United States General Accounting Office

GAO

Report to the Honorable
Butler Derrick, House of Representatives

June 1989

WATER RESOURCES

Corps of Engineers' Drought Management of Savannah River Projects

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GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-234347

June 12, 1989

The Honorable Butler Derrick
House of Representatives

Dear Mr. Derrick:

This report responds to your March 24, 1988, letter and subsequent discussions with your office regarding the U.S. Army Corps of Engineers Savannah District's management of the three Savannah River Basin reservoirs—Hartwell, Richard B. Russell, and J. Strom Thurmond—during the current drought, which began in July 1987. The report provides our analysis of how the district managed the reservoirs during the drought, the effects of the drought on the reservoirs' purposes, and the district's efforts to develop the required drought contingency plan for the three reservoirs.

Background

During the 1980s, drought conditions have been experienced nationwide. Last year's drought impacted waterborne traffic on the Mississippi River and reduced agricultural yields in the Midwest. Three droughts have occurred in the Savannah River Basin during the decade. The current drought is the most severe as measured by rainfall deficit and reduced inflows from groundwater and streams into the Savannah River.

The district operates three interconnected reservoir and dam projects in the upper reaches of the Basin for hydropower, flood control, fish and wildlife, recreation, water supply, and water quality purposes.[1] It manages the lakes as an integrated system to make the most complete practical use of the Basin's water resources. To limit the impact of droughts on the operation of the reservoir and dam projects, the district attempts to conserve water so the lakes can support all project purposes at degraded but acceptable levels. The district conserves water by restricting the release rate at Thurmond—the southernmost project—and by adjusting releases from Hartwell and Russell to maintain the desired balance between the three lakes. A 1980 Corps regulation requires all districts to develop drought contingency plans that contain an operating strategy that will guide their actions in response to periods of water shortages. (See app. I.)

[1]Our Office of General Counsel plans to issue a separate opinion on the Corps' basis for using each of the reservoirs for water supply purposes.

Results in Brief

The district managed the deteriorating rainfall conditions in the three reservoirs by gradually decreasing releases from Hartwell, Russell, and Thurmond in order to prolong its ability to meet downstream needs for water supply and water quality—the two purposes of highest priority to the district during the drought. Overall, the district has met the water supply and water quality needs, although the water release rate sharply reduced hydropower generation. In addition, the low lake levels, caused for the most part by the severe shortages of rainfall, seriously decreased recreational opportunities. We believe the Corps' decision to make water supply and water quality purposes the highest priorities appeared reasonable because, during extremely severe droughts, water supply and water quality meet a critical public need for which there is no readily available alternate source.

Because the Corps placed low priority on drought contingency plans, the district had not completed its required plan when the current drought began and did not have the benefit of a well-defined and planned course of action. The district began emphasizing the development of a drought contingency plan in January 1987. The plan, however, was not completed until March 31, 1989, more than 3-1/2 years after the target completion date. It is evident, however, that because the drought has been so severe, lake levels would have fallen over time and project purposes would have been impacted, even if the now completed plan had been followed since the onset of the drought.

Because of the importance of managing reservoirs under drought conditions, we reviewed the district's plan. The plan (1) was not based on data clearly showing a relationship between the needs of downstream users and the release rate purported to meet those needs, (2) did not adjust Thurmond's release rate to take into account downstream inflows for water supply needs, and (3) did not address what actions the district should take when the lake levels become insufficient to meet downstream water supply or water quality needs.

Drought Management

To decelerate the decline in lake levels in the early stages of the drought, the district reduced weekly average releases from the projects, cutting Thurmond releases from 7,800 cubic-feet-per-second (cfs) to 5,400 cfs in November 1987, to 4,700 cfs in January 1988, and to 3,600 cfs in April 1988. The district has maintained Thurmond releases at the 3,600-cfs rate since April 1988, in accordance with a key provision of the drought plan completed on March 31, 1989.

In spite of the district's efforts to minimize the effects of the drought, Thurmond and Hartwell levels were almost 17 and 15 feet below the top of their conservation pools,[2] respectively, by December 1988. By April 15, 1989, rainfall had raised both the Thurmond and Hartwell lake levels to about 9 feet below the top of their conservation pools but still lower than the lake levels were 1 year ago. Lake Russell remained within its 5-foot conservation pool throughout the drought.

Under normal operating conditions, the Corps can fulfill all project purpose requirements. However, in managing the three reservoirs during the extended, severe drought, the district established priorities among the equal, but in some cases, competing project purposes. The district gave water supply and water quality the highest priorities, and it attempted to manage the hydropower and recreation purposes so that both purposes would be similarly affected, rather than minimize the impacts to one purpose to the detriment of the other.

Drought Impacts

The district was not able to fully meet two of the four project purposes we reviewed.[3] According to district officials, the district continued to meet the water supply and water quality needs of inlake and downstream users. Water quality was marginally affected—Georgia recorded three minor violations in the summer of 1988. However, drought conditions severely affected the hydropower and recreation purposes that compete for use of the reservoirs' waters. Because of reduced releases, the district was unable to generate sufficient hydropower to satisfy the Southeastern Power Administration's (SEPA) contractual obligations. SEPA, the agency that markets Corps hydropower, had to purchase power from alternative sources. The low lake levels also drastically affected water-dependent recreational facilities at Lakes Thurmond and Hartwell, and the public's visits to all three projects were curtailed. (See app. II.)

[2]The conservation pool represents that portion of each reservoir's storage that can be released downstream during periods of droughts. The top of conservation pool is the designated full reservoir lake level, and the bottom of conservation pool is the lake level when the conservation pool storage is depleted.

[3]We did not review the navigation, flood control, and fish and wildlife purposes because (1) commercial navigation is no longer conducted upstream of the Savannah Harbor, (2) flood control is not a concern during drought management, and (3) fish and wildlife were not significantly affected by the drought.

Delays in Drought Plan Development

The district had not yet completed a drought management plan when the current drought began in July 1987. Before January 1987 the district gave low priority to developing the drought contingency plan required by the 1980 regulation because the district viewed droughts as sporadic and short term. As such, the district allocated few resources toward completing a drought contingency plan. Drought planning efforts prior to 1987 generally were reactions to the two drought periods that occurred earlier in the decade—1980-81 and 1985-86—and were not aimed at developing the required drought plan.

The district began placing additional emphasis on developing a drought contingency plan in January 1987. Work to meet the December 1987 target completion date, however, was delayed several times because of resource constraints. As a result, when the district took its first drought response action in November 1987 by reducing Thurmond releases, a drought plan had not yet been completed. The district completed its drought plan on March 31, 1989, 8-1/2 years after the regulation requiring the plan's development was issued and 3-1/2 years after the target completion date set by Corps headquarters. The plan details the district's operating strategy of using the reservoirs' existing storage in response to drought periods and outlines procedures for coordinating drought management decisions with public, state, and local officials. Had the district managed the drought using the now completed drought contingency plan, district officials estimate that Lake Thurmond would have been as much as 3.4 feet higher and Lake Hartwell as much as 2.5 feet higher during the 1988 recreation season. Although the higher lake levels would have improved conditions for recreation, hydropower generation during the 1987 fall months would have been reduced.

Drought planning in other Corps districts nationwide is languishing. According to Corps headquarters officials, plans for two-thirds of Corps water resource projects for which drought contingency plans are required have not been completed as of March 1989. (See app. III.)

Drought Plan Not Based on Key Data

The major provision of the drought plan—to release no less than 3,600 cfs from Lake Thurmond to meet downstream user water supply needs—is based principally on the needs of the Department of Energy's Savannah River Site. The plant produces military grade nuclear products. A 1981 study by the Savannah River Site showed it required a streamflow of 3,300 cfs at the plant's intakes, about 81 miles downstream of Thurmond. The district determined that to meet this need, a release rate of

3,600 cfs from Lake Thurmond was necessary. The district told downstream water users that 3,600 cfs was the lowest release rate the users could expect from Thurmond. When the district surveyed the needs of Savannah River Basin users in 1986, the survey results, in the district's view, did not provide a basis to change the release rate of 3,600 cfs.

In preparing the drought plan, the district did not develop data that clearly supported a release rate necessary to meet such objectives as providing users with sufficient streamflows to meet water supply needs and maintain water quality standards, even though meeting water supply and water quality needs are key provisions of the plan. Also, the district did not adjust its determination of Thurmond's release rate for downstream water supply requirements to account for downstream inflows, which historically have been relatively constant and reliable. According to a district estimate, had the district adjusted for a hypothetical 300-cfs volume of downstream inflows when it reduced Thurmond's release rate to 3,600 cfs in mid-April 1988, the lake level at Lake Thurmond would have been 2.6 feet higher by December 31, 1988.[1] Higher lake levels would have given the district the opportunity to conserve additional water and to increase its ability to meet water supply and water quality needs for a longer period.

Further, the plan does not address what actions the district should take if drought conditions so deteriorate that the remaining reservoir storage cannot sustain downstream water supply and water quality requirements. It states that releases would equal reservoir inflows. For example, the plan does not address how water supply priorities should be set among users, nor how communities or industries along the river might need to limit wastewater discharges to protect water quality.

The South Atlantic Division Commander concurred with our position that the district managed the drought without the benefit of a completed drought plan and that in determining Thurmond's release rate, the district should consider all downstream user needs and the feasibility of adjusting the rate for downstream inflows. In addition, the Commander agreed with us that a drought contingency plan should address the Corps' management actions when lake levels drop below the bottom of conservation pool and minimum user needs can no longer be met.

[1]U.S. Geological Survey data at the gauge 50 miles below Lake Thurmond showed that inflows averaged well over 300 cfs between April and December 1988 based on last week of month weekly average data. (See table III.1.)

Conclusions

The district managed the drought by balancing the competing demands of the recreation and hydropower purposes, while minimizing the drought's effects on water quality and water supply. Because of the severity of the drought in the Savannah River Basin, lake levels would have gradually declined and project purposes would have been impacted, regardless of whether the district had managed the reservoirs with the benefit of a completed drought contingency plan.

The droughts that have occurred in the nation over the past 2 years make it essential for the Corps to be prepared to most effectively manage its projects under drought conditions by following well-developed and thought-out plans. The district's drought plan was not based on a thorough determination of the water supply needs of all downstream users in terms of minimum required streamflows, and it did not adjust Thurmond's release rate to account for downstream inflows when calculating the release rate necessary to meet these water supply needs. Also, the plan does not provide guidance as to the actions the district needs to take in an extremely severe drought or worst-case situation. Drought contingency plans would be more useful if they contained a strategy for extremely severe or worst-case situations, defined the Corps' role and responsibilities during these conditions, and provided overall guidance on critical water use priorities for such situations.

Recommendations

In order for the district to be better prepared to manage drought conditions in the Savannah River Basin, we recommend that the Assistant Secretary of the Army (Civil Works) require the Chief Engineer of the Corps to improve the Savannah District's drought contingency plan by ensuring that the plan (1) is based on thoroughly documented and current water supply needs, (2) includes downstream inflows in determining releases from the projects, and (3) includes actions to be taken in worst-case situations. Further, so that the Corps is prepared nationwide to better manage ongoing and future drought situations, we recommend that the Assistant Secretary direct the Chief Engineer to assure that each district have drought contingency plans for all controlled reservoir storage projects, and that the plans are based on a thorough analysis of user needs, adjust release rate calculations to account for downstream inflows, and include worst-case situation plans.

Scope and Methodology

To obtain information on the Corps' management of Lakes Hartwell, Russell, and Thurmond during the current drought and its efforts to develop a drought contingency plan, we interviewed Corps officials in

the South Atlantic Division and Savannah District offices. We reviewed authorizing legislation for the three projects, documents and reports on the Corps' drought management actions, and the draft and final drought contingency plans. We also interviewed Georgia and South Carolina state water management officials and representatives of the Southeastern Power Administration, and toured the three lakes. (See app. IV.)

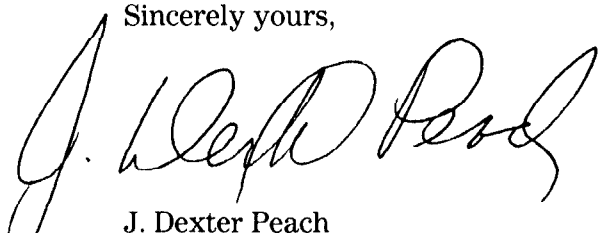
Agency Comments

We discussed the information in the report with Corps officials at headquarters, division, and district levels and made changes where appropriate. As requested, however, we did not obtain official agency comments on a draft of this report.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the Secretary of Defense, the Secretary of the Army, and other interested parties.

This work was performed under the direction of James Duffus III, Director, Natural Resource Management Issues. Major contributors to this report are listed in appendix V.

Sincerely yours,



J. Dexter Peach
Assistant Comptroller General

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Abbreviations

cfs	cubic-feet-per-second
SEPA	Southeastern Power Administration
USGS	U.S. Geological Survey

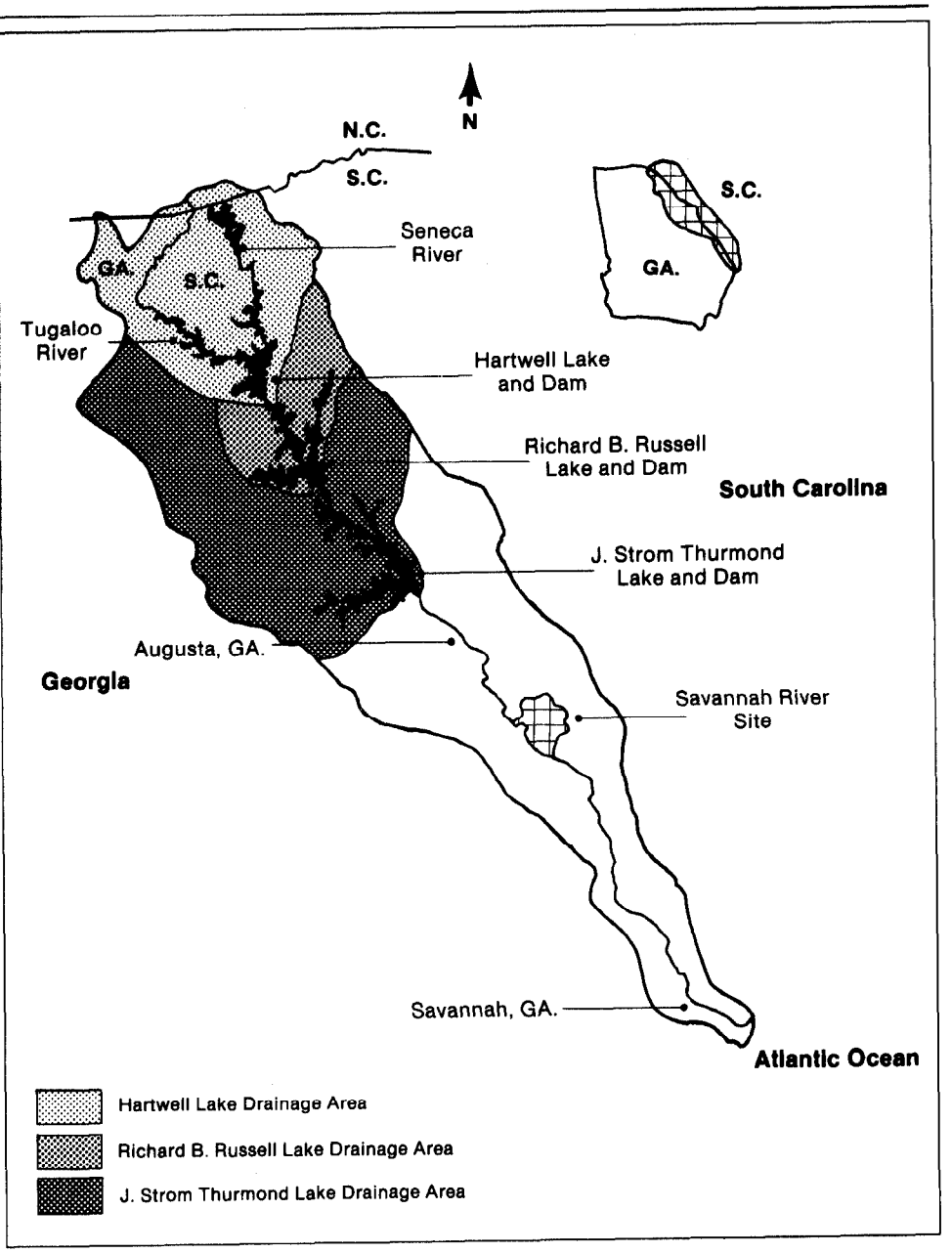
Background

Since 1980 the Savannah River Basin has suffered through three severe droughts. The most recent of these droughts began in July 1987 and continues today. It is now considered the most severe drought the Basin has ever experienced in terms of rainfall shortages and deficits of inflows from streams, rainfall, and groundwater into the three reservoirs' drainage areas. From July 1987 through December 1988, rainfall in the reservoirs' drainage areas was 28 inches below normal and inflows were 60 percent below normal.

Savannah River Basin Projects

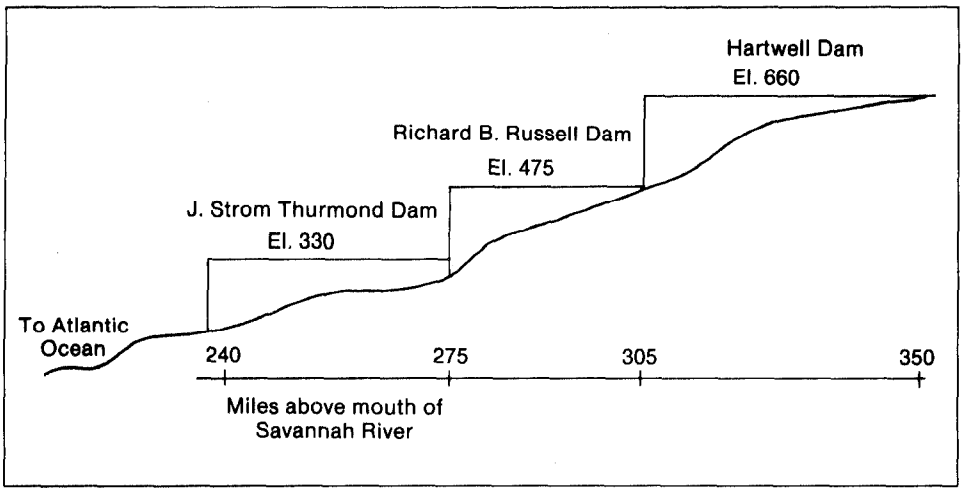
The Savannah River Basin, a long and relatively narrow basin, has a total area of 10,577 square miles, of which 175 are in North Carolina, 4,581 in South Carolina, and 5,821 in Georgia. Two principal streams, the Seneca and Tugaloo Rivers, join near Hartwell, Georgia, to form the Savannah River. From this point, the Savannah flows about 300 miles south-southeasterly and discharges into the Atlantic Ocean just below Savannah, Georgia. On the upper Savannah River, the Corps built and operates three multipurpose projects that form a chain of lakes stretching 120 miles. Hartwell Lake and Dam is the northern-most project, followed by Russell Lake and Dam, and Thurmond Lake and Dam. (See figs. I.1 and I.2.) Table I.1 shows the geographic characteristics of each project.

Figure I.1: Savannah River Basin Projects and Reservoir Drainage Areas



Source: Corps of Engineers.

Figure I.2: Crossview of the Savannah River Basin Projects Showing Interconnections (Lake Levels in Feet Above Mean Sea Level)



Source: Corps of Engineers.

Table I.1: Geographic Characteristics of Lakes Hartwell, Russell, and Thurmond at the Top of Conservation Pool

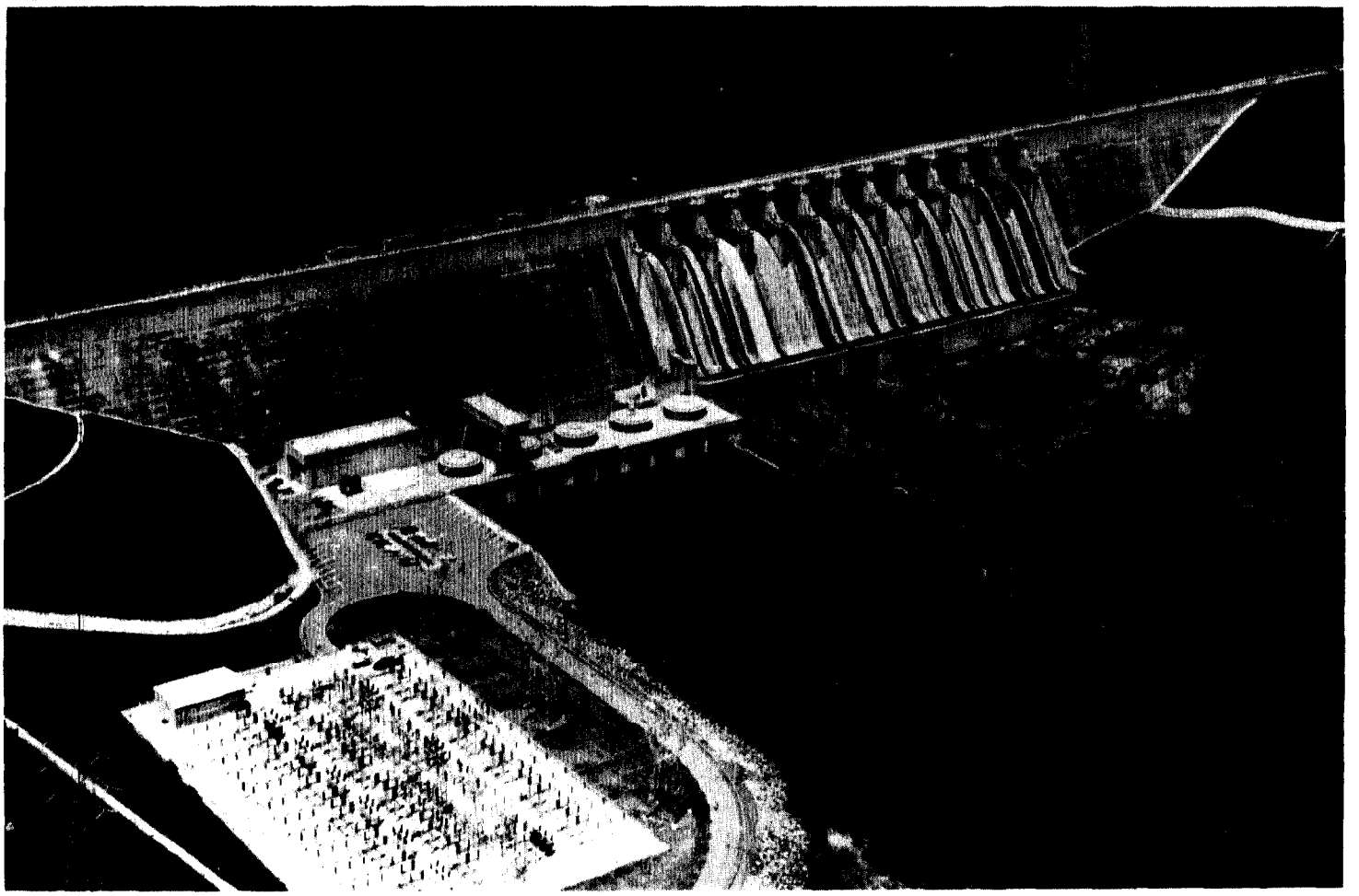
Project name	Date completed	Area covered (Acres)	Miles of shoreline	Drainage area sq.mi.	Conservation storage (Acre Ft)[a]
Hartwell	1962	55,950	982	2,088	1,416,000
Russell	1985	26,650	542	2,837	126,800
Thurmond	1954	70,000	1,200	6,144	1,045,000

[a]An acre foot is the quantity of water required to cover 1 acre to a depth of 1 foot.

Nine municipalities and industries use Hartwell, five use Russell, and six use Thurmond as their source of water supply. The downstream users that depend on Thurmond for their water supply needs include the cities of Augusta and Savannah, Georgia; the Department of Energy's Savannah River Site, which produces military grade nuclear products; Plant Vogtle (a privately operated nuclear power plant); and a major paper products manufacturing plant.

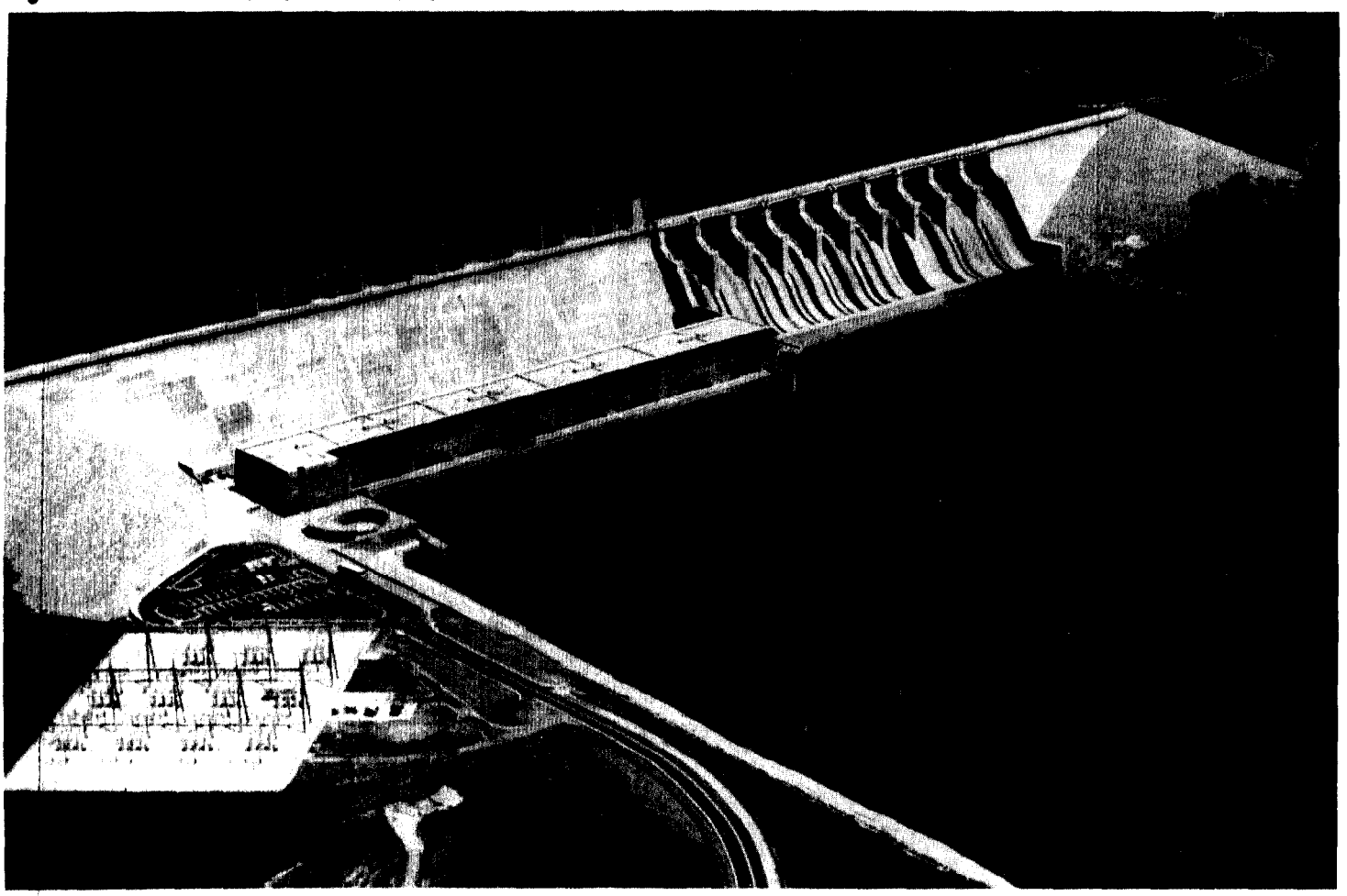
In addition, the projects generate hydropower marketed by the Department of Energy's Southeastern Power Administration (SEPA). The projects generate hydropower when water released from reservoirs passes through hydropower turbines. Hartwell has five hydroelectric turbines capable of producing 344 megawatts; Russell has four operating turbines with a 300-megawatt capacity; and Thurmond has seven turbines capable of generating 280 megawatts. Figures I.3, I.4, and I.5 show the hydropower facilities at the three projects.

Figure I.3: Hartwell Lake and Dam



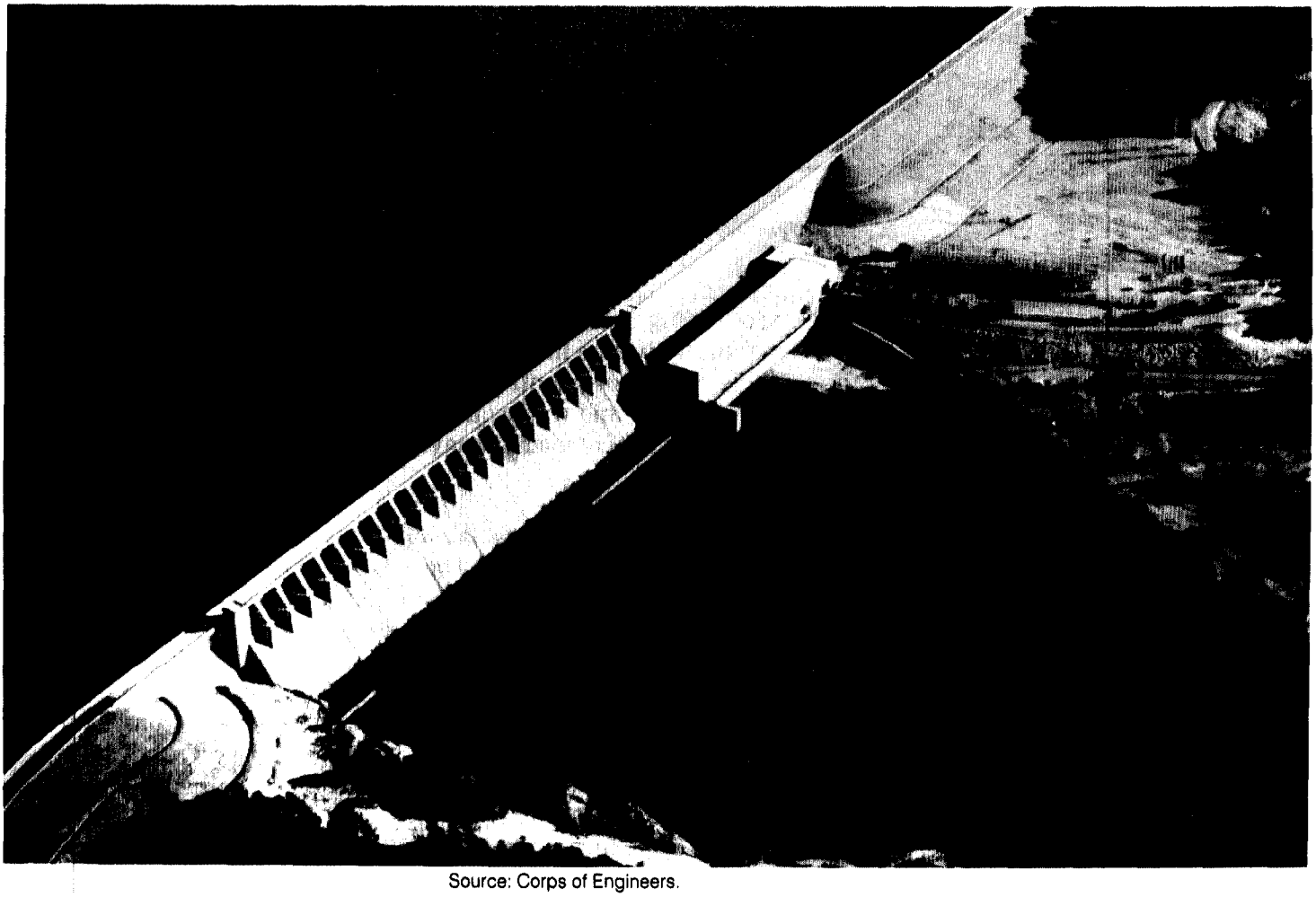
Source: Corps of Engineers.

Figure I.4: Richard B. Russell Lake and Dam



Source: Corps of Engineers.

Figure I.5: J. Strom Thurmond Lake and Dam



Source: Corps of Engineers.

Droughts in the 1980s

The first drought in the Savannah River Basin began in June 1980 and ended in December 1981. The second drought occurred between December 1985 and October 1986. The current drought began in July 1987 and continues today. These droughts created severe water shortages in the Savannah River Basin. Table I.2 shows the lowest levels the lakes reached during the two earlier droughts, as well as the current drought through April 30, 1989.

Table I.2: Lowest Lake Levels at Lakes Hartwell, Russell, and Thurmond During the Past Three Droughts. (Lake Levels in Feet Above Mean Sea Level)

Lake	Top of conservation pool	1980-81	1985-86	Current drought[a]	Bottom of conservation pool
Hartwell	660	642.4	646.3	645.4	625
Russell	475	[b]	470.0	470.0	470
Thurmond	330	317.5	316.4	312.9	312

[a]Lowest lake levels through April 30, 1989.

[b]Russell was not filled until 1985.

Corps Management Responsibility for the Three Projects

The Corps of Engineers' Savannah District, under the command of the South Atlantic Division in Atlanta, manages the three upper Savannah River projects for flood control, hydropower, fish and wildlife, recreation, water supply, and water quality. The Corps no longer manages the Savannah River for commercial navigation upstream of the Savannah Harbor.

The district operates the three Savannah River Basin projects as a mutually interrelated system to make the most complete practical use of the Basin's water resources. Under normal rainfall and inflow conditions, the Corps can fulfill project purpose requirements. Under these conditions, sufficient water is available to maintain high lake levels for recreational use during the summer and generate the hydropower needed to meet SEPA contractual commitments. Under normal conditions Thurmond releases are more than ample to meet water supply needs and state water quality standards.

The district's operating strategy calls for Hartwell and Thurmond to be maintained as near as possible to the top of conservation pool (also referred to as full summer pool) from April 18 for Hartwell and May 1 for Thurmond through mid-October.[1] Beginning in mid-October, the district lowers Hartwell and Thurmond lake levels 4 feet to accommodate expected higher inflows caused by heavy winter and spring rainfall. The top of conservation pool level less this 4 feet is the full winter pool.

For Russell, the district maintains its level as near as possible to the top of its conservation pool year round. Designed with a shallow 5-foot conservation pool, Russell is primarily a flow-through project, capturing

[1]The conservation pool represents that portion of each reservoir's storage that can be released downstream during periods of drought. The top of conservation pool is the designated full reservoir lake level, and the bottom of conservation pool is the lake level when the conservation pool storage is depleted.

Hartwell releases, and generating hydropower as it releases water into Thurmond. If the lake levels fall below the bottom of the conservation pool for any of the three projects, the district's ability to generate capacity hydropower, which is energy power available on demand, is impeded and damage to the hydropower turbines can result.

During droughts, the district attempts to mitigate and balance drought impacts among all project purposes but assigns a higher priority to water quality and water supply because they meet a critical public need with no readily available alternate source. The district's ultimate objective is to conserve the water in the conservation pools so that the lakes will have sufficient water to support project purposes at degraded, but acceptable levels, during a drought no worse than the most severe drought recorded for the Savannah River Basin.

The district manages the water in the three-project chain in terms of cubic-feet-per-second (cfs) release rates at Thurmond. As the southernmost project, Thurmond releases dictate, to a large degree, the quantity and quality of water in the Savannah River between Thurmond and Savannah, Georgia. When Thurmond releases are reduced, the district also adjusts releases from Hartwell and Russell to maintain the desired balance between the three lakes.

District's Management of the Current Drought and the Drought's Effects on Project Purposes

The three lakes fully recovered from the 1985-86 drought, returning to their full conservation pool levels by March 1987. This condition was short-lived since drought conditions began 4 months later. The effects of this drought were still being felt as of April 1989.

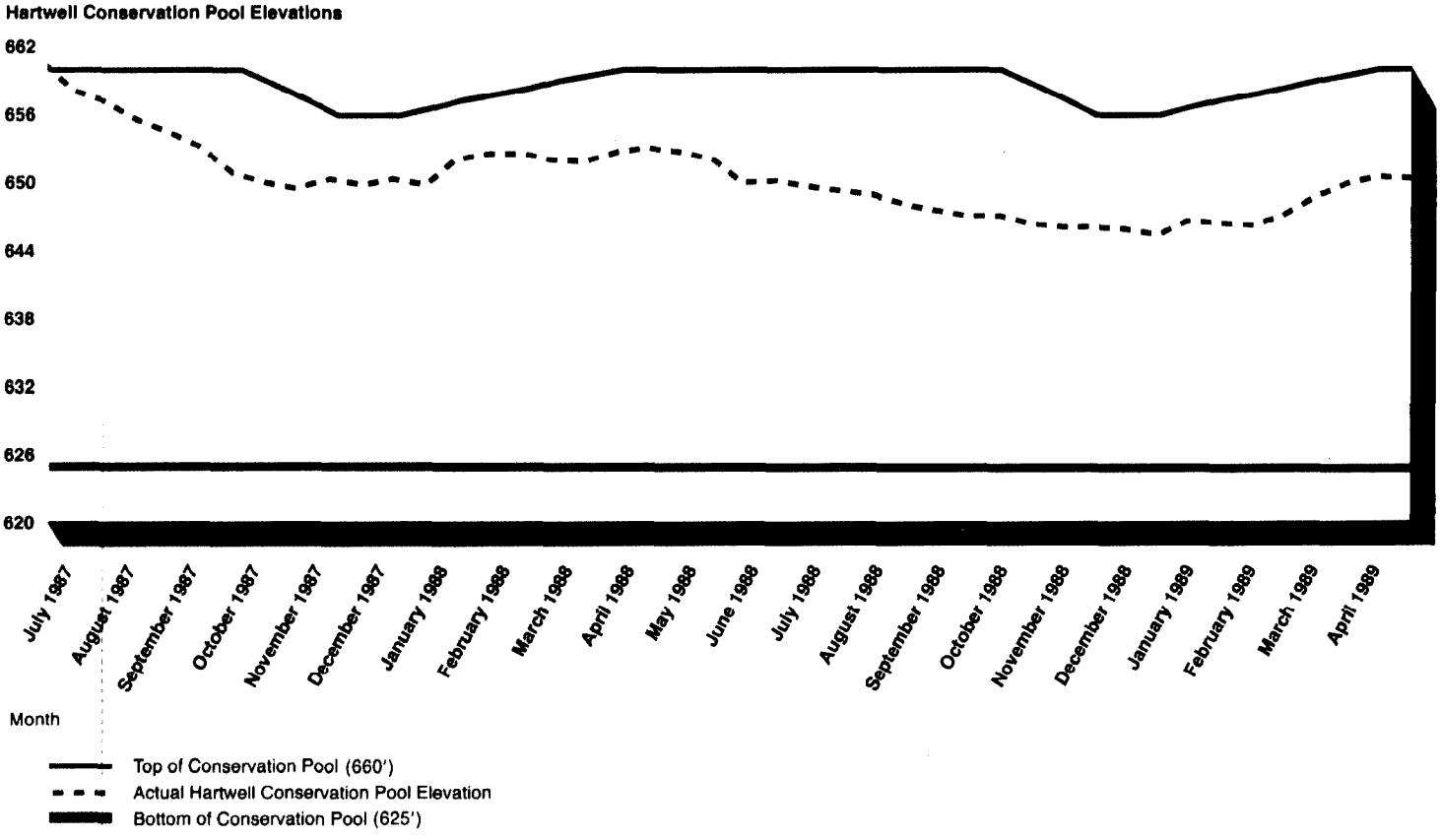
As drought conditions developed in the Basin in July 1987, Hartwell and Thurmond lake levels soon began declining again. From July through December 1987, the Basin rainfall deficit totaled almost 9 inches, which was 37 percent below normal, and inflows were 57 percent below normal.

Basin drought conditions continued through 1988, with the Basin rainfall deficit slightly over 19 inches, or 35 percent below normal for the year. Inflows for 1988 were 61 percent below normal. At the end of 1988, Thurmond was almost 17 feet below the top of its conservation pool, and Hartwell was almost 15 feet below the top of its conservation pool. Beginning in July 1987, through December 1988, the Basin's rainfall deficit totaled 28 inches, or 36 percent below normal.

By April 15, 1989, rainfall had raised Thurmond and Hartwell lake levels to about nine feet below the top of their conservation pools, which was still lower than 1 year ago. Inflows from January 1, 1989, through April 15, 1989, were 44 percent below normal, and the rainfall deficit totaled 5.1 inches, or 28 percent below normal.

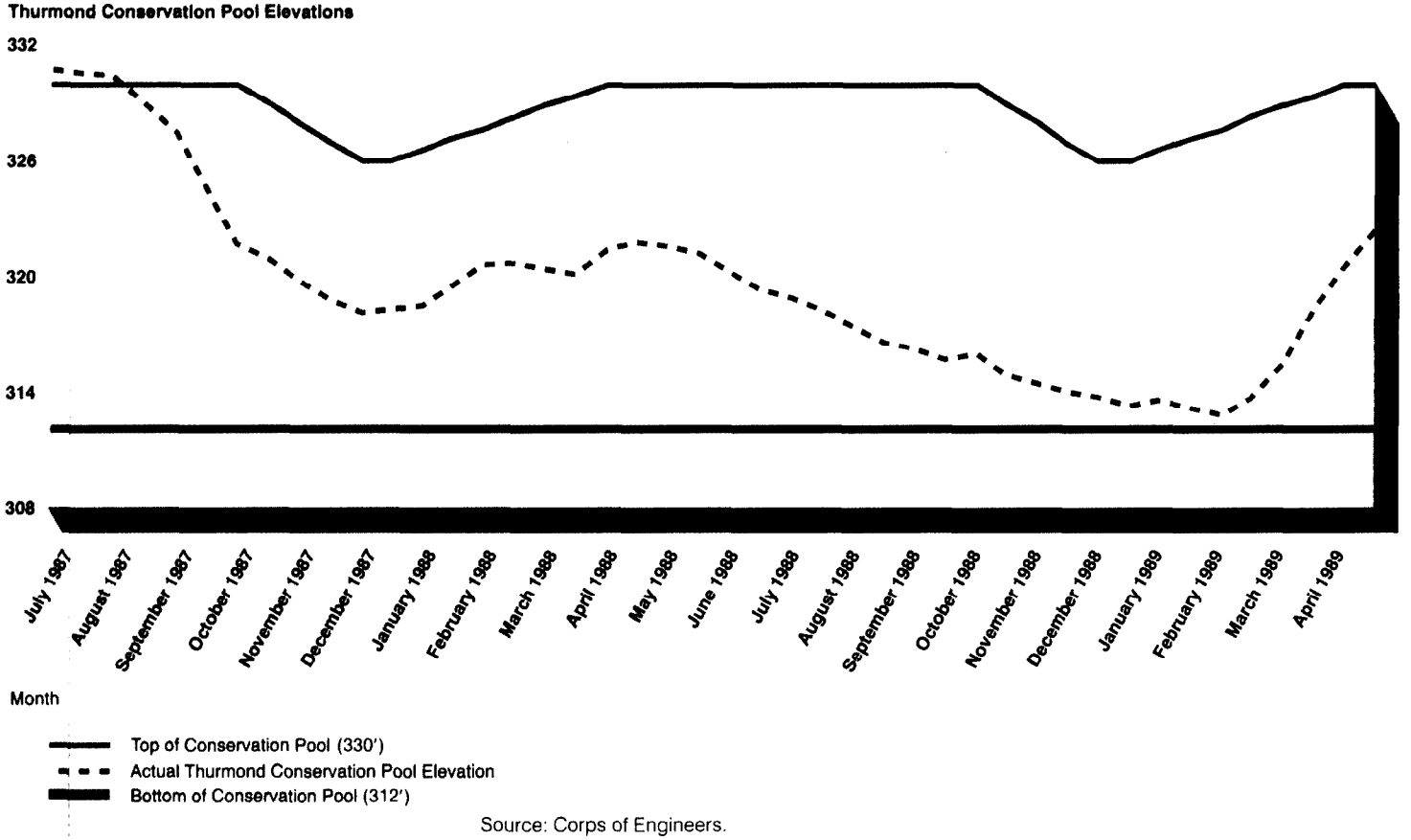
Figures II.1 and II.2 show the effect of the drought on lake levels at Lakes Hartwell and Thurmond between July 1987 and April 1989.

Figure II.1: Lake Level at Lake Hartwell During the Current Drought in Feet Above Mean Sea Level



Source: Corps of Engineers.

Figure II.2: Lake Level at Lake Thurmond During the Current Drought in Feet Above Mean Sea Level



Source: Corps of Engineers.

Corps Management of the Drought in 1987

Hartwell and Thurmond, both above the top of their conservation pools at the onset of the drought, remained full through July 21 and August 20, respectively. Russell remained near the top of its conservation pool through mid August. Because of the projects' high lake levels, the district in August 1987 increased releases in order to make up hydropower deficits from the three Apalachicola/ Chattahoochee/Flint Basin

projects,[1] part of the Georgia/Alabama system,[2] which were experiencing drought conditions and unable to generate the power needed to meet their scheduled SEPA allocation.

The lake levels began dropping rapidly because of the releases for hydropower and the continuing drought conditions. By mid-October, Hartwell and Thurmond were below the top of their conservation pools by about 9 feet and 8 feet, respectively. Russell's lake level fell to 2-1/2 feet below the top of its conservation pool.

On October 20 the district informed its division that the Savannah River projects could not continue to generate sufficient hydropower to meet SEPA contractual commitments and still have a reasonable chance of refilling in 1988. Increasingly concerned with the deteriorating situation and in an effort to conserve water, the district in November reduced Thurmond releases, which had averaged 7,800 cfs to 5,400 cfs and also reduced Hartwell and Russell releases.

The district presented the plan to Georgia and South Carolina water management officials and SEPA on October 28, 1987. SEPA officials objected to the plan because they did not believe the hydrologic conditions warranted the reductions, and they were concerned that the reduced releases would prevent them from meeting contractual commitments. Despite SEPA objections, the district implemented the plan on November 7, 1987.

By making the cutback in November, district officials believed they would minimize the impact to recreation should the drought continue and protect future water supplies needed by municipalities and industries. The district projected that by reducing Thurmond releases to 5,400 cfs in November, and assuming that inflows would average 95 percent of normal, Hartwell and Thurmond lake levels would be 4 feet higher and the lake level at Russell would be 2 feet higher by the end of April 1988. In May 1988, according to a district official, the decision to reduce releases in November was consistent with plan objectives to minimize the impacts of low streamflows on all users, generate essential hydropower for a minimum of 2 hours, maximize to the fullest extent possible

[1]The Apalachicola/Chattahoochee/Flint River Basin is comprised of three Corps projects—Buford, West Point, and W.F. George.

[2]The Georgia/Alabama system is comprised of 10 Corps projects in or bordering Alabama and Georgia.

all project benefits, operate the system to conserve water, and balance the lake levels of all three reservoirs to the extent possible.

The November reduction was not sufficient to prevent the lakes from further declining under the deteriorating drought conditions. By the end of December 1987, the Basin rainfall deficit for the year was 11.7 inches, 8.9 inches of which had accumulated since June, the last month of normal Basin rainfall. Hartwell, Russell, and Thurmond lake levels fell to about 10 feet, 4 feet, and 12 feet, respectively, below the top of their conservation pools.

Corps Management of the Drought in 1988

In early January 1988, the district again reduced releases from all three lakes, Thurmond to 4,700 cfs, and Hartwell and Russell to about 2,900 cfs and 3,100 cfs, respectively. District officials told us in August 1988 that they made this decision because the Savannah River below Augusta was getting above-normal inflows, which they expected to continue, and because the reduction would have no noticeable impact on the quantity and quality of water in the river. According to the officials, since mid-December 1987, they also had been able to generate sufficient hydropower to meet SEPA contractual obligations. Projects in the basin for the Apalachicola/Chattahoochee/Flint Rivers generated sufficient power to make up any deficit resulting from the three Savannah River Basin projects' reduced releases, according to district officials.

In spite of increased rainfall during the first 2 months of 1988, inflows to the reservoirs were 42 percent below normal by the end of February. Although Thurmond and Hartwell lake levels recovered slightly during this period, district officials told us the probability that the lakes would refill to the top of conservation pool by summer was very small unless further reductions were made.

The district discussed the prevailing drought conditions during a March 3, 1988, meeting of the Savannah River Basin Drought Coordination Committee.[4] Concerned with the lakes' conditions and the possibility that spring rains would not materialize to refill the lakes, the district convened an emergency meeting of the committee on March 25, 1988, to present its plan to further reduce Thurmond releases to 3,600 cfs. South

[4]Established in December 1987, the committee consists of the Corps' Savannah District Chief of the Engineering Division and Chief of the Hydrology and Hydraulics Branch, and representatives from the South Carolina Water Resources Commission and the Georgia Department of Natural Resources. The Corps uses the committee to obtain feedback on its planned drought management actions.

Carolina and Georgia officials, along with SEPA representatives, supported the plan. Several months later, however, Georgia officials expressed concern that if the drought continued, releases of 3,600 cfs might not be sufficient to maintain water quality standards because the river's ability to assimilate waste deteriorates during a long drought.

The district began releasing an average of 3,600 cfs from Thurmond on April 16, 1988, and has maintained this rate through April 1989. Hartwell and Russell releases were reduced to about 2,100 cfs and 2,300 cfs, respectively.

Drought Effects on Project Purposes

Legislation authorizing the three Savannah River Basin projects does not prioritize project purposes. During severe droughts, however, the district cannot manage the projects to equally satisfy all project purposes because some project purposes conflict with one another as lake levels decline. For example, keeping the lakes at or near the top of the conservation pool for the recreation purpose conflicts with the release requirements to generate hydropower and meet water supply needs of downstream users. The district's ability to generate the desired amount of hydropower is restricted when releases are reduced to conserve water.

The district's management of the three projects during 1987 and 1988 affected the extent to which they satisfied project purposes. Overall, water supply user needs and water quality standards were generally met. Hydropower generation, however, declined as the district reduced releases from all three projects and SEPA had to purchase power to meet its contractual obligations. Recreational opportunities for swimming and boating diminished because of the low lake levels.

Water Supply Needs Are Being Met

The Savannah River and the three Corps lakes through which it flows are the source of water for 64 municipal and industrial users. District officials advised us that the water supply needs of both inlake and downstream users had been met as of December 1988. Meeting water supply needs was the district's first priority in managing water releases during the drought. A weekly average release rate of 3,600 cfs from Thurmond is the amount the district determined as the minimum necessary to meet downstream water supply needs.

The Savannah River Site manager, however, has indicated that higher release rates will be necessary to meet its future needs. In response to its

1981 low streamflow study, the plant officials advised the district that streamflows of 3,300 cfs at the plant's intakes were necessary to operate its reactors. In April 1988, however, the plant manager told the district that 4,880 cfs are needed to operate its three reactors. Since August 1988 no reactors have operated because of safety concerns, but plans are to issue a restart implementation plan for the reactors in the near future. The district advised us that it would not increase releases from Thurmond to accommodate the plant's needs unless directed by higher Corps authorities. According to district officials, increasing the release rate above 3,600 cfs would jeopardize the district's ability to meet future water supply needs of all users if the drought continues.

Water Quality Requirements Have Generally Been Met

Through December 1988, in accordance with the district's emphasis on water quality, the quality of the water in the three reservoirs and the river below Thurmond has generally met Georgia's and South Carolina's water quality standards. These standards are based on the federal Clean Water Act. Each month Georgia and South Carolina sample water to determine if it meets established standards for dissolved oxygen, water temperature, bacteria, phosphorus, and toxic wastes. On a quarterly basis, each state performs a more intensive review, testing for additional pollutants. The district also continuously monitors releases from Thurmond, Russell, and Hartwell to ensure that water in the reservoirs meets state standards for several parameters, including dissolved oxygen, temperature, and phosphorus.

Georgia officials detected three minor water quality violations in June and August 1988—the dissolved oxygen count was two-tenths of a percent below the state requirement in two instances and one-tenth of a percent in the other instance.

Releases from Thurmond can affect the extent of saltwater intrusion into the Savannah Harbor from the Atlantic Ocean. As of December 1988, saltwater intrusion had not threatened the industrial and municipal freshwater intakes of Savannah, Georgia. Officials from the Savannah Wildlife Refuge, located just above the mouth of the Savannah River, raised concerns with the district that saltwater intrusion in impounded areas of the refuge may have been caused by low streamflows. As of December 1988, the district had not developed data confirming that low river streamflows may have caused the intrusion problem.

South Carolina and Georgia officials are concerned that Thurmond releases averaging 3,600 cfs may not be sufficient to meet water quality standards and offset the continuing general deterioration of water quality resulting from the prevailing drought. Georgia officials are also concerned that continued releases of 3,600 cfs may inhibit their ability to issue additional wastewater permits, thereby limiting future development of the Basin.

Hydropower Production Limited Because of Low Lake Levels

SEPA markets hydropower generated by Corps projects in the southeastern United States. The three Savannah River projects join with seven other Corps projects to form the Georgia/Alabama system. SEPA estimates how much hydropower the system can collectively produce on a reliable basis and negotiates contracts every 5 years with its customers—private power companies and public utilities—that specify the quantities of energy it will provide to each customer and at what cost.

SEPA considers each project's design and historical hydrologic data to determine how much hydropower it can reliably market. SEPA is prepared to purchase energy from other power companies when drought conditions prevent the system from collectively generating the contracted hydropower. The revenue from the sale of hydropower is used to retire, over 50 years, that portion of each project's construction debt allocated to hydropower.

SEPA contracts with its customers to deliver hydropower in two ways — energy power and capacity power. Energy power is the hydropower sold to customers and is commonly referred to in kilowatt hours of electricity. Capacity power is a specific portion of energy power available on demand at a given point in time. Because of its demand availability, capacity is much more expensive than energy. During fiscal year 1987, SEPA received $59.1 million from the sale of capacity power and $13.6 million from the sale of energy power.

The Corps' hydropower generation has enabled SEPA to fulfill its contractual commitments for Georgia/Alabama system capacity power since the drought began. SEPA, however, was not able to provide all the energy power it contracted to deliver from the system and had to purchase from other commercial sources 551,050 megawatt hours of energy at a cost of about $13.9 million between November 10, 1987, and December 31, 1988. Since customers reimbursed SEPA about $4 million for this power, SEPA's net cost was about $10 million. Most of these purchases

came after April 16, 1988, when the district reduced releases from its Savannah River projects to meet water supply needs.

To estimate how much of the energy purchase related to the three Savannah River projects' inability to generate expected power, we determined that these projects generated about 54 percent of the total system requirement (capacity and energy) during the last normal year of operation. Thus, about $5.4 million of SEPA's power cost could be attributable to the reduced releases from the three Savannah River Basin projects.

Recreation Has Been Affected by Low Lake Levels

Low lake levels have severely affected recreational opportunities. When the lake levels at Hartwell and Thurmond fell 8 feet below the top of conservation pool, water-dependent recreational facilities experienced major impacts. Hartwell reached this level in October 1987, recovering slightly during winter and spring 1988, before declining below this level for most of the summer recreation period. Thurmond went below this level in October 1987 and was considerably lower during the entire 1988 summer recreation season. Russell's recreational facilities were designed to operate at any level within its shallow 5-foot conservation pool. Because the district maintained Russell's level within its conservation pool, Russell's facilities have not been affected.

South Atlantic Division data show that the number of visitors declined by about 3.8 million recreation days, or 16 percent between 1988 and 1987. Although district officials do not know precisely why visits dropped at each lake, they attribute the decline in part to the low lake levels. They also speculate that publicity surrounding the low lake levels kept some people from visiting Russell even though the drought did not affect recreational facilities there. Table II.1 shows visitation at the three projects during the past 2 years.

Table II.1: Decline in Recreation Days From 1987 to 1988

Project	Number of visits 1987	Number of visits 1988	Percent decline
Hartwell	14,434,700	13,024,971	10
Russell	850,182	747,082	12
Thurmond	8,016,012	5,743,060	28

Note: A recreation day is one visitor to a project, regardless of the amount of time spent during the visit.

Thurmond and Hartwell recreational facilities have been severely affected by the drought. District data showed that by mid-July 1988, 100 percent of the beaches, 35 percent of the public boat ramps, and 70

percent of the private boat docks were unusable at Thurmond. Although no marinas closed, marina operators had to move floating boat docks into deeper water. At Hartwell, 100 percent of the beaches, 31 percent of the boat ramps, and 53 percent of the private docks were unusable as of mid-July 1988. Like Thurmond, no marinas closed at Hartwell.

By the end of 1988, 84 percent of the public boat ramps and all of the private docks at Thurmond were unusable. At Hartwell, 45 percent of the public boat ramps and 71 percent of the docks were unusable. Figures II.3 to II.6 illustrate the impact of the low lake levels on recreation.

Figure II.3: Swimming Buoys on Dry Land at Squirrel Nest Beach, Lake Thurmond

Figure II.4: Unusable Private Docks at a Lake Hartwell Subdivision

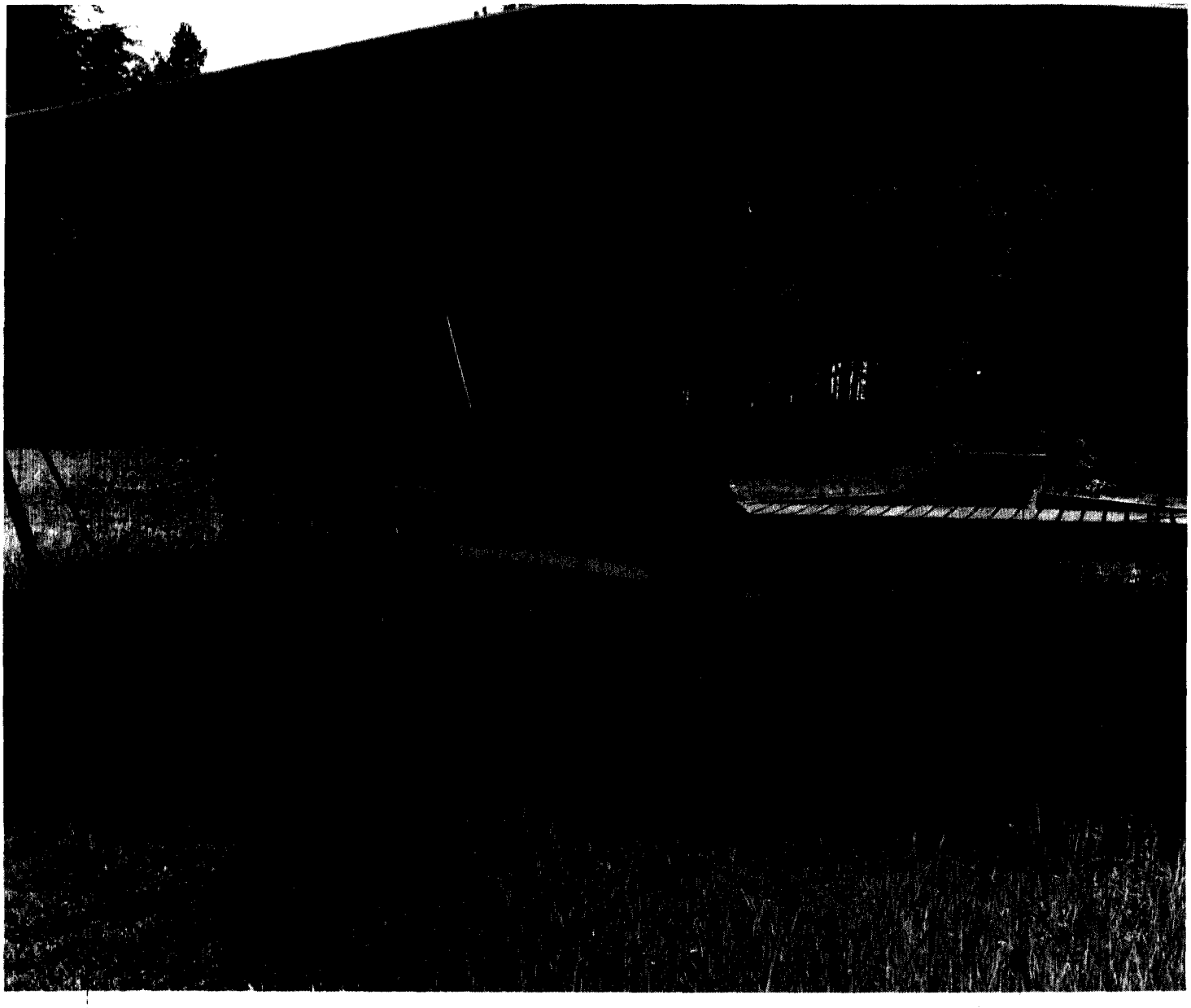


Figure II.5: Depth Pole At Singing Pines, Lake Hartwell (Normally at 6 Feet)

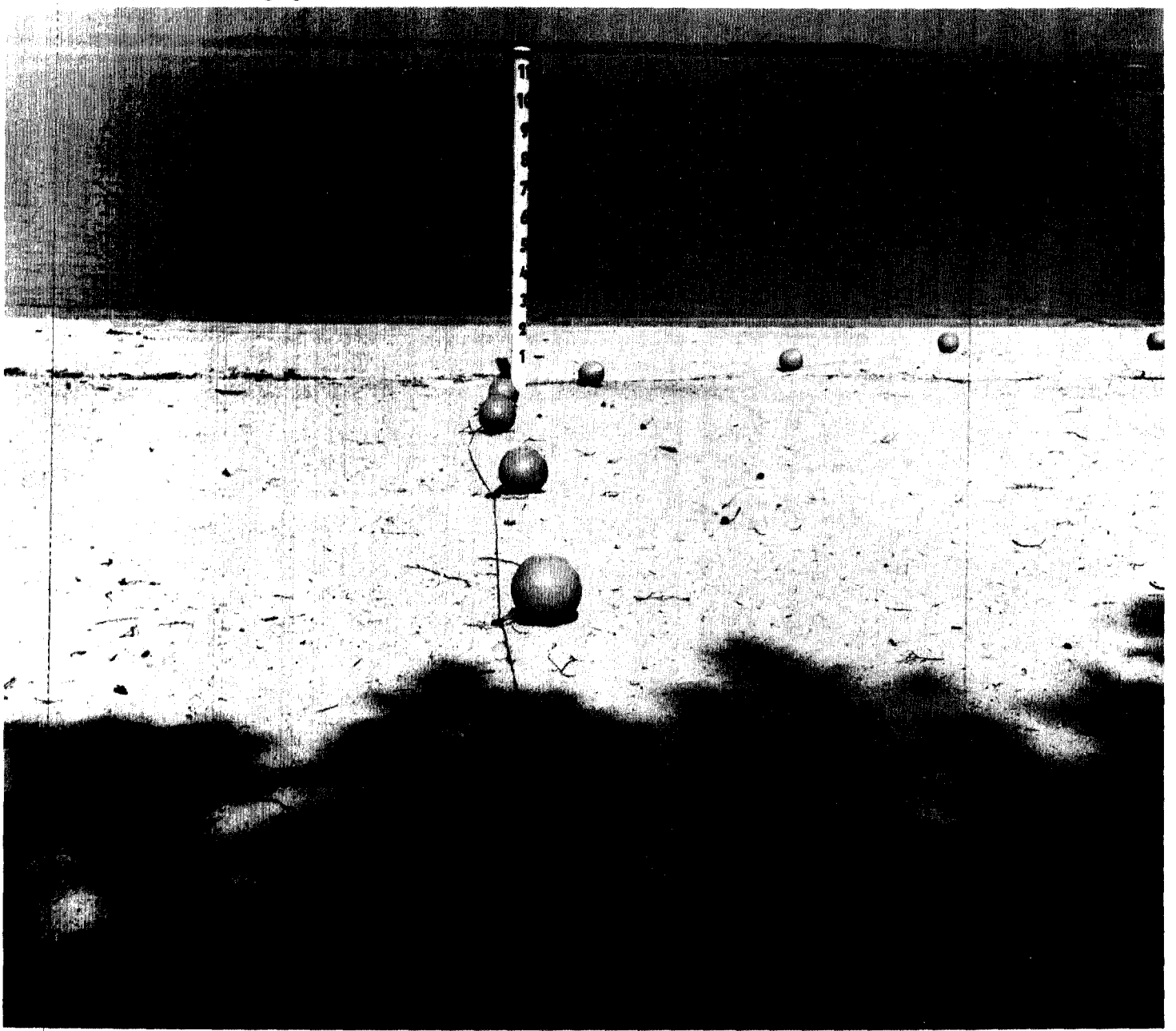
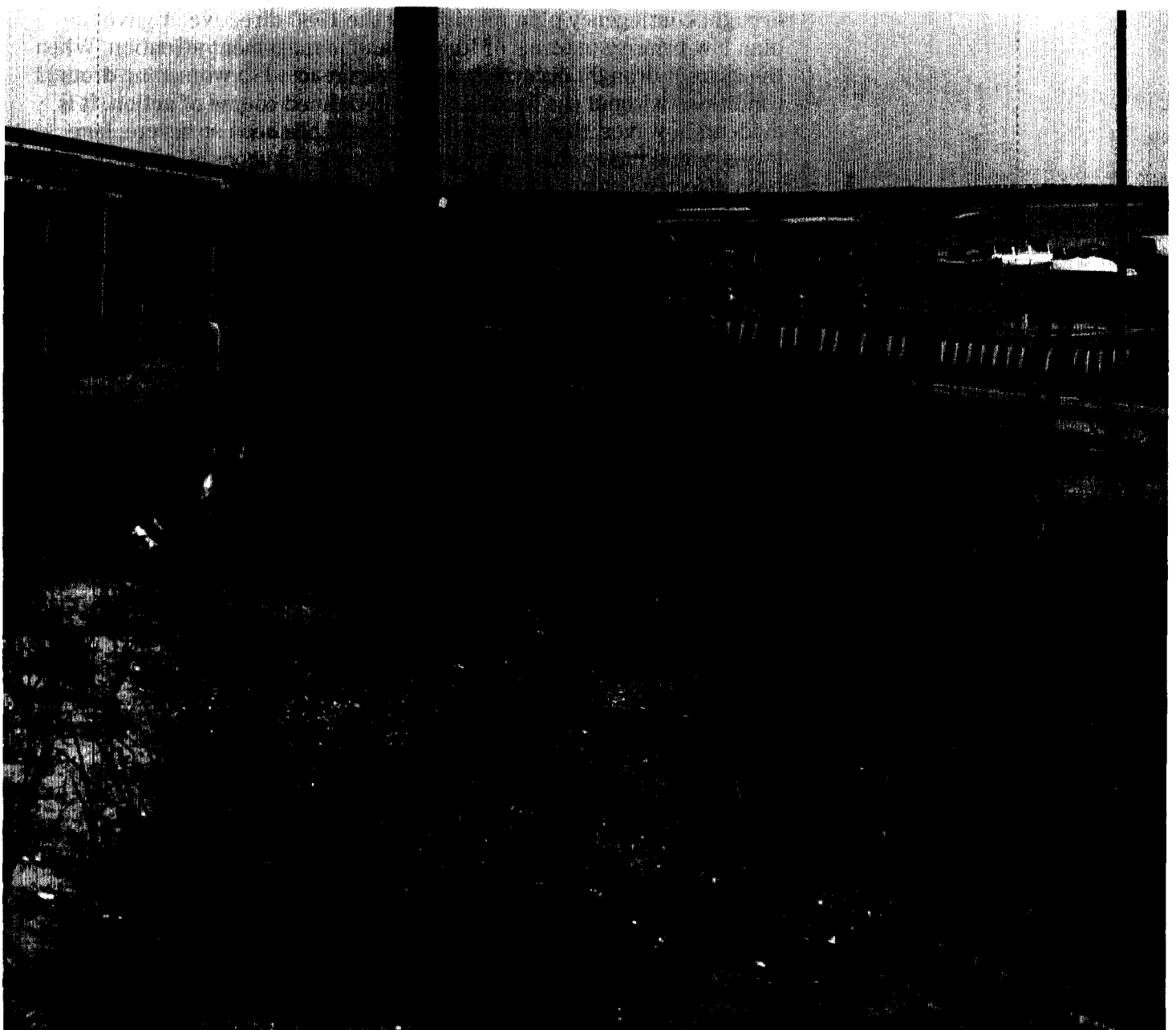


Figure II.6: Unusable Boat Slip at a Lake Thurmond Marina



Drought Management Planning Problems

Prior to January 1987, the district put little effort into preparing the drought contingency plan required by the 1980 directive. It gave the plan low priority in terms of funding and management attention. When the current drought occurred, the district reacted to worsening drought conditions without the benefit of a well-defined course of action. It is evident, however, that because the drought has been so severe, lake levels would have fallen over time, and project purposes would have been affected, even if the now completed plan had been followed at the onset of the drought.

The district issued the drought contingency plan on March 31, 1989, nearly 2 years after the current drought had begun. Our analysis of the plan and its supporting documentation showed that the district (1) had not thoroughly determined the quantities of water needed in the Savannah River to meet key plan objectives such as providing users with sufficient streamflows and meeting water quality standards, (2) did not adjust Thurmond's release rate for water supply needs to account for downstream inflows, and (3) did not include a strategy to deal with extremely severe or worst-case situations that might occur if the drought does not end.

Drought Plan Not Completed Until March 1989

Corps of Engineers Regulation ER-1110-2-1941, dated September 15, 1980, directed all Corps districts to develop drought contingency plans for Corps projects with controlled reservoir storage such as those in the upper Savannah River Basin. The plans were to contain (1) an operating strategy to use projects' existing storage to respond to short-term periods of water shortages, (2) procedures for coordinating decisions with public, state, and local officials, and (3) a mechanism to identify needed conservation actions prior to drought crisis situations. The district did not receive any supplemental guidance on plan development from Corps headquarters or the South Atlantic Division. Corps headquarters expected the plan to be completed within 5 years of the regulation's issuance.

1980-86 Drought Planning Efforts

Between September 1980 and December 1986, the district made little progress toward completing the required drought contingency plan. Drought management planning performed was in reaction to the 1980-81 and 1985-86 droughts, rather than in the development of the required plan.

The district originally planned to complete the drought plan during fiscal year 1984, but it did not allocate funds for drought planning purposes in fiscal years 1981 and 1982. For fiscal years 1983 and 1984, the district used only $5,700 of the $36,400 available for work on a plan. A district official advised us that preparing a drought contingency plan was not a high priority during this time because the district was not experiencing a drought nor expecting one in the immediate future. Because it continued to give the plan low priority, the district did not allocate funds for drought plan development in fiscal year 1985.

In the spring of 1986, the district allocated funds to work on an interim drought management strategy in response to a drought that had begun in December 1985. Its objective was to develop a management strategy for the three lakes for the remainder of the drought to prevent the lakes from reaching the bottom of their conservation pools for at least another year.

The district completed the strategy paper in September 1986. The plan called for Thurmond and Hartwell releases of 3,600 cfs and 2,600 cfs, respectively, and for operating Russell as a flow-through project. The district implemented the strategy shortly before the drought ended in October. The district then gradually increased Hartwell and Russell releases in December, before resuming normal operations at all three projects in February 1987. The district did not view the development of the strategy paper as fulfilling the 1980 requirement for a drought contingency plan but rather as the strategy to cope with the drought occurring at the time.

Drought Planning Efforts Begun in 1987 Resulted in March 1989 Plan

In January 1987 the district began a more intensive effort to develop a drought contingency plan in response to the 1980 regulation, and it used hydrologic and water release data gathered during the two earlier droughts. The district developed one plan for the three reservoirs because the reservoirs are interconnected and operated as a system. It allocated $97,000 to the project, which had a December 1987 target completion date. Using the 1986 interim drought management strategy as a guide, the district established the following objectives for the drought management plan:

- Lake levels should not be drawn below the bottom of the conservation pool.
- Releases of no less than 3,600 cfs at Lake Thurmond should be maintained for downstream users.

- Most of the conservation pool water in the reservoirs should be used under drought conditions equal to the most severe drought recorded in the basin (the so-called drought of record), although some water should be protected in case the drought exceeds the drought of record.
- Capacity hydropower capability should continue to be maintained.
- Releases required to meet state water quality standards from Lake Thurmond should be maintained for as long as possible without jeopardizing water supplies.
- Impacts to recreation during the recreation season should be minimized.

In developing a plan to meet these objectives, the district decided to use a water shortage indicator as a triggering mechanism to initiate action before a crisis occurred. This indicator would tell the district when to reduce releases from the lakes and to what level during varying drought conditions. The district considered the indicator as a guideline and reserved the right to manage differently if circumstances warranted.

A district official advised us that, like previous efforts, personnel shortages and higher priority work prevented the district from completing the plan by the December target date. Because the Basin was in the midst of the drought that had begun in July 1987, the chief of the district's Engineering Division asked his staff in November 1987 to prepare an interim paper reflecting the district's drought planning efforts up to that time. The district issued the interim paper in December 1987 and completed its first draft drought plan in January 1988.

The January draft contained water shortage indicators determined by using complex computations that factored average rainfall over the previous 4 months, relative to normal rainfall, and the current lake levels, relative to normal lake levels. The district would reduce Hartwell and Thurmond releases when a predetermined water shortage indicator number was reached. Georgia and South Carolina water management agency officials complained that the mathematical computation process was too difficult to understand, the indicator numbers could not be readily computed, and/or that the plan was technically flawed.

In response, the district decided to substitute lake levels as water shortage indicators. In April 1988 they issued a revised plan to the Drought Coordination Committee and SEPA that contained guidelines based on the new indicators. The guidelines called for four gradual reductions to Hartwell and Thurmond releases as lake levels decline.

After making minor changes to the April draft in response to the committee's comments, the district issued a third draft plan for public comment in August 1988. During public hearings on this plan, considerable concern was expressed about the need to reduce releases earlier than outlined in the draft. The general consensus was that the draft plan should require stricter conservation measures by reducing the release rates at higher lake levels.

After considering the public's input, the Corps issued another draft plan in February 1989 that modified the water shortage indicator guidelines. For example, releases from Thurmond would be reduced to 4,500 cfs when the lake fell 6 feet below the top of the summer conservation pool, which is 1,800 cfs less than called for by the April and August plans. The plan also called for reducing Thurmond releases to 3,600 cfs when the lake fell 14 feet below the top of summer conservation pool. The plan further provided that if Thurmond releases were reduced to either 4,500 cfs or 3,600 cfs during a drought, releases would be maintained at the reduced rate until all three lakes approached the top of conservation pool levels. The district Commander, however, stated that because of the severity of the current drought, the district would continue releases of 3,600 cfs from Thurmond until the lakes had reached the top of their conservation pools.

The district completed a drought contingency plan for the three Savannah River Basin projects on March 31, 1989, 3-1/2 years after the Corps headquarters' target completion date, and 8-1/2 years after the regulation was issued.

We asked the district to determine whether lake levels would have changed if they had followed the completed drought plan when the current drought began. According to the district's computation, Thurmond would have been 1.6 feet higher and Hartwell 0.9 feet lower as of December 31, 1988. During the 1988 summer recreation season, Hartwell's level would have ranged from 0.3 foot to 2.5 feet higher and Thurmond's level would have ranged from 1.6 feet to 3.4 feet higher. Because of Russell's shallow 5-foot conservation pool, its lake level would not have changed significantly. It should be noted, however, that the analysis was premised on the completed plan, which in our view included various shortcomings regarding the district's method of determining downstream user needs and its failure to adjust Thurmond's release rate for water supply needs to account for downstream inflows.

Corps Drought Planning Nationwide Has Not Been a High Priority

The Savannah River Basin droughts are not isolated occurrences. Last year the nation experienced severe droughts, devastating spring and summer crop production in the Midwest and affecting waterborne traffic on the Mississippi River. California experienced a second straight year of drought conditions. These droughts represent the possibility that potentially serious water shortage problems could occur throughout the nation, with impacts that could cause significant changes in the way we live.

Other Corps districts, besides Savannah, have not been responsive to the 1980 requirement to develop drought contingency plans for projects with controlled reservoir storage. A nationwide Corps analysis of the status of plan development showed that Corps districts prepared plans for only about 30 percent of projects as of March 1989. Districts, however, have included development of drought contingency plans for most projects in their fiscal year 1990 budget requests. (Because of time constraints, we did not review these plans in terms of meeting the drought contingency plan criteria outlined in the Corps regulation.) We were advised by a Corps headquarters official that until the current drought occurred, the Corps was not very concerned about developing drought contingency plans. The Assistant Secretary of the Army (Civil Works) noted in November 1988 that the Corps has not planned for droughts. The Corps fiscal year 1990 budget proposes a multiyear study of alternative ways and means to manage the nation's water resources in order to better deal with droughts. The 1990 budget requests $500,000 to initiate the first phase of the study.

Drought Contingency Plan Has Various Shortcomings

Corps regulations require that, to respond fully to public needs during drought situations, districts prepare drought contingency plans on a regional, basinwide, and project basis and include in the plans provisions for coordination with appropriate state and other federal interests. So district management can maximize the use of reservoirs' conservation pools during periods of water shortages, drought contingency plans must also thoroughly reflect public needs.

The Savannah District's drought contingency plan is not based on a thorough analysis of public needs, nor on data supporting its assertion that downstream water supply needs and water quality standards require Thurmond releases of 3,600 cfs. The release rate for downstream water supply was not adjusted to account for downstream inflows, which would have reduced releases. Further, the drought plan does not contain a strategy to deal with worst-case situations that might occur if

the ongoing drought persists and releases are no longer sufficient to meet water supply and water quality requirements.

Corps Determination of Water Release Requirements

The district's drought contingency plan is premised on Thurmond releases of 3,600 cfs to meet downstream water supply needs and maintain state water quality standards. The district determined this release on the basis of (1) a 1981 Savannah River Site low streamflow study and (2) a 1986 user needs survey. The district, however, did not thoroughly consider and determine all user needs when calculating the release rate from Thurmond for water supply requirements.

1981 Savannah River Site Low Streamflow Study

During the 1980-81 drought, the district gradually reduced releases from Thurmond so that Savannah River Site officials could identify the minimum streamflow required at the plant, which the district considered as the major Savannah River user. Plant officials monitored their intakes at various streamflow rates and determined that a streamflow of 3,300 cfs at the intakes would not affect plant safety and/or operations. District officials told us that they added 300 cfs as a safety margin and would release 3,600 cfs from Lake Thurmond, about 81 miles upstream of the plant, to meet the plant's needs of 3,300 cfs at its intakes. According to the officials, the 3,600-cfs release rate was not adjusted to account for inflows between Thurmond and the plant because they considered these inflows to be unreliable and sporadic. District officials believe that it was prudent to have the additional safety margin that downstream inflows provided because of the type of operations conducted at the Savannah River Site.

Water User Needs Survey

Subsequent to the 1981 Savannah River Site's low streamflow study, the district told water users that 3,600 cfs was the lowest release rate the users could expect from Thurmond. District officials told us that the 3,600-cfs Thurmond release rate was supported by the 1986 user needs survey that updated information the district had obtained in a similar 1981 survey. For the 1986 survey, the district requested all Savannah River users to submit data on their river intake type, location, and elevation, and water withdrawal or consumption requirements. The district did not request information from users on the streamflow needed at their intakes.

District officials also told us that nothing came to their attention during the 1986 survey to indicate a need to change the 3,600-cfs release rate

originally determined during the 1981 study. In response to the 1986 drought and the district's drought management actions, two major downstream users adjusted their intakes to operate at river levels sustained with 3,600 cfs releases.

Savannah River Site Revised Its Streamflow Needs

In April 1988, the Savannah River Site manager advised the district that the plant needed a streamflow higher than the 3,600 cfs determined during the 1981 low streamflow study. The manager stated that operation of three reactors required a streamflow of 4,880 cfs and a streamflow of 4,130 cfs if two reactors were operating. The plant, however, did not operate more than one reactor at any given time between April and August 1988. Since August 1988 none of the reactors has operated.

According to district officials, Thurmond releases will not be increased to provide the streamflows plant officials say are needed until the district performs an independent study or plant officials provide convincing data supporting the need for these increased releases. Regardless of the resulting data, district officials told us that the decision to increase releases to meet the Savannah River Site's needs would have to be made at a higher level than the district's.

Corps Views and Our Analysis

We asked district officials why they had not systematically gathered and analyzed basinwide data supporting their determination of the 3,600-cfs release rate. The district Deputy Commander for Civil Works stated that the district relied on data gathered during earlier droughts and engineering judgment to set the release rate.

District officials acknowledged, however, that they did not test a lower rate and that the rate could possibly have been reduced by 100 or 200 cfs. The district did not obtain data to determine the streamflow needed in the lower Savannah River to protect two users, the Savannah Wildlife Refuge and the city of Savannah's municipal and industrial water supply intakes, from saltwater intrusion. Further, the 1986 user needs study did not address the streamflow needed to ensure that state water quality standards would be met.

The district also stated that the 3,600-cfs release rate satisfied water needs of a major paper products manufacturing company, located just below the city of Augusta, and that rate plus inflows provided a sufficient streamflow in the lower Savannah River to prevent saltwater intrusion.

We noted that district tests conducted at the paper products manufacturing company indicated it could operate with a streamflow of 3,400 cfs at its intake, considerably less than the streamflow provided by the combination of the 3,600-cfs release rate from Thurmond and downstream inflows. As measured by the Augusta gauge located 3 miles above the company's intake, the streamflow has been at least 4,000 cfs and frequently much higher than 4,000 cfs from the beginning of the current drought through December 31, 1988.

We asked the district to provide supporting information on safeguarding against saltwater intrusion. The district told us that, ideally, streamflows of 5,500 cfs to 6,000 cfs are needed to prevent saltwater intrusion resulting from such conditions as high winds or high tides. Because these conditions would occur infrequently, district officials do not feel it is necessary to increase Thurmond releases to continuously maintain streamflows of 5,500 cfs to 6,000 cfs in the lower river. The weekly average for streamflows in the lower river, with the 3,600-cfs Thurmond release rate and downstream inflows, has been at least 4,500 cfs, with one minor exception, and has been sufficient to hold back saltwater intrusion. District officials added, however, that salinity is monitored very closely and that if saltwater intrusion becomes a problem, Thurmond's releases can be increased.

Thurmond Releases Not Adjusted for Downstream Inflows

The district did not adjust Thurmond's releases for the Savannah River Site's operations to account for downstream inflows. We determined that inflows were generally consistent in the river downstream of Lake Thurmond. Table III.1 shows streamflows, as measured by U.S. Geological Survey (USGS) gauges located at the New Savannah Bluff Lock and Dam south of Augusta, Georgia (Augusta gauge), the Savannah River Site (Jackson gauge), and the town of Clyo, Georgia (Clyo gauge), located about 61 miles above the Savannah River's delta.

Table III.1: Last Week of Month Weekly Average Releases From Thurmond and cfs Streamflow Measurements Below Thurmond

Week ending	Thurmond releases mile 237.7	Augusta streamflow mile 187.4	Jackson streamflow mile 156.8	Clyo streamflow mile 60.9
04-29-88	3,771	5,631	6,163	7,581
05-27-88	3,532	4,469	4,670	5,336
06-24-88	3,657	4,571	4,713	a
07-29-88	3,626	4,186	4,500	4,647
08-26-88	3,673	4,384	4,737	4,970
09-30-88	3,685	4,199	4,701	5,976
10-28-88	3,783	4,459	4,921	5,204
11-25-88	3,722	4,421	4,931	5,403
12-30-88	3,642	4,181	4,589	a

Note: Mile indicates the location of the gauge along the Savannah River.
[a]USGS data for this week not available.

Our analysis of the USGS streamflow records showed that inflows are substantial and reliable. From April 1988 to December 1988, when Thurmond releases were a weekly average of about 3,600 cfs, the minimum streamflow recorded by USGS gauges at the Savannah River Site was 4,300 cfs on a weekly average and higher than 4,500 cfs for 218 days of the 260-day period.

To determine the impact that inflows might have on Thurmond releases, we asked the district to estimate how much higher the lakes would be had they reduced Thurmond releases a weekly average of 300 cfs from mid-April 1988, through the end of December 1988. According to district calculations, lake levels would have been 2.6 feet higher at Thurmond and 0.7 foot higher at Hartwell if Thurmond's releases had been adjusted to account for this amount of inflows during the 8-1/2 month period.

We asked district officials why they did not include inflows in determining the release rate for water supply purposes. The district said that inflows are too unreliable to use to calculate releases and that they did not have a streamflow gauge above Augusta, the first primary downstream user, to measure the inflows. We noted that the USGS gauge located a few miles below Augusta recorded relatively constant inflows.

In order for the district to obtain more data on the extent of inflows to the river, the district requested that additional streamflow gauges be installed below Lake Thurmond. USGS recently installed a gauge north of

the city of Augusta at its canal intake location, which will be operational in May 1989 after calibration.

In addition, the Corps' Mobile District will be contracting in May 1989 for a study of the Chattahoochee River to determine the feasibility of using downstream inflows to reduce planned releases from Lake Lanier when the situation permits. The Mobile District expects the study to be completed in July 1989. The South Atlantic Division commander told us that after reviewing the study results, he will consider conducting a similar study in the Savannah River Basin.

The district Commander recently acknowledged the possibility of reducing Thurmond releases when downstream inflows permit. Responding to the South Carolina Water Resources Commission's proposal that Thurmond releases be gradually reduced from 3,600 cfs to 3,000 cfs during the spring months to further conserve water in the lakes, the district Commander in February 1989 stated that present conditions would not allow a reduction at this time. However, if conditions in the lower Basin improved to the point that the district could assure that minimum water quality and water supply needs could be met, he would support a test to determine if Thurmond releases could be temporarily reduced.

The district also indicated that it is not technically and economically feasible to monitor inflows for the purpose of adjusting releases. Adjusting Thurmond releases when downstream inflows permit is impractical because hydropower generation schedules are based on established weekly releases and would result in scheduling problems if less power than expected was produced. We are not advocating release adjustments for every fluctuation in inflows. Rather, we believe the district has opportunities to (1) reduce Lake Thurmond releases on the basis of a historical pattern of dependable downstream inflows and (2) further reduce the release rate when major storms or prolonged rains significantly increase Basin inflows for an extended period. In addition, the district could continue to establish weekly hydropower schedules, using a fixed rate of dependable, historical inflows to set these schedules, adjusting the hydropower schedules for above-normal inflows only when these inflows occur over an extended period.

Plan Does Not Address Worst-Case Conditions

The district's drought contingency plan does not include a strategy to address the potential drought situation in which lake levels fall below the bottom of the conservation pool and Thurmond releases of 3,600 cfs cannot be sustained, other than noting that if this condition occurs,

releases from the reservoir will equal inflows. The district Commander does not believe that planning for a worst-case situation is necessary because, in his opinion, lake levels would never be that depleted during a drought.

The severity of the current drought raises questions as to when the drought will end. The district projected on February 3, 1989, that had the weather conditions experienced during the last 6 months of 1988 continued, Hartwell and Thurmond would have exhausted their conservation pools by the end of 1990 and Russell would have had about 1 foot remaining in its conservation pool. When the lake levels fall below the bottom of the conservation pool at any of the three reservoirs, hydropower generation capacity is impeded and damage to the hydropower turbines can result. Furthermore, if the district increases releases to meet water quality requirements during the 1989 summer, which Georgia state officials believe may be necessary, the lake levels at the three projects may decline to the bottom of conservation pool sooner than the projected December 1990 date. As such, the need to address actions beyond those prescribed in the plan may not be as remote as the district believes.

We believe the plan could be a much more useful tool to manage such conditions if the district established a framework for decision-making on the difficult issues resulting from severe drought conditions. These issues include determining how priorities should be set among various water users, whether wastewater discharges into the river should be restricted and how this should be done, and when critical downstream users should be notified of the need to modify their intake elevations. The plan should also address the tradeoffs that would have to be made if sufficient releases to meet downstream water needs and maintain water quality standards cannot be sustained, and the Corps' role in establishing these tradeoffs.

The South Atlantic Division Commander agreed with us that a drought contingency plan should address the Corps' management actions when lakes levels drop below the bottom of conservation pool and user needs can no longer be met. The South Carolina Department of Health and Environmental Control, in a letter dated February 28, 1989, commented that the plan should include a description of all contingencies in the event that water quality standards cannot be met.

Objectives, Scope, and Methodology

In a March 24, 1988, letter, Representative Butler Derrick requested that we evaluate the Corps of Engineers' management of the three Savannah River Basin reservoirs—Hartwell, Richard B. Russell, and J. Strom Thurmond. He was concerned that the Corps had not managed the lakes properly during the current drought, which began in July 1987. On the basis of his request and subsequent discussions with his office, we focused our review on (1) the Corps' management of the lakes during the current drought, (2) the effects of the drought on reservoir purposes, and (3) the Corps' efforts to develop a drought contingency plan. On April 22, 1988, the Chairman, Environment, Energy and Natural Resources Subcommittee, House Committee on Government Operations, endorsed the request.

To document the Corps' management of the drought and rationale for its decisions, we (1) reviewed authorizing legislation for the three projects, applicable Corps regulations, policies, and guidelines for management of the reservoirs, and data, correspondence, and reports prepared by the Corps that pertained to managing the droughts, and (2) interviewed Corps officials in the Savannah district, Savannah, Georgia, and South Atlantic Division in Atlanta. To document the hydrologic conditions of the reservoirs, we reviewed district records pertaining to drought management, such as daily inflow, releases, and lake level logs for the lakes, monthly water control management reports, and monthly summary of project operations reports.

We also assessed how the severity of the drought affected project purposes. As agreed, we focused on the four project purposes—hydropower, water supply, water quality, and recreation—which we considered the most sensitive to drought conditions and the most important in terms of impact on the general welfare of the population that depends on the Savannah River and the three lakes for water.

To document the effects on hydropower, we met with representatives of SEPA and obtained data from SEPA and the district on daily hydropower generation. We visited each project's powerhouse and discussed hydropower operations with the powerhouse operators.

To determine how water supply needs were being met, we discussed water supply requirements of inlake and downstream users with Corps officials in Savannah and Atlanta. To determine downstream user needs, we reviewed Corps documents and U.S. Geological Survey data on

streamflow rates and river levels, and visited downstream sites, including Augusta, Georgia, the South Carolina Electric & Gas Company at Stevens Creek, and the Savannah River Site.

Regarding the effects on water quality, we discussed water quality requirements with state officials from the South Carolina Water Resources Commission and Department of Health and Environmental Control, the Georgia Department of Natural Resources, and the U.S. Environmental Protection Agency. We also reviewed state water quality summary reports to identify whether state water quality standards were being met.

To identify effects on recreation, we visited the three projects to observe low water conditions and discussed the impacts on recreation with each lake's resource manager and two marina owners. We obtained Corps data on unusable facilities and recreation visits to each lake.

Regarding the Corps' development of its drought contingency plan, we reviewed and discussed with the Corps the 1986 Interim Drought Management Strategy, four draft drought contingency plans issued in January, April, and August 1988, and February 1989, and the final report issued on March 31, 1989. We reviewed minutes of the Savannah River Basin Drought Coordination Committee meetings to gain an understanding of the Corps' basic philosophy in drought management and attended public hearings in Anderson, South Carolina, and Augusta and Hartwell, Georgia, to observe public reaction and input to the Corps' drought management and plan development efforts.

We discussed the information we developed with the district and the division in early 1989. The district provided us its views orally and in writing, and we held follow-up meetings on these matters with division and district officials. We also obtained the views of officials from Corps headquarters, and those of other organizations, and incorporated these views into the report where appropriate. As requested, however, we did not ask the Corps to comment officially on a draft of this report.

Our work was conducted between May 1988 and April 1989 in accordance with generally accepted government auditing standards.

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