energy, 1993.

______. *The Changing Structure of the Electric Power Industry, 2000: An Update*. Washington, DC: US Department of Energy, 2000.

Ezzell, Patricia Bernard. *TVA Photography, 1963-2008: Challenges and Changes in the Tennessee Valley*. Jackson: University Press of Mississippi, 2008.

Fehner, Terrence R. and Jack M. Hall. *Department of Energy, 1977-1994: A Summary History*. Washington, DC: Department of Energy, 1994.

Flanders, Archie, John McKissick, and Tommie Shepard. "Georgia Economic Losses Due to 2007 Drought." The University of Georgia, Center for Agribusiness and Economic Development, Report CR-07-10, July 2007.

Grant, Douglas L. "Interstate Allocation of Rivers Before the United States Supreme Court: The Apalachicola-Chattahoochee-Flint River System." *Georgia State Law Review* 21, no.2 (2004): 401-427.

Hargrove, Erwin C. *Prisoners of Myth: The Leadership of the Tennessee Valley Authority, 1933-1990*. Princeton: Princeton University Press, 1994.

Hargrove, Erwin C. and Paul K. Conkin. *TVA: Fifty Years of Grass-roots Bureaucracy*. Urbana: University of Illinois Press, 1983.

Hartzer, Richard B. *To Great and Useful Purpose: A History of the Wilmington District Corps of Engineers*. Bloomington, Indiana: David A. Clary and Associates, 1984.

Hay, Duncan. *Hydroelectric Development in the United States, 1880-1940*. Washington, DC: Edison Electric Institute, 1983.

Hughes, Thomas P. *Networks of Power: Electrification in Western Society, 1880-1930*. Baltimore: Johns Hopkins University Press, 1983.

Hull, Jonathan Watts. "The War over Water." Prepared for the Council of State Governments, Southern Legislative Conference. Internet online: http://www.csg.org/knowledgecenter/docs/slc-0010-warwater.pdf. Available from 10 March 2010.

Jeane, Gregory and Bruce G. Harvey. *A History of the Mobile District Corps of Engineers, 1815-1985*. Mobile, Alabama: US Army Corps of Engineers, 2002.

Kelliher, Joseph T. "Pushing the Envelope: Development of Federal Electrical Transmission Policy." *American University Law Review* 42, no.2 (1993): 543-606.

Kufahl, Pam. "Privatization Alaska Offers a Lesson in How to Sell Power." *Transmission and Distribution World*, March 1, 1996.

Johnson, Leland R. *Engineers on the Twin Rivers: A History of the Nashville District Corps of Engineers*. Nashville, Tennessee: US Army Corps of Engineers, 1978.

______. *The Headwaters District: A History of the Pittsburgh District, US Army Corps of Engineers.* Pittsburgh: US Army Corps of Engineers, 1979.

______. *The Ohio River Division US Army Corps of Engineers: The History of a Central Command*. Cincinnati, Ohio: US Army Corps of Engineers, 1992.

Lathrop, Alyssa S. "A Tale of Three States: Equitable Apportionment of the Apalachicola-Chattahoochee-Flint River Basin." *Florida State University Law Review* 36 (2009): 865-902.

Moreel, Ben. *Our Nation's Water Resources: Policies and Politics.* New York: Arno Press, Inc., 1956.

Norwood, Gus. *Gift of the Rivers: Power for the People of the Southeast. A History of the Southeastern Power Administration*. Washington, D.C.: Government Printing Office, 1990.

______. *Columbia River Power for the People. A History of Policies of the Bonneville Power Association*. Portland: US Department of Energy, Bonneville Power Association, 1981.

Nye, Peter. "Hydropower Leaks." *Rural Electric Magazine* (January 2009), 28-32.

Pless, Al. "Alternative to Federal Appropriations: Federal Hydropower Rehab in the Southeast." *Proceedings of the 2005 Georgia Water Resources Conference*, April 25-27, 2005, University of Georgia.

Radin, Alex. "Public or Private Power." *The Rotarian* (November 1954).

______. *Public Power-Private Life*. Washington, DC: American Public Power Association, 2003.

Riley, Jack. *Carolina Power and Light Company, 1908-1958*. Raleigh: Edwards and Broughton, 1958.

Ruhl, J.B. "Water Wars, Eastern Style: Divvying Up the Apalachicola-Chattahoochee-Flint River Basin." Paper presented at the Universities Council on Water Resources Conference, July 2004. Available online at http://opensiuc.lib.siu.edu/ucowrconfs_2004/102/.

Rowley, William D. *The Bureau of Reclamation: Origins and Growth to 1945, Volume 1*. Denver: Bureau of Reclamation, US Department of the Interior, 2006.

Sadler, James F. "Financing: Partnering to Rehabilitate Federal Hydro Plants using Non-Federal Funding." *Hydro World*, September 1, 2011.

Senate. "Theodore Roosevelt and the Conservation Movement." *Senate Document No. 121*. 85th Congress, 2nd session. Washington, DC, 1958.

Shallat, Todd. *Structures in the Stream: Water, Science, and the Rise of the US Army Corps of Engineers*. Austin: University of Texas Press, 1994.

Simpson, Donald E., Marilyn Phipps, and Arturo L. Ressi di Cervia, "Constructing a Cutoff Wall in Front of Walter F. George Dam in 100 Feet of Water." *Hydro Review* (March 2006).

United States District Court: Middle District of Florida. Memorandum and Order. Tri-State Water Rights Litigation, Case No. 3:07-md-01, Filed July 17, 2009.

U.S. General Accounting Office. *Federal Power: Outages Reduce the Reliability of Hydroelectric Power Plants in the Southeast*. July 25, 1996. Report GAO/T-RCED-96-180.

______. *Power Marketing Administrations: Cost Recovery, Financing, and Comparison to Nonfederal Utilities*. September 1996. Report GAO/AIMD-96-145.

______. *Federal Power: Issues Related to the Divestiture of Federal Hydropower Resources*. March 1997. Report GAO/RCED-98-48.

______. *Federal Power: Implications of Reduced Maintenance and Repairs of Federal Hydropower Plants*. March 1999. Report GAO/RCED-99-63.

______. *Federal Power: The Evolution of Preference in Marketing Federal Power*. February 2001. Report GAO-01-373.

Vince, Clinton A. and Nancy A Wodka. "Recent Legal Developments and Legislative Trends in Federal Preference Power Marketing."

Wallace, Megan A. "A Negotiated Alternative to Mandatory Wheeling," *Energy Law Journal* 99, no. 10 (1989): 99-120.

Waltrip, John Richard. *Public Power during the Truman Administration*. New York: Arno Press, 1979.

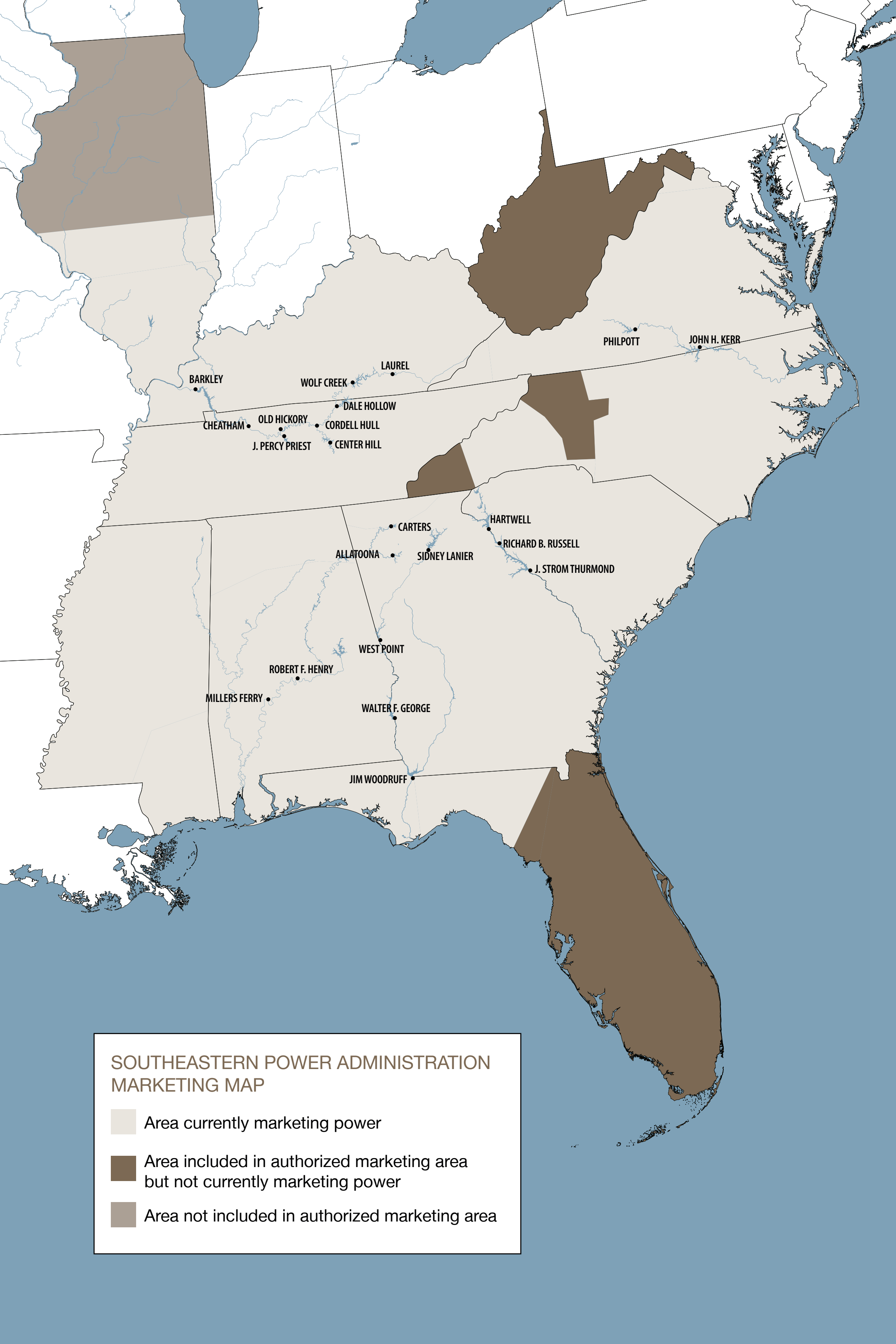
Western Power Administration. *Serving the West: Western Power Administration's First 25 Years as a Power Marketing Agency*. Available online from January 27, 2010. http://www.wapa.gov/about/historyproj.htm

White, Dennis L. and Philip E. Mihlmester. *US Department of Energy Integrated Resource Planning Program: Accomplishments and Opportunities.* Oak Ridge: Oak Ridge National Laboratory, December 1993.

Willoughby, Lynn. *Flowing Through Time: A History of the Lower Chattahoochee*. Tuscaloosa: University of Alabama Press, 1999.

Wright, Wade H. *History of the Georgia Power Company, 1855-1956*. Atlanta: Foote and Davies, Inc., 1957.

SYSTEM MAPS *and* DATA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CORDELL HULL
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CENTER HILL
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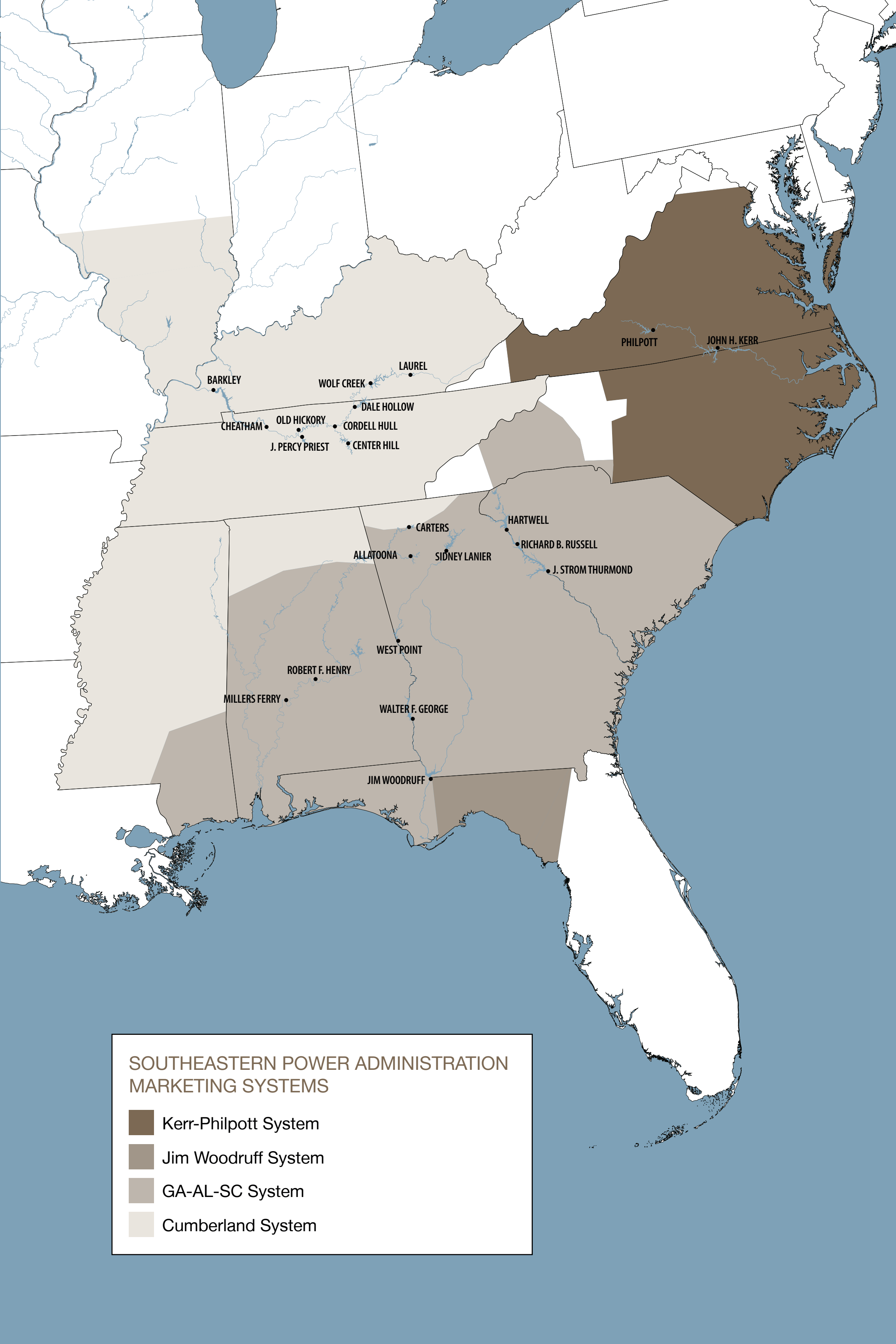
JOHN H. KERR
CARTERS
ALLATOONA
SIDNEY LANIER
HARTWELL
RICHARD B. RUSSELL
J. STROM THURMOND
WEST POINT
ROBERT F. HENRY
MILLERS FERRY
WALTER F. GEORGE
JIM WOODRUFF
SOUTHEASTERN POWER ADMINISTRATION
MARKETING MAP
Area currently marketing power
Area included in authorized marketing area
but not currently marketing power
Area not included in authorized marketing area



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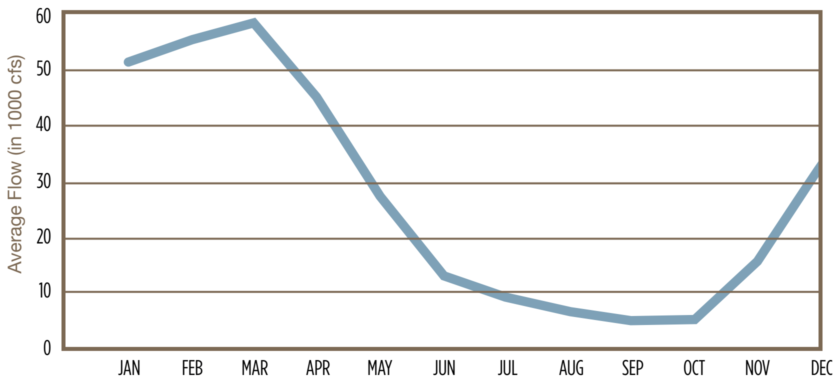
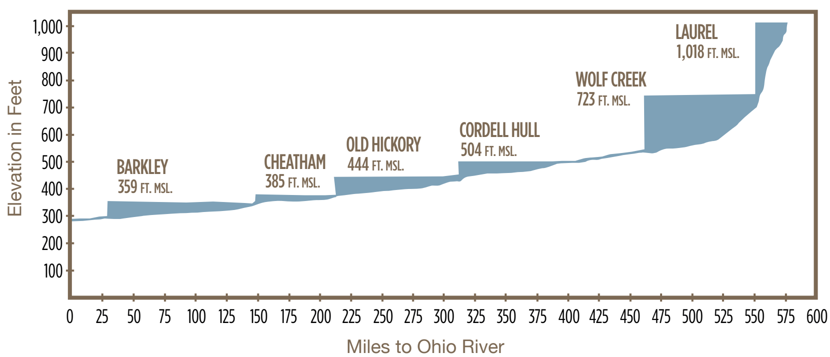
ROBERT F. HENRY
MILLERS FERRY
WALTER F. GEORGE
JIM WOODRUFF
SOUTHEASTERN POWER ADMINISTRATION
MARKETING SYSTEMS
Kerr-Philpott System
Jim Woodruff System
GA-AL-SC System
Cumberland System

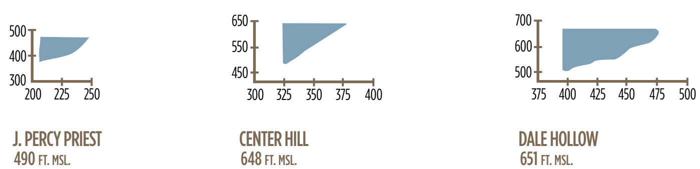
SOUTHEASTERN POWER ADMINISTRATION
CUMBERLAND SYSTEM

MONTHLY AVERAGE FLOW OF CUMBERLAND RIVER BELOW BARKLEY DAM



CUMBERLAND RIVER PROFILE





❶ BARKLEY DAM

INITIAL YEAR OF OPERATION
1966

GENERATING UNITS
4

SUMMER POOL
359 FT. MSL.

PLANT CAPACITY
148 MW

AVERAGE ENERGY
601,000 MWH

❷ CHEATHAM DAM

INITIAL YEAR OF OPERATION
1959

GENERATING UNITS
3

SUMMER POOL
385 FT. MSL.

PLANT CAPACITY
41 MW

AVERAGE ENERGY
163,000 MWH

❸ OLD HICKORY DAM

INITIAL YEAR OF OPERATION
1957

GENERATING UNITS
4

SUMMER POOL
444 FT. MSL.

PLANT CAPACITY
116 MW

AVERAGE ENERGY
470,000 MWH

❹ J. PERCY PRIEST DAM

INITIAL YEAR OF OPERATION
1970

GENERATING UNITS
1

SUMMER POOL
490 FT. MSL.

PLANT CAPACITY
30 MW

AVERAGE ENERGY
71,000 MWH

❺ CORDELL HULL DAM

INITIAL YEAR OF OPERATION
1973

GENERATING UNITS
3

SUMMER POOL
504 FT. MSL.

PLANT CAPACITY
114 MW

AVERAGE ENERGY
355,000 MWH

❻ CENTER HILL DAM

INITIAL YEAR OF OPERATION
1950

GENERATING UNITS
3

SUMMER POOL
648 FT. MSL.

PLANT CAPACITY
156 MW

AVERAGE ENERGY
370,000 MWH

❼ DALE HOLLOW DAM

INITIAL YEAR OF OPERATION
1948

GENERATING UNITS
3

SUMMER POOL
651 FT. MSL.

PLANT CAPACITY
62 MW

AVERAGE ENERGY
121,000 MWH

❽ WOLF CREEK DAM

INITIAL YEAR OF OPERATION
1951

GENERATING UNITS
6

SUMMER POOL
723 FT. MSL.

PLANT CAPACITY
312 MW

AVERAGE ENERGY
899,000 MWH

❾ LAUREL DAM

INITIAL YEAR OF OPERATION
1977

GENERATING UNITS
1

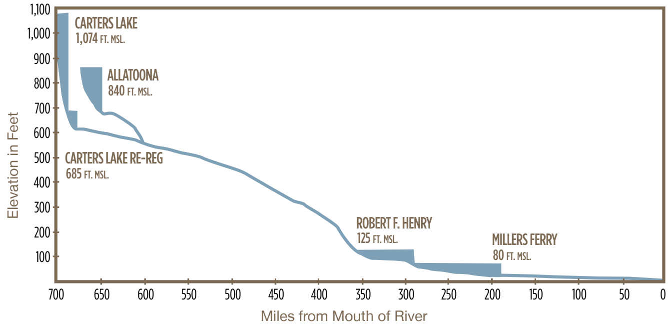
SUMMER POOL
1,018 FT. MSL.

PLANT CAPACITY
70 MW

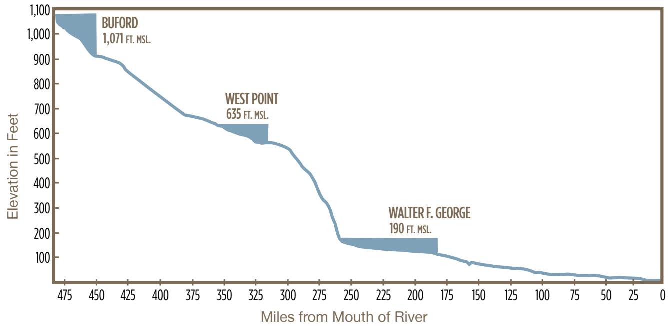
AVERAGE ENERGY
64,000 MWH

SOUTHEASTERN POWER ADMINISTRATION
GA-AL-SC SYSTEM

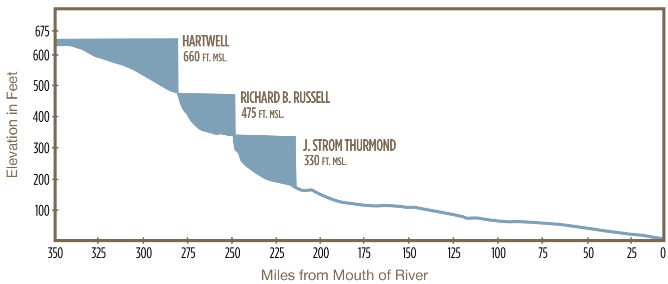
ALABAMA-COOSA RIVER PROFILE



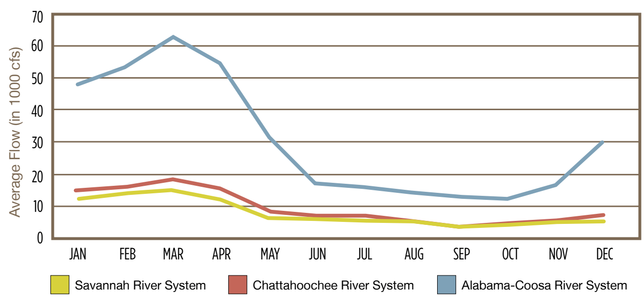
CHATTAHOOCHEE RIVER PROFILE

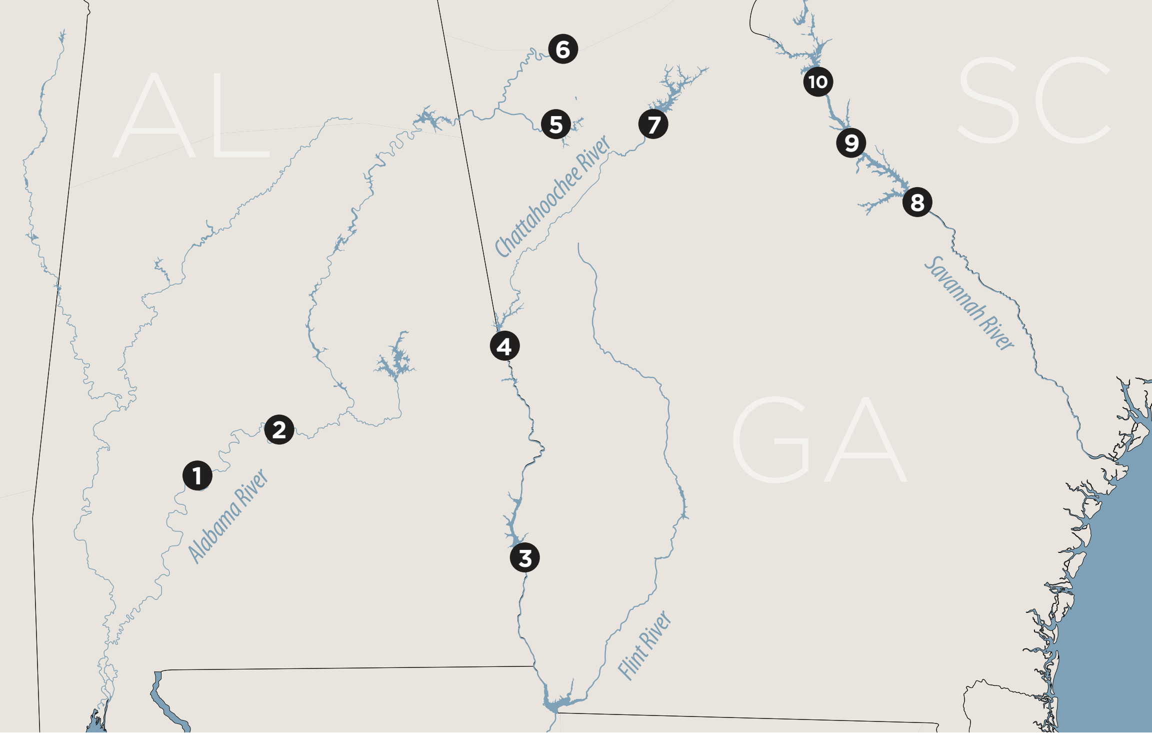


SAVANNAH RIVER PROFILE



MONTHLY AVERAGE FLOWS OF RIVERS BELOW LAST DAM





1 MILLERS FERRY DAM
INITIAL YEAR OF OPERATION
1970
GENERATING UNITS 3
SUMMER POOL 80 FT. MSL.
PLANT CAPACITY 90 MW
AVERAGE ENERGY 384,000 MWH

2 ROBERT F. HENRY DAM
INITIAL YEAR OF OPERATION
1975
GENERATING UNITS 4
SUMMER POOL 125 FT. MSL.
PLANT CAPACITY 82 MW
AVERAGE ENERGY 335,000 MWH

3 WALTER F. GEORGE DAM
INITIAL YEAR OF OPERATION
1963
GENERATING UNITS 4
SUMMER POOL 190 FT. MSL.
PLANT CAPACITY 168 MW
AVERAGE ENERGY 438,000 MWH

4 WEST POINT DAM
INITIAL YEAR OF OPERATION
1975
GENERATING UNITS 3
SUMMER POOL 635 FT. MSL.
PLANT CAPACITY 87 MW
AVERAGE ENERGY 202,000 MWH

5 ALLATOONA
INITIAL YEAR OF OPERATION
1950
GENERATING UNITS 3
SUMMER POOL 840 FT. MSL.
PLANT CAPACITY 82 MW
AVERAGE ENERGY 151,000 MWH

6 CARTERS DAM
INITIAL YEAR OF OPERATION
1975
CONVENTIONAL GENERATING UNITS 2
PUMP TURBINE UNITS 2
SUMMER POOL 1,074 FT. MSL.
PLANT CAPACITY 606 MW
AVERAGE ENERGY 405,000 MWH

7 BUFORD DAM
INITIAL YEAR OF OPERATION
1957
GENERATING UNITS 3
SUMMER POOL 1,071 FT. MSL.
PLANT CAPACITY 127 MW
AVERAGE ENERGY 186,000 MWH

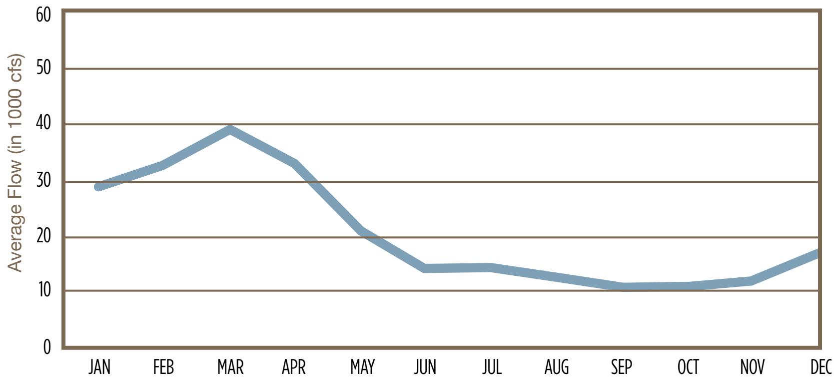
8 J. STROM THURMOND DAM
INITIAL YEAR OF OPERATION
1953
GENERATING UNITS 7
SUMMER POOL 330 FT. MSL.
PLANT CAPACITY 364 MW
AVERAGE ENERGY 707,000 MWH

9 RICHARD B. RUSSELL DAM
INITIAL YEAR OF OPERATION
1985
CONVENTIONAL GENERATING UNITS 4
PUMP TURBINE UNITS 4
SUMMER POOL 475 FT. MSL.
PLANT CAPACITY 664 MW
AVERAGE ENERGY 685,000 MWH

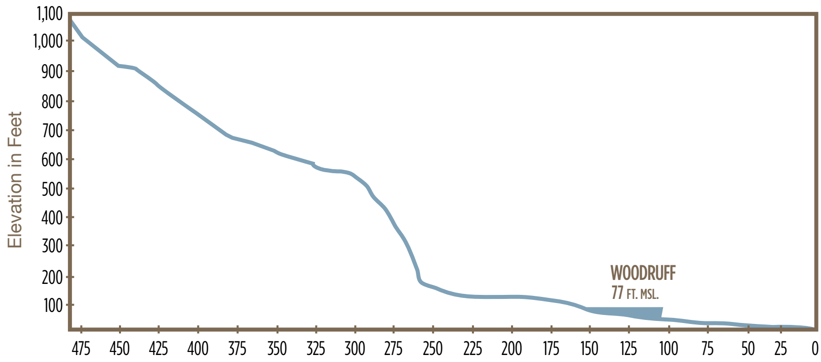
10 HARTWELL DAM
INITIAL YEAR OF OPERATION
1962
GENERATING UNITS 5
SUMMER POOL 660 FT. MSL.
PLANT CAPACITY 432 MW
AVERAGE ENERGY 470,000 MWH

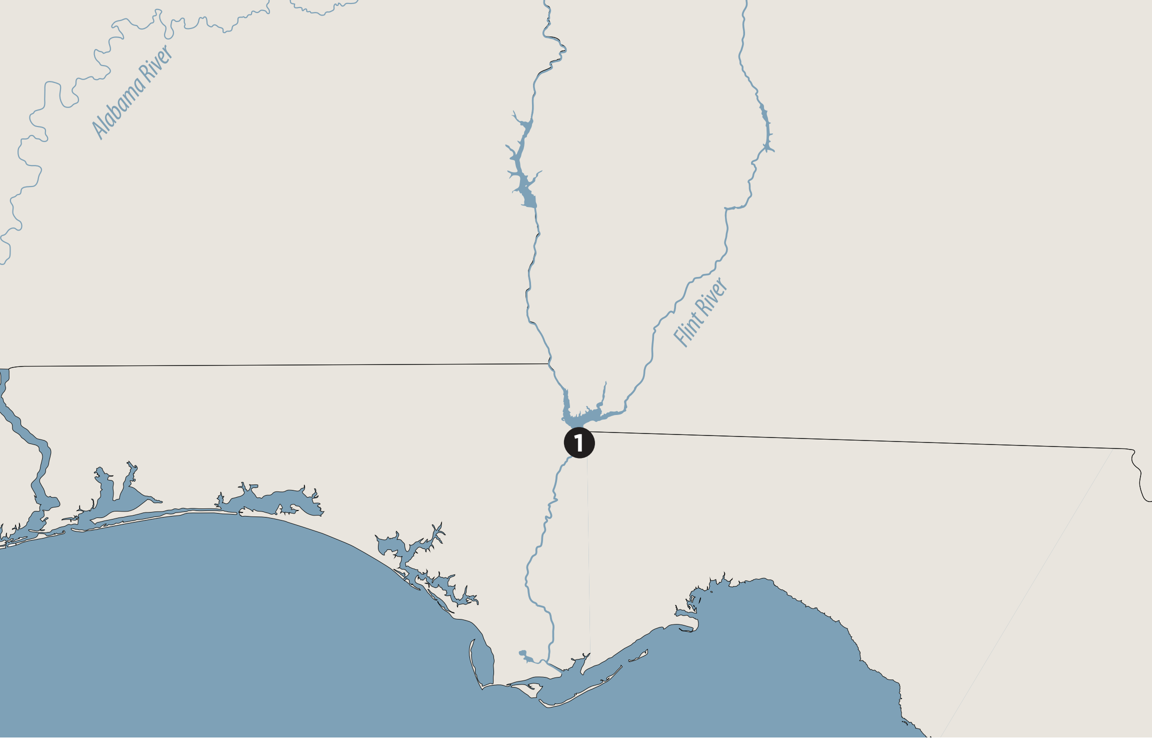
SOUTHEASTERN POWER ADMINISTRATION
WOODRUFF SYSTEM

MONTHLY AVERAGE FLOWS OF RIVERS BELOW WOODRUFF DAM



CHATTAHOOCHEE RIVER PROFILE





❶ JIM WOODRUFF DAM

INITIAL YEAR OF OPERATION
1957

GENERATING UNITS
3

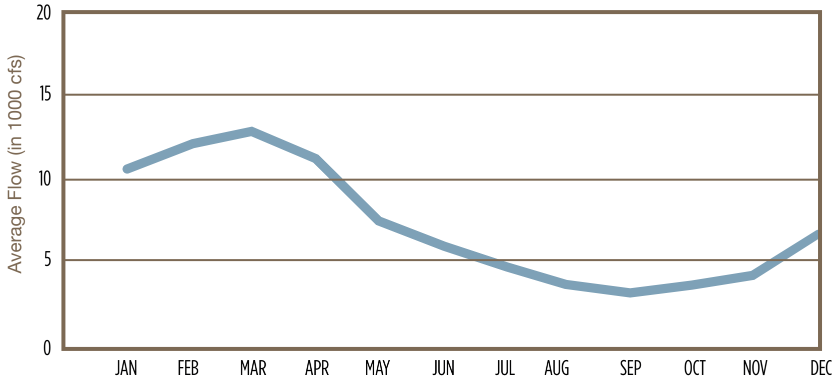
SUMMER POOL
77 FT. MSL.

PLANT CAPACITY
43 MW

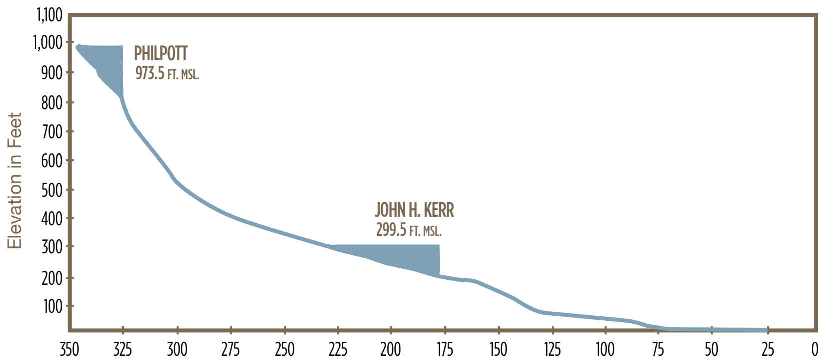
AVERAGE ENERGY
233,000 MWH

SOUTHEASTERN POWER ADMINISTRATION
KERR-PHILPOTT SYSTEM

MONTHLY AVERAGE FLOW OF ROANOKE RIVER BELOW JOHN H. KERR DAM



ROANOKE-DAN-SMITH RIVER PROFILE



1 JOHN H. KERR DAM

INITIAL YEAR OF OPERATION
1952

GENERATING UNITS
7

SUMMER POOL
299.5 FT. MSL.

PLANT CAPACITY
267 MW

AVERAGE ENERGY
437,000 MWH

2 PHILPOTT DAM

INITIAL YEAR OF OPERATION
1953

GENERATING UNITS
3

SUMMER POOL
973.5 FT. MSL.

PLANT CAPACITY
15 MW

AVERAGE ENERGY
25,000 MWH

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