UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

Before the Licensing Board:

G. Paul Bollwerk, III, Chairman
Nicholas G. Trikouros
Dr. James Jackson

In the Matter of	Docket No. 52-011-ESP
SOUTHERN NUCLEAR OPERATING CO.	ASLBP No. 07-850-01-ESP-BD01
(Early Site Permit for Vogtle ESP Site)	September 22, 2008

JOINT INTERVENORS' MOTION TO ADMIT NEW CONTENTION

In accordance with 10 C.F.R. § 2.309(C)(2) and the May 7, 2007 Memorandum and Order (Prehearing Conference and Initial Scheduling Order) of the Atomic Safety and Licensing Board ("ASLB" or "Board"), as revised by the Board's July 14, 2008 Memorandum and Order (Revised General Schedule), Joint Intervenors move to admit a new contention based upon information contained in the Final Environmental Impact Statement for an Early Site Permit ("ESP") at the Vogtle Electric Generating Plant Site ("FEIS"), NUREG-1872, issued on August 21, 2008. This motion is timely filed on September 22, 2008, as required under the Board's revised scheduling Order.

Intervenors' seek to admit a new contention challenging the adequacy of the FEIS, raising issues under the National Environmental Policy Act ("NEPA"). The Nuclear Regulatory Commission (the "NRC") rules of procedure provide:

> On issues arising under the National Environmental Policy Act, the petitioner shall file contentions based on the applicant's environmental report. The petitioner may amend those contentions or file new

> contentions if there are data or conclusions in the NRC draft or final environmental impact statement, environmental assessment, or any supplements relating thereto, that differ significantly from the data or conclusions in the applicant's documents.

10 C.F.R. § 2.309(f)(2).

As discussed below, Intervenors' proposed new contention meets the standard for admissibility because the FEIS contains data and conclusions that differ significantly from that presented in the Southern Nuclear Operating Company ("SNC") Environmental Report ("ER") and the Draft Environmental Impact Statement ("DEIS"). Furthermore, Intervenors demonstrate below that the "proposed new contention meets the standard admissibility requirements of 10 C.F.R. § 2.309(f)(1)(i) – (vi)." Entergy Nuclear Vermont Yankee L.L.C. (Vermont Yankee Nuclear Station), 62 N.R.C. 813, 819. As a result, the Board should grant Intervenors' motion and admit the proposed contentions for adjudication.

> Proposed Contention EC 6.0: The discussion of potential impacts associated with dredging and use of the Savannah River Federal navigation channel is inadequate and fails to comply with NEPA because it relies on the Army Corps of Engineers (the "Corps") to analyze these impacts in the future. As a result, the staff's conclusion that impacts would be moderate runs counter to the evidence in the hearing record. Additionally, the FEIS wholly fails to address impacts of navigation on the Corps' upstream reservoir operations, an important aspect of the problem.

Bases for Proposed Contention:

1. The FEIS contains substantially different data and conclusions from the ER or DEIS.

The FEIS reveals, for the first time, that substantial dredging of the Federal navigation channel will likely be needed to allow barge traffic for construction of VEGP Units 3 and 4. (FEIS at 4-27). Chapter 7 of the EIS includes two new paragraphs

dedicated to potential impacts of dredging the Federal navigation channel. (FEIS at 7-20). Although this discussion is vague and lacking detail, the NRC staff "anticipates that dredging the Federal navigation channel in the Savannah River downstream of the VEGP site would have the potential for adverse impacts to aquatic organisms." Id.

While the ER and DEIS mention the Federal navigation channel in passing, neither suggests that extensive dredging will likely occur as a result of the ESP, or the potential adverse impacts of dredging the Federal navigation channel. In its ER, SNC simply states that it "plans to utilize the . . . navigation channel to support delivery of large components and modules for construction of Units 3 and 4." (ER at 2.5-10). The ER then claims that SNC "will be working with" the Corps to develop a "strategic plan" that "will include a schedule of shipments, identify maintenance needs and navigation aids, and identify contingencies, where appropriate." (ER 2.5-11). The DEIS repeats this discussion almost verbatim. (DEIS at 4-48). These statements do not address the dredging of over 100 miles of the Savannah River and, therefore, differ significantly from the discussion of the Federal navigation channel in the FEIS. 10 C.F.R. 2.309(f)(2).

2. Using the Federal navigation channel to barge components to the VEGP site is necessary for construction of Units 3 and 4.

All major components of the existing Units 1 and 2 were delivered to the VEGP site by barge using the Federal navigation channel. (FEIS at 2-105). The Federal navigation channel, together with the existing barge slip, must be expanded "to support the unloading of the Westinghouse AP1000 reactor components." (FEIS at 4-26). According to the ER, "the advanced reactor construction is based around installation of large modules fabricated at a dedicated fabrication facility and delivered to the site." (ER

at 2.5-10). The FEIS does not identify any alternatives to barging for transport of these large reactor components.

The purpose of the ESP "is to provide for early resolution of many safety and environmental issues that may be identified for the ESP site." (FEIS at 1-5). The FEIS "analyzes the environmental impacts that could result from construction and operation of new units at the VEGP site." Id. The FEIS purports to resolve issues related to dredging the navigation channel and concludes that "cumulative impacts to aquatic organisms in the region from the construction including the dredging of a navigation channel could be MODERATE, depending on the type of mitigation." (FEIS at 7-20). Thus, the proposed new contention is clearly is within the scope of the proceeding. 10 C.F.R. § 2.209(f)(1)(iii).

3. Environmental impacts stemming from the use of the Federal navigation channel are direct impacts of the proposed construction of Units 3 and 4 that must be addressed in the FEIS.

An agency must address three types of actions, "connected," "cumulative," and "similar" actions, in an EIS. 40 C.F.R. § 1508.25. Actions are "connected" if they: "(1) Automatically trigger other actions which may require environmental impact statements; (2) cannot or will not proceed unless other actions are taken previously or simultaneously; or (3) are interdependent parts of a larger action and depend on the larger action for their justification." 40 C.F.R. § 1508.25(a)(1). Moreover, actions are connected if it would be "irrational, or at least unwise" to undertake one action without the other. Save the Yaak Comm. v. Block, 840 F.2d 714, 720 (9th Cir. 1988) (a "clear nexus" linked road reconstruction and timber sales, and thus, the two actions were

deemed connected actions); Thomas v. Peterson, 753 F.2d 754, 759 (9th Cir. 1985) (road and timber sales were "inextricably intertwined").

The Army Corps of Engineers has the responsibility for maintaining a 27.4-m wide by 2.74-m deep (90-ft wide by 9-ft deep) channel in the Savannah River for navigational purposes. The Federal navigation channel was last used for a commercial shipment in 1979 and has not been maintained by the Corps since that time. The FEIS reports:

> By 1980, shipping along the river had essentially ceased, and maintenance of the channel was discontinued (USACE 2006a). Consequently, Hartwell, Russell, and Thurmond dams are no longer operated for navigation, and minimum discharges from J. Strom Thurmond Dam are based on the needs of downstream water supply withdrawals without concern for navigation.

(FEIS at 2-18). Construction of Units 3 and 4 would require a revival of navigation on, and expansion of, the Federal navigation channel. Because this construction cannot proceed until the Federal navigation channel is expanded, the construction of Units 3 and 4 and the expansion of the Federal navigation channel are "connected." Accordingly, the impacts of such expansion must be analyzed in the FEIS.

4. The conclusion, set forth in the "Cumulative Impacts" chapter of the FEIS, that the large-scale dredging from Savannah Harbor to the VEGP site could have MODERATE impacts is inadequately supported.

The FEIS fails to adequately support its conclusion that environmental impacts posed by dredging the Federal navigation channel could be MODERATE. Agencies are required to "identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusion in the [EIS] statement." 40 C.F.R. §1502.24. See Environmental Defense v. U.S. Army Corps of Engineers, 515 F. Supp. 2d 69 (D.D.C, 2007). In

the FEIS, the staff concludes that dredging the Federal navigation channel will have potential for adverse impacts. (FEIS at 7-20). The Construction impacts, "including navigation channel dredging could be MODERATE." (FEIS 7-20). However, the FEIS does not identify any methodology used or make any reference to sources relied upon the NRC staff in reaching its impacts determination. In fact, the FEIS admits that "a detailed assessment has not been conducted." (FEIS 7-20).

5. Dredging the Federal navigation channel has potentially significant impacts on the environment.

Dredging of the Federal navigation channel has potentially foreseeable and environmentally significant impacts. Declaration of Donald Hayes, ¶ 6. Such dredging will likely result in "temporary loss of benthic habitat, disruption of spawning migrations, [and] resuspension of sediments that may be contaminated …" (FEIS at 7-20). The web dynamics, spawning success and population size of freshwater mussels, shortnose sturgeon (an endangered species), Atlantic sturgeon, striped bass, robust redhorse and other catostomids, catfish species and benthic organisms may also be affected. Declaration of Shawn Young, ¶ 11, 12. Moreover, because the Federal navigation channel dredging is a sizable project with a lengthy duration, the extent of these aforementioned impacts is expected to be substantial. Hayes Dec., ¶ 9.

In addition to the impacts of the dredging itself, management of the sediments resulting from such dredging may also have substantial impacts. (FEIS at 7-20). In order to properly manage these sediments, multiple confined disposal facilities ("CDFs") will likely be required. These "CDFs will permanently alter the landscape and associated return water discharges could potentially have significant impacts on the Savannah River

environment. In the event the sediments contain hazardous materials, additional sediment management and disposal issues will also arise." Hayes Dec, ¶ 11.

6. The NRC staff abdicated its duty to independently assess potential impacts of dredging in the FEIS.

The NRC staff failed to satisfy its obligation to assess environmental impacts of dredging of the Federal navigation channel, 42 U.S.C. § 4332(C)), and instead wholly deferred to future analyses of such impacts to be conducted by the Army Corps of Engineers. (FEIS at 7-20). While the NRC may consider existing assessments prepared by the Corps of Engineers in its environmental impact analysis, where no such assessments exist, the NRC must establish its own impact determination. (NUREG-1555, 4.2.2-4,5). Because the potential impacts of the dredging have not yet been analyzed by USACE (FEIS at 7-20), the staff's reliance on the prospective evaluations and certifications of the Corps of Engineers is inappropriate. See Calvert Cliffs Coordination Committee, Inc. v. United States Atomic Energy Commission, 449 F.2d 1109 (D.C. Cir. 1971). In fact, a Memorandum of Understanding (the "MOU") between the Corps, U.S. Army and the NRC for the Regulation of Nuclear Power Plants, expressly provides that the NRC must exercise primary responsibility in conducting environmental reviews – including analysis of dredging impacts. (NUREG-1555, 4.3.1.-5, citing 40 Fed. Reg, 60115). While the MOU permits the Corps to help draft the material for sections regarding dredging activities, it in no way permits deferral of the requisite analysis. Id.

The FEIS states:

> At the present time the dredging project is incompletely defined, the amount of material to be removed is unknown, and the locations of the dredged material disposal areas have not been identified. Specifics of the project would be provided in the USACE's assessment to fulfill the NEPA requirement. This would presumably include mitigative actions to

> preserve the threatened, endangered, and sensitive mussel species that occur in the Savannah River.

(FEIS at 7-20). Of course, the purpose of an EIS is to define the project parameters, such as the amount of material to be removed and the location of spoil disposal areas. The NRC may not depend upon the Corps' future NEPA compliance to fulfill its obligations under NEPA. Furthermore, the discussion of future mitigation measures to protect threatened and endangered species is nothing more than speculation at this time. Although "a detailed assessment has not been conducted," the staff nevertheless "concludes that the cumulative impacts to aquatic organisms in the region from the construction including dredging of a navigation channel could be MODERATE." (FEIS at 7-20). This conclusion cannot be reconciled with the evidence in the hearing record.

7. Navigation requires release of significant amounts of water from upstream reservoirs, which is not addressed in the FEIS.

In addition to dredging the Federal navigation channel, operation of the Federal navigation channel also requires the Corps to release water from storage in upstream reservoirs to augment river flow. The FEIS states that "most areas of the Federal navigation channel above rkm 56 (RM 35) would likely need to be dredged to allow barge traffic during normal river flow." (FEIS at 4-27, 7-20). However, the FEIS does not define "normal flow" and fails to consider impacts on upstream reservoirs from supplying such flows. Even with dredging the Federal navigation channel, a 5,800 cfs flow from Thurmond Reservoir is needed to provide a 9 foot navigation channel. See Savannah River Drought Contingency Plan, USACE 1989 at 9. The FEIS presumes that adequate storage will be available in the reservoir to provide navigation flows.

As previously discussed, the Corps does not currently manage its Savannah River reservoirs to provide navigation flows, and minimum flows are based on the needs of

downstream water users. According to the FEIS, average Savannah River discharge is 8,800 cfs. (FEIS at 7-4). Thus, while much of the time there is sufficient flow in the Savannah River for commercial navigation, this is by no means guaranteed. In fact, discharge from Thurmond Dam has been limited under the Drought Contingency plan since June 2007, and is currently capped at 3,600 cfs. http://water.sas.usace.army.mil/cf/KavaPlot/KPlot.cfm?project=Thurmond. If recent drought conditions do not lift, the Corps cannot supply water needed to augment river flows for commercial navigation.

The full extent of potential impacts on the Corps reservoirs can not be determined without also knowing the number of barge shipments required for the construction, which is not disclosed in the FEIS. According to internal e-mail obtained from the Corps of Engineers through the Freedom of Information Act, SNC is contemplating 100 or more barge trips for construction of Units 3 and 4. E-mail from Jason O'Kane, Project Manager, Coastal Branch, Regulatory Division, Savannah District, USACE (March 27, 2008)(attached). Given the current state of the reservoirs and the ongoing drought, the Corps cannot possibly provide sufficient flows to support the Plant Vogtle expansion without significant impacts to other water users in the basin. The FEIS entirely fails to consider impacts of navigation on other authorized purposes of the upstream reservoirs.

8. The NRC staff failed to consult with the Army Corps of Engineers, as required by NEPA.

Prior to issuing a FEIS, NEPA requires a federal agency to "consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved." 42 U.S.C. § 4332 (2)(C). The Staff failed to consult with or obtain comments from the Corps. (FEIS §4.4, §4.5).

As a result, the FEIS dredging discussion is not only vague and insufficient, but also fails to satisfy the NEPA consultation requirements.

The NRC staff incorrectly "determined that there were no Federal project activities that would make it desirable for another Federal agency to become a cooperating agency for preparation of this EIS" and that "no other Federal activities or projects are associated with the proposed ESP for of the VEGP site." (FEIS at 2-123). In fact, the Federal navigation channel is absolutely associated with the proposed ESP for the VEGP site, as is indicated elsewhere in the FEIS. In addition, the Corps has jurisdiction over the Federal navigation channel, as well as special expertise in water resource management. Yet, while the "NRC consulted with the FWS and NOAA Fisheries" it inexplicably not with the Corps. (FEIS at 2-124).

"Consultation" constitutes more than informal verbal communication between NRC staff and the Corps. Instead, NEPA requires that NRC staff actually "obtain" written comments and input from the Corps. "Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to … the public as provided by and shall accompany the proposal through the existing agency review processes. 42 USC §4332 (2)(C)." Warm Springs Task Force v. Gribble, 621 F.2d 1017, 1022 (D.C. App. 1980). Because written comments from the Corps were not obtained in connection with the impacts of dredging, the NEPA consultation requirement was not satisfied.

Respectfully submitted this 22nd day of September, 2008,

[Original signed by L. Sanders]

Lawrence D. Sanders
Turner Environmental Law Clinic
Emory University School of Law
1301 Clifton Road
Atlanta, GA 30322
(404) 727-3432
Email: lsanders@law.emory.edu

Diane Curran
Harmon, Curran, Speilberg & Eisenberg, LLP
1726 M Street N.W., Suite 600
Washington, D.C. 20036
(202) 328-3500
Email: dcurran@harmoncurran.com

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
SOUTHERN NUCLEAR OPERATING COMPANY	)	Docket No. 52-011-ESP
	)	
	)	
(Early Site Permit for the Vogtle ESP Site)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing JNT SUPPLEMENT TO PETITION FOR INTERVENTION have been served upon the following persons by Electronic Information Exchange and/or electronic mail.

Office of Commission Appellate Adjudication
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: ocaamail@nrc.gov

Administrative Judge
G. Paul Bollwerk, III, Chair
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: gpb@nrc.gov

Administrative Judge
Nicholas G. Trikouros
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: ngt@nrc.gov

Administrative Judge
James Jackson
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: jackson538@comcast.net

Moanica Caston, Esq.
Southern Nuclear Operating Company
40 Inverness Center Parkway
P.O. Box 1295, Bin B-022
Birmingham, AL 35201-1295
E-mail: mcaston@southernco.com

Emily Krauss
Law Clerk
Atomic Safety and Licensing Board Panel
Mail Stop - T-3 F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: eik1@nrc.gov

Office of the Secretary
ATTN: Docketing and Service
Mail Stop 0-16C1
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Email: HEARINGDOCKET@nrc.gov

Jeffrey Stair, Esq.
Georgia Public Service Commission
244 Washington Street
Atlanta, GA 30334
Email: jeffreys@psc.state.ga.us

Steven P. Frantz, Esq.
Kathryn M. Sutton, Esq.
Paul M. Bessette, Esq.
Mary Freeze
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Avenue, NW
Washington, DC 20004
Email: sfrantz@morganlewis.com; Ksutton@morganlewis.com; pbessette@morganlewis.com; mfreeze@morganlewis.com

Kenneth C. Hairston, Esq.
M. Stanford Blanton, Esq.
Peter D. LeJeune, Esq.
C. Grady Moore, III, Esq.
Balch & Bingham LLP
1710 Sixth Avenue North
Birmingham, Alabama 35203-2014
E-mail: kchairston@balch.com; sblanton@balch.com; plejeune@balch.com; gmoore@balch.com

Ann P. Hodgdon, Esq.
Tison A. Campbell, Esq.
Patrick A. Moulding, Esq.
Jonathan M. Rund, Esq.
Kathryn L. Winsberg, Esq.
Robert M. Weisman, Esq.
Office of the General Counsel
Mail Stop - O-15 D21
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: aph@nrc.gov; tac2@nrc.gov; pam3@nrc.gov; jmr3@nrc.gov; rmw@nrc.gov; klw@nrc.gov

Dated this 22nd day of September, 2007

[Original signed by L. Sanders]

Lawrence D. Sanders

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)
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SOUTHERN NUCLEAR OPERATING COMPANY	) Docket No. 52-011-ESP
	)
(Early Site Permit – Vogtle Electric Generating Plant)	) ASLBP No. 07-850-01-ESP-BD01
_____	)

DECLARATION OF DONALD HAYES

I, Donald F. Hayes, do hereby declare as follows:

1. My name is Donald F. Hayes. I am the Director of the Institute for Coastal Ecology and Engineering and an Endowed Professor of Civil Engineering at the University of Louisiana at Lafayette. My office is located in Lafayette, Louisiana. My professional and educational experience is summarized in the curriculum vitae attached to this declaration.

2. I received a Bachelor of Science in Civil Engineering and a Masters of Science in Civil Engineering from Mississippi State University. I also hold a PhD in Civil Engineering with emphases in Environmental Engineering and Water Resources Planning and Management from Colorado State University. I am a registered Professional Engineer in the State of Mississippi and a Board Certified Environmental Engineer by the American Academy of Environmental Engineers. I am also on the Board of Directors of the Western Dredging Association.

3. I have 27 years experience as engineer, much of it related to dredging and associated environmental impacts.

4. I am familiar with the application of Southern Nuclear Operating Company ("SNC") for an early site permit (the "ESP") at the Vogtle Electric Generating Plant (the "VEGP") site. I

have reviewed excerpts of the Final Environmental Impact Statement for an Early Site Permit at the Vogtle Electric Generating Plant (the "FEIS") prepared by the staff of the Nuclear Regulatory Commissions ("NRC").

5. I am providing this declaration in support of Intervenors' motion to admit new or amended contentions.

Dredging Impacts

6. The National Environmental Policy Act ("NEPA") requires analysis of all reasonably foreseeable environmental impacts associated with the construction and operation of a new nuclear power generating facility at the VEGP site. According to the FEIS, three distinct dredging activities are required in connection with such construction and operation that could have potential environmental impacts: (i) dredging of the Federal Navigation Channel (the "FNC") in the Savannah River to its authorized dimensions of nine (9) feet deep by ninety (90) feet wide; (ii) excavation of a two hundred forty (240) foot long by one hundred seventy (170) feet wide by ten (10) feet deep (below the normal water surface) cooling water intake channel; and (iii) dredging of a barge slip to accommodate the heavy equipment needed for VEGP construction.[1] While the potential impacts of each of the aforementioned dredging activities are both foreseeable and environmentally significant (as explained below), the FEIS fails to address and/or adequately analyze them.

7. Dredging in any area where the overlying water is in contact with the Savannah River will have some environmental impacts, and – in my opinion – the impacts to the Savannah River ecosystem could be significant. Dredging typically raises concerns about benthic habitat destruction and water quality impairment. Sediment resuspended into the water column by the

[1] Excavation is also required for a discharge pipe, but will be done using conventional excavation behind a sheet pile wall.

dredging operation impairs water quality; these impacts are exacerbated when anthropogenic contaminants are associated with the sediments. Notably, the NRC staff seem to agree, identifying "…temporary loss of benthic habitat, disruption of spawning migrations, resuspension of sediments that may be contaminated, …" (FEIS 7-20) as issues of concern for the FNC dredging.

8. The extent of dredging impacts set forth in paragraph 7 of this declaration depends partially on the size and duration of the dredging operations and the areas of benthic habitat that will be disturbed. The FEIS provides that the intake channel dredging is proposed to start from the west (dry) end and move eastward, leaving the area disconnected from the river as long as possible, to minimize its impacts. However, the FEIS does not include estimates of the duration of dredging while the channel would be exposed to the river or provide the sediment volume to be removed. Moreover, these metrics cannot be estimated based upon the limited data provided in the FEIS. Without such metrics, the environmental impact of the intake channel dredging cannot be determined, much less assessed and analyzed.

9. The FNC dredging project is much larger than the intake channel dredging project. According to the FEIS, most of the FNC above rkm 56 (RM 35) will be dredged. VEGP is located at RM 150.9; thus, one hundred sixteen (116) miles of river channel (which has not been dredged since 1979 (or before) due to lack of use) will need to be dredged. For a ninety (90) foot wide channel, the requisite dredging activities could disturb one hundred forty (140) acres or more of benthic habitat and result in about two million cubic yards of sediment per foot of deepening required. Thus, this is a sizable dredging project with a significant duration. I should note that these estimates are mine, based upon information provided in the FEIS. Surprisingly, the FEIS does not even estimate of the size of the FNC dredging project, stating "[a]t the present

time the dredging project is incompletely defined, the amount of material to be removed is unknown, and the locations of the dredged material disposal areas have not been identified." (FEIS 7-20). Without these estimates, the FEIS is unable to assess or analyze the potentially substantial environmental impacts.

10. The potential impacts from these dredging projects, particularly the FNC dredging, is environmentally significant and worthy of discussion within the FEIS. The FEIS rates the potential cumulative impacts as MODERATE and the on-site impacts as SMALL, but does not provide any evidence that the ranking is based upon a quantitative evaluation. Instead, the FEIS only mentions that Section 404 permits (from the USACE and EPA) and 401 Water Quality Certifications (from the State of Georgia) will be required. Since the FEIS does not provide any quantitative analysis or adequate data to independently conduct those analyses, I cannot evaluate the MODERATE ranking suggested by the FEIS for the FNC dredging or the SMALL ranking suggested for the on-site activities.

Sediment Placement Impacts

11. The FEIS is also entirely silent on the issue of sediment placement. Dredging will require managing the generated sediments and carrier water. Whether the dredging is conducted hydraulically or mechanically, some sediment management will be necessary. Depending upon the sediment characteristics and volumes, these sediments will likely require the construction of multiple confined disposal facilities ("CDFs") along the Savannah River unless those facilities already exist and have adequate capacity. The CDFs will permanently alter the landscape and associated return water discharges could potentially have significant impacts on the Savannah River environment. In the event the sediments contain hazardous materials, additional sediment

management and disposal issues will also arise. Just as the FEIS should consider dredging impacts, it should also include an assessment of sediment placement alternatives.

I declare under penalty of perjury that the foregoing is true and correct.

Date: ___9/21/08_____

DECLARANT:

Executed in Accord with 10 CFR 2.304(d)

Donald F. Hayes
782 Sunset Strip
Sunset, LA 70584
Phone: (337) 482-5929
Email: don.hayes@environmentaldredging.com

Donald F. Hayes, Ph.D., P.E., DEE

Civil Engineering, University of Louisiana at Lafayette
Department of Civil Engineering P.O. Box 42291, Lafayette, LA 70504-229
(337) 482-5929
hayes@louisiana.edu

RESEARCH INTERESTS

Contaminated sediments
Environmental impacts of dredging, managing contaminated sediments, sediment treatment options

Coastal Restoration and Protection
Engineering design of wetlands restoration projects, use of dredged sediments for restoration, water quality considerations, sediment quality

Surface water quality
Fate and transport of suspended sediments and toxic constituents, TMDL assessment, watershed management

Systems analysis applications
Reservoir operations, stormwater management, water quality implications

EDUCATION

Ph.D., Civil Engineering, Colorado State University, December 1990
Environmental Engineering and Water Resources Planning and Management
M.S., Civil Engineering, Mississippi State University, December 1986
B.S. (honors), Civil Engineering, Mississippi State University, Dec. 1981

EMPLOYMENT HISTORY

1/07 – present	Director, Institute for Coastal Ecology and Engineering UNOCAL/BORSF Professor of Civil Engineering Department of Civil Engineering University of Louisiana at Lafayette Lafayette, LA
9/94 – 12/06	**Assistant/Associate Professor** Environmental & Water Resources Engineering Leader Department of Civil & Environmental Engineering University of Utah, Salt Lake City, UT
8/02 – 8/03 (sabbatical leave)	**Research Associate** HR Wallingford, Ltd. Wallingford, UK
8/91 to 8/94	**Assistant Professor** Department of Civil Engineering University of Nebraska – Lincoln Omaha, NE
8/87 to 8/91	**Research Civil Engineer** Environmental Engineering Division Environmental Laboratory USAE Waterways Experiment Station Vicksburg, MS
8/86 to 8/87	**Ph.D. Student** Civil Engineering Department, Colorado State University Fort Collins, CO
1/82 to 8/86	**Civil Engineer** Environmental Engineering Division Environmental Laboratory USAE Waterways Experiment Station Vicksburg, MS

AWARDS AND NOMINATIONS

2006 Outstanding Educator Award, American Water Resources Association, Utah Section.

Diplomate, American Academy of Environmental Engineers, invited based upon Eminence, November 2004.

Utah Civil Engineering Educator of the Year, 2001. Utah Section, ASCE

Best Paper Award, Dredging Contractors of America, WEDA XX/TAMU 32nd Annual Dredging Conference, Providence, RI, June 2000.

Outstanding Teaching Recognition, University of Utah, 1994-95, 1995-96, 1997-98, 1998-99, 1999-2000, 2000-2001, and 2001-2002.

Civil Engineering Department Nominee, College of Engineering and Technology Teaching Award, University of Nebraska-Lincoln, 1993.

Graduate Faculty Member, University of Nebraska-Lincoln (1992)

Waterways Experiment Station, Long-Term Training Fellowship, 1986-87.

USACE Performance Awards, 1980, 1983, 1988, 1990, 1991

Chi Epsilon Honor Society (President)

Tau Beta Pi Honor Society

SIGNIFICANT PROFESSIONAL ACTIVITIES

Member, Great Salt Lake Selenium Science Panel, October 2004 - present

Member, *Drinking Water Board*, State of Utah, 1996 – 2002 (Gubernatorial appointment).

SDWA Revolving Fund Loan Review Committee*, Utah Drinking Water Board*, 1997 – 2002.

Member*, Committee on Contaminated Marine Sediments, Marine Board*, National Academy of Engineering, 1992-1996.

Chair, *Innovative Technologies for Managing Contaminated Sediments Workshop*, sponsored by the National Academy of Engineering, April 1994, Chicago, IL.

Conference Chair, *From Swamps to Wetlands*, Center for Wetlands and Riparian Design, Salt Lake City, UT, October 1998 (250 registrants).

Official Delegate, *16th US/Japan Experts Meeting on Management of Bottom Sediments Containing Toxic Substances*, October 1993, Kitakyusu, Japan.

Committee Member, *Impact of Construction Materials on Surface and Groundwater Quality*, National Cooperative Highway Research Program (NCHRP) Research Panel 25-9, 1993 – 2000.Salt Lake City Watershed Management Advisory Committee, May 2000 - present.

Utah TMDL Task Force, Department of Environmental Quality, 1998 - Present.

Member, *Lake Powell Water Quality Improvement Technical Advisory Committee*, 1997 - present.

PROFESSIONAL ORGANIZATIONS & ACTIVITIES

Registered Professional Engineer, State of Mississippi (#09728)

American Society of Civil Engineers

- Chair, *Wetlands and River Restoration Committee*, Coastal, Oceans, Ports, and Rivers Institute (COPRI), 1999 – 2004.
- Technical Program co-chair (with David Stevens, USU), Environmental and Water Resources Institute Annual Water Congress, Salt Lake City, UT, June 2004.
- America's Wetland Task Committee, 2002-2004.
- Conference Co-chair (with J. Craig Fischenich), *2nd ASCE Wetlands Engineering and River Restoration Specialty Conference*, August 2001, Reno, NV.
- Conference Co-Chair (with J. Craig Fischenich), 1998 *ASCE Wetlands Engineering and River Restoration Specialty Conference*, March 22-27, 1998, Denver, CO.

American Water Resources Association

- President, Utah Section, 2004-05
- Technical Program Chair, *Decision Support Systems in Water Resources Management*, AWRA Conference, June 2001, Salt Lake City, UT.

Water Environment Federation

- Chair, Student Activities Committee, Utah Section, 1997 – 2002

Western Dredging Association

- Member, Environmental Commission, 1999 - present.
- Editorial Board, Journal of Dredging Engineering, 1999 – present.

INVITED PRESENTATIONS & KEYNOTE ADDRESSES

"Dredging and Dredged Material Management," NATO Advanced Research Workshop, Comenius University, Bratislava, Slovakia, May 18-21, 2005.

"Remediation PCB Contaminated Rivers: Decisions for Two Large US Rivers," University of Ghent, Feb. 21, 2003, Ghent, Belgium.

"Dredging Contaminated Sediments," NATO Pan American Advanced Studies Institute, Rio de Janeiro, Brazil, July 2002.

"Ecological Considerations for Sediment Remediation," NATO Pan American Advanced Studies Institute, Rio de Janeiro, Brazil, July 2002.

"Role of Dredging in Remediating PCB-Contaminated Sediments," *Committee on Remediation of PCB-Contaminated Sediments*, National Research Council, Sept. 28, 1999, Green Bay, WI.

"Managing Contaminated Sediments in Ports and Waterways," opening address (shared with Dr. Frank Bohlen, Univ. of Connecticut) to *National Symposium on Contaminated Sediments: Coupling Risk Reduction with Sustainable Management and Reuse*, May 27-29, 1999.

Predicting Contaminant Release During Dredging Operations, Workshop on Contaminated Sediment Remediation Options in the Port of New York and New Jersey, Rutgers University, February 1994.

INVITED PRESENTATIONS & KEYNOTE ADDRESSES (continued)

"Assessing Impacts of Environmental Dredging Operations," official US delegate and invited presentation at *16th U.S./Japan Experts Meeting on Management of Bottom Sediments Containing Toxic Substances*, Kitakyushu, Japan, October 1993.

"Anticipating Sediment Resuspension and Contaminant Release During Environmental Dredging Operations," *1992 International Environmental Dredging Symposium*, Buffalo, NY, Sept 1992.

JOURNAL PUBLICATIONS

Hong, P.K..; S. Nakra; J. Kao; and D. Hayes, "Pressure-assisted ozonation of PCB and PAH contaminated sediments," Chemosphere, 72 (2008) 1757–1764.

Choi, Y., K. Johnson, and D. Hayes, "Pilot Scale Aerated Submerged Bio-Film (ASBF) Reactor for Organics Removal and Nitrification at Cold Temperatures," Water Environment Research, Volume 80, Number 4, April 2008, pp. 292-297.

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Nakra, S.; Hong, A.; and D. Hayes, "Integrated Chemical and Biological Treatment for Polycyclic Aromatic Hydrocarbons in St. Louis River Sediment," submitted for review to Environmental Sciences and Technology.

T. Neville Burt and Donald F. Hayes, "Framework for Research Leading to Improved Assessment of Dredge Generated Plumes," *Terra et Aqua*, Number 98, pp. 20-31, March 2005.

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Reible, D.D., D. Hayes, C. Lue-Hing, J. Patterson, N. Bhowmik, M. Johnson, and J. Teal , "Comparison of the Long-Term Risks of Removal and In-Situ Management of Contaminated Sediments in the Fox River," *Journal of Soil and Sediment Contamination, 12(3):325-344.*

Wu, P.Y. and Hayes, D.F., "Verification and Modification of TSS Source Strength Models for Hydraulic Cutter Dredging Operations," ***World Dredging and Marine Construction***, August 2000.

Robins, J.P., Rock, J., Hayes, D.F., and Laquer, F.C., "Nitrate Removal From Synthetic Platte Valley, Nebraska Groundwater Using A Constructed Wetland Model," ***Environmental Technology***, Volume 21, No. 6, June 2000.

Hayes, D.F., T.R. Crockett, and T.J. Ward, "Near-Field Sediment Resuspension During Cutterhead Dredging Operations," ***ASCE Journal of Coastal, Ports, and Waterways*****,** Vol. 126, No. 3, May/June 2000.

Hayes, D.F., Labadie, J.W., Sanders, T.G., and Brown, J.K., "Optimal Hydrosystem Operation for Downstream Water Quality," ***Water Resources Research***, March 1998**.**

Kuo, A.Y. and Hayes, D.F., "A Model for Turbidity Plume Induced by Bucket Dredge," ***ASCE Journal of Waterways, Port, Coastal, and Ocean Engineering***, November 1991.

BOOKS, BOOK CHAPTERS, & SPECIAL PUBLICATIONS

J. Selke, D. Hayes, and D. Stevens (editors), ***Critical Transitions in Water & Environmental Resources Management,*** American Society of Civil Engineers, Proceedings of the 2004 World Water and Environmental Congress, June 2004 (CD-ROM).

America's Wetland Task Committee, ***Restoring Coastal Louisiana: Enhancing the Role of Engineering and Science in the Restoration Program***, American Society of Civil Engineers, 2004, ISBN 0-7844-0736-3.

Malcolm Pirnie and TAMS/EarthTech, ***Hudson River PCBs Superfund Site: Engineering Performance Standards***, US Environmental Protection Agency, April 2004. (co-author of most sections and primary technical responsibility for document)

D. Hayes and M. McKee (editors), ***Decision Support Systems for Water Resources Management***, American Water Resources Association, Proceedings of the AWRA/UCOWR 2001 Summer Specialty Conference.

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Hayes, D.F., T.J. Olin, J.C. Fischenich, and M.R. Palermo, ***Wetlands Engineering Handbook***, U.S. Army Corps of Engineers, June 2000, 812 pages (including appendices).

Hayes, D.F. (editor), ***Engineering Techniques for Wetland and Riparian Engineering***, American Society of Civil Engineers, Proceedings of the 1998 Wetlands Engineering and River Restoration Conference, December 1998, 1150 pages (CD-ROM).

Hayes, D.F. (editor), ***Presentation Summaries for the 1998 Wetlands Engineering and River Restoration Conference***, American Society of Civil Engineers, March 1998, 193 pages.

National Research Council, ***Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies***, National Academy Press, Washington, D.C., March 1997, 295 pages. (*co-author*)

USDA Soil Conservation Service, ***Wetland Restoration, Enhancement, or Creation***, USDA Soil Conservation Service, January 1992, 79 pages. (*co-author*)

Palermo, M.R. and Hayes, D.F., "Environmental Effects of Dredging," in ***Handbook of Coastal and Ocean Engineering***, Gulf Publishing Company, Houston, Texas, January 1992, pp. 1169-1175 (7 pages).

REFEREED CONFERENCE PUBLICATIONS

Averett, D.E., Hayes, D.F., and Schroeder, P.R., "Estimating Contaminant Losses During Dredging," ***Proceedings of the 15th World Dredging Congress, Las Vegas***, NV, July 1998.

Hayes, D.F., "Water Quality Management During Low-Flow Periods: A Systems Analysis Approach," in ***Computerized Decision Support Systems for Water Managers***, ASCE Press, 1989.

SOFTWARE RELEASES SOFTWARE RELEASES

CDF Design Versions 2.0 released October 2004
Description: *Complete rewrite of prior DOS version (named SETTLE) plus incorporation of hydraulic efficiency estimating routines and updated settling data analysis methods. Evaluates sedimentation test data and performs "state-point" design of confined dredged sediment disposal facilities.*
Availability: *Distributed by the U.S. Army Corps of Engineers for internal and public use.*

DREDGE Version 2.0 released December 1999
Description: *Windows application for estimating suspended sediment and contaminant concentrations resulting from environmental dredging operations; intended for a priori assessments.*
Availability: *Distributed by the U.S. Army Corps of Engineers for internal and public use.*

Cumberland River Optimization Model Version 1.0, released July 1995
Description: *Determines optimal daily releases from the nine major reservoirs in the Cumberland River to meet downstream water quality criteria during low-flow periods*
Availability: *Site-specific use only; not available for public use.*

SETTLE Version 3 released in 1993, previous versions released in 1988 and 1985.
Description: *Evaluates sedimentation test data and performs "state-point" design of confined dredged sediment disposal facilities.*
Availability: *Distributed by the U.S. Army Corps of Engineers for internal and public use.*

PCDDF USER INTERFACE released in 1988
Description: *PCDDF is a finite difference program that estimates long-term subsidence of dredged sediments in confined disposal facilities.*
Availability: *Distributed by the U.S. Army Corps of Engineers for public use from 1988 – 1994; now replaced by PSDDF which is a newer, more capable program developed by Dr. Timothy Stark, University of Illinois.*

INVENTIONS

Remediation with Ozone of Sediments Containing Organic Contaminants, United States Patent # 7,115,203 issued October 3, 2006.

In-Situ Sediment Ozonator for PCB Remediation, United States Patent # 7,011,749 issued March 14, 2006.

Automated Water Quality Monitoring System for Dredging Operations, Invention Disclosure, August 1999.

SHORT-COURSE LECTURES (since 2001)

"Mechanical Dredging," Texas A&M Dredging Short Course, College Station, TX, January 2003-2008.

"Dredging Contaminated Sediments," National Science Foundation Pan-American Advanced Study Institute on In-Situ Assessment and Remediation of Contaminated Sites, July 22-August 2, 2002, Rio de Janeiro, Brazil.

"Ecological Considerations for Sediment Remediation," National Science Foundation Pan-American Advanced Study Institute on In-Situ Assessment and Remediation of Contaminated Sites, July 22-August 2, 2002, Rio de Janeiro, Brazil.

"How to Use the Corps' Wetlands Engineering Manual," 2001 Society of Wetland Scientists Annual Meeting, Chicago, IL, June 2001.

CONFERENCE PAPERS AND PRESENTATIONS

Hayes, D.F., L. Hvasta, and W. Montgomery (2008). "Turbidity Barriers In Simple Flow Regimes," Presented at WEDA XXVIII & TAMU 39, June 2008, St. Louis, MO.

Hayes, D.F., T.D. Borrowman, and P.R. Schroeder, "Process-based Estimation of Sediment Resuspension Losses During Bucket Dredging," *Proceedings of the World Dredging Congress*, May 28 – June 1, 2007.

Palermo, M., Hayes, D., Reible, D., Verduin, J., Warren, S. and J. McAuliffe, "Onondaga Lake Sediment Remediation – Dredging And Capping Alternatives**," *Proceedings of the WEDA XXV and TAMU 37th Annual Conference***, New Orleans, LA, July, 2005.

Fidler, B.; Garvey, E.; Hayes, D; and Hess, A., "Hudson River Performance Standards: Protection and Production," ***Third International Conference on Remediation of Contaminated Sediments**, 2005.*

Hayes, D.F. and P.K. Andy Hong, "Innovative Concept for In Situ Contaminated Sediment Remediation," ***Proceedings of the WEDA XXIV and TAMU 36th Annual Conference***, Orlando, FL, July 6-9, 2004.

Burt, T.N. and D.F. Hayes, "Framework for Research Leading to Improved Assessment of Dredge Generated Plumes," ***Proceedings of the WEDA XXIV and TAMU 36th Annual Conference***, Orlando, FL, July 6-9, 2004.

Herrenkohl, M.J., Hayes, D.F., Marnicio, R., and Lally, J., "Predicting Residual Contamination In Surface Sediments After Dredging," ***Proceedings of the 2003 Pacific Coast Chapter Annual Meeting***, Maui, HI, October 2003.

Burt, T.N. and D.F. Hayes, "US-UK Cooperation On Dredging Turbidity Modeling," ***Proceedings of the WEDA XXIII and TAMU 35th Annual Conference***, Chicago, IL, June 10-13, 2003.

Hayes, Donald F., "The Dredging Process: Opportunities to Avoid Windows," ***PIANC Environmental Windows Workshop: Achieving Dredging Decisions That Balance Economic And Environmental Concerns,*** April 16, 2002, Vicksburg, MS. (Presentation Only)

Hayes, Donald F., "Toxic Constituent Losses During Dredging of

CONFERENCE PAPERS AND PRESENTATIONS

Contaminated Sediments," ***EPA Superfund Workshop on Contaminated Sediments***, Alexandria, VA, May 30-June 1, 2001.

Hayes, Donald F. and Wu, Pei-Yao, "Simple Approach to TSS Source Strength Estimates," ***Proceedings of the WEDA XXI and TAMU 33rd Annual Conference***, Houston, TX, June 25-27, 2001.

Hayes, D., Borrowman, T., and Welp, T., "Near-Field Turbidity Observations During Boston Harbor Bucket Comparison Study," ***Proceedings of WEDA XX and TAMU 32nd Annual Conference***, Providence, RI, June 2000.

Hayes, D.F., "Empirical Modeling of Flocculent Settling Processes," 1999 Annual Conference, Water Environment Association of Utah, St. George, UT, April 1999.

Hayes, D.F., "Engineering for Successful Wetland Restoration," ***Proceedings of the 1998 From Swamps to Wetlands Conference***, October 1998.

Hayes, D.F., "Designing Wetland Restoration Projects," Proceedings of the 1998 Water Environment Association of Utah Annual Conference, April 1998.

Hayes, D.F., "A Handbook for Designing Wetland Restoration Projects," ***Proceedings of the 1998 Wetland Engineering and River Restoration Conference***, March 1998.

Hayes, Donald F., "Using ADDAMS to Design Wetland Restoration Projects," ***Proceedings of the Corps of Engineers Workshop on Wetlands Restoration and Establishment, Baltimore, MD***, July 1997.

Hayes, Donald F., "Minimizing the Costs of Remediating Contaminated Sediments: Where Should Our Efforts Be Placed?," ***Proceedings of the WERC/HSRC Joint Conference on the Environment***, Albuquerque, NM, April 22-24, 1997.

Hayes, Donald F., "Ensuring a Quality Non-Traditional Engineering Graduate Program," ***Proceedings of the 1994 American Society of Engineering Education Midwest Section Meeting***, Lincoln, NE, March 1994.

Hayes, Donald F. and Douglas A. Heistercamp, "Ethical Considerations in Civil Engineering Software Development and Use," ***First Congress on Computing in Civil Engineering***, American Society of Civil Engineers, June 1994.

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Hayes, D.F. and M.R. Palermo, "Engineering Aspects of Wetland Design," **Proceedings of WATER FORUM '92**, American Society of Civil Engineers, Baltimore, MD, August, 1992.

Hayes, Donald F., "Operating Multireservoir Systems for Water Quantity and Quality," **Proceedings of the 102nd Annual Meeting of the Nebraska Academy of Sciences**, Lincoln, NE, April 1992.

Hayes, D.F., J.W. Labadie, and T.G. Sanders, "Optimal Operation of Multireservoir Hydropower Systems for Water Quality and Quantity," **Proceedings of the Fourth Water Resources Operations Management Workshop**, Mobile, AL, March 1992.

Zappi, P.A. and D.F. Hayes, "Innovative Technologies for Dredging Contaminated Sediments," **International Conference on Physical Modeling of Transport and Dispersion**, Cambridge, Mass., August 1990.

Brown, J.K. and D.F. Hayes, "Development of the Cumberland Basin Reservoir Model for Water Quality Control," **US Army Corps of Engineers Eighth Seminar on Water Quality**, February 1990.

Hayes, Donald F., "Water Quality Management During Drought Periods in the Cumberland River Basin," **Proceedings of the ASCE Water Resources for the Future: The Management Challenge Conference**, Sacramento, CA, May 1989.

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Hayes, Donald F., "Water Quality Management During Low-Flow Periods: A Systems Analysis Approach," **Proceedings of the 3rd Water Resources Operations and Maintenance Workshop, Computerized Decision Support Systems for Water Managers**, Fort Collins, CO, June 1988.

Hayes, D.F., McLellan, T.N., and G.R. Raymond, "Sediment Resuspension from Dredging Activities," **Proceedings of the ASCE Dredging '84 Specialty Conference**, Clearwater Beach, FL, November 1984.

Walski, T.M., D.F. Hayes, S.A. Pranger, and T.E. Schaefer, "Automated Dredging and Disposal Activities Management System (ADDAMS)," **Proceedings of the ASCE Dredging '84 Specialty Conference**, Clearwater Beach, FL, November 1984.

TECHNICAL REPORTS

Hayes, D.F., "Resuspension Factor Approach for Estimating Dredging-related Sediment Resuspension," Engineer Research and Development Center Technical Note DOER-Ex, September 2004. (in review)

Hayes, D.F., "Practicality of Dredging PCB-contaminated Sediments from Dick's Creek," Expert Report (letter form) to US Department of Justice, September 2004.

Hayes, D.F. and Herrenkohl, M.J., "Technically-based Cost Allocation for the Greens Bayou Stipulation Requirements," Expert Report in the matter of GB Biosciences and ISK-Magnetics vs. Occidental Chemical Corporation, July 2004.

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Hartman, G.L., Hayes, D.F., and Herrenkohl, M.J., "Comprehensive Evaluation of Alternatives for Greens Bayou," Expert Report to Fulbright and Jaworski, LLP., April 30, 2003.

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Dearden, Mary and Hayes, Donald F., "Management Plan for BP Amoco SLC Wetland," final report to BP Amoco SLC Business Unit, May 2001.

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Hayes, D. F. and C.H. Je, "User's Manual and Documentation for WinSETTLE," **Instructional Report**, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS, final report submitted June 1999.

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Hayes, Donald F., "Wetlands Creation Using Dredged Material in Tiger Pass, Louisiana," **Technical Report EL-98-xx**, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS, final report submitted August 1997.

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Hayes, Donald F., "Documentation of the SETTLE Module for ADDAMS: Design of Confined Disposal Facilities for Solids Retention and Initial Storage," **Environmental Effects of Dredging Program Technical Note EEDP-06-18**, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS, December 1992.

Maynord, S.T., Landin, M.C., McCormick, J.W., Davis, J.E., Evans, R.A. and Hayes, D.F., "Design of Habitat Restoration Using Dredging Material at Bodkin Island, Chesapeake Bay, Maryland," **Wetlands Research Program Technical Report WRP-RE-3**, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS, June 1992.

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Hayes, Donald F., "Effects of Norfolk Harbor Deepening on Management of Craney Island Disposal Area," **Miscellaneous Paper EL-88-2**, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, MS, April 1988.

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GRANTS & FUNDED PROJECTS

Augmented Supercritical Fluid for Sediment Contaminants Degradation, NOAA/CICEET, July 2005-June 2005, $25,000.

Selenium Speciation and Partitioning in Wetlands of the Great Salt Lake, Utah Department of Environmental Quality, June 2005 – December 2006, $114,203.

Treatment of Asphaltene in Petroleum Byproducts and Oil Sand for Recovery of Chemicals, Western Oil Sands, $206,050, March 2005 – March 2007 (Co-PI with Andy Hong)

In Situ Sediment Ozonator (ISO) for Remediation of PCB, PAH, and Other Recalcitrant Chemicals—Technology Demonstration with NERR Sediments, Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) Environmental Technology Development , $229,979, August 2004 – August 2006 (Co-PI with Andy Hong)

GRANTS & FUNDED PROJECTS

In-Situ Sediment Ozonator (ISO) for PCB Remediation, Planning Grant Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) Environmental Technology Development, $5,000, July 2002 – December 2002 (Co-PI with Andy Hong)

Environmental Laboratory Equipment Gift (toward GC/MS), Honeywell Corporation, $30,000, February 2004.

Evaluation of Remedial Alternatives for Greens Bayou, TX, GB Biosciences, $204,000, October 2000 – December 2004.

Design and Evaluation of a Test Section to Minimize Legacy Highway Impacts on Lateral Groundwater Flow and Great Salt Lake Wetlands, Utah Department of Transportation, $35,000, January 2001 – December 2003.

Development of a Resuspension Matrix for Estimating Water Quality Impacts From Dredging Operations, US Army ERDC Waterways Experiment Station, $42,000, June 2002 to December 2003.

Reducing Phosphorus Impacts on Lake Okeechobee Water Quality, South Florida Water Management District, $110,000, January 2001 – January 2003.

Evaluation of Remedial Alternatives for Greens Bayou, Houston, TX, GB Biosciences Corporation, $75,000, October 2000 – December 2002.

Anaerobic Digestions Aided by BioPac, EnviroBact Technologies, $4,868, November 1999 – June 2000.

Monitoring of Turbidity Generation by Bucket Dredge Operations in Boston Harbor, $3,300, USAE Waterways Experiment Station, June 1999 – June 2000.

A Methodology for Determining the Best Areas to Expand Wastewater Collection Systems in the US/Mexico Border Region, EPA Southwest Center for Environmental Research and Policy, $100,286 (with Bernardo Flores-Baez, Universidad Autonoma de Baja California and John Labadie, Colorado State University), June 1998 - May 2000.

Design of a Wetland Systems for Migratory Bird Habitat and Water Quality Improvement in Association with Secondary for System Development, City of Riverton, Utah, $220,000 (with Carollo Engineers and Western Wetland Systems), September 1999 - August 2000.

Development of a Water Quality Database for the Upper Colorado River Basin, US Bureau of Reclamation, $13,000, February 1999 - December 1999.

Evaluation of Water Quality Impacts of Abandoned Mines in the Vernon-Sheeprock Mountains, Uinta National Forest, $10,803, September 1998 - September 1999.

Comparative Evaluation of Wastewater Screens, JWC Environmental, $14,153 (with Robert Okey), October 1998 - April 1999.

Water Quality Impacts of Contaminated Sediment Removal Using Hydraulic Dredges, National Science Foundation, $95,917, August 1998 - August 1999.

GRANTS & FUNDED PROJECTS

Sedimentation Properties and Associated Mercury Release of Sediments from the Point Comfort Superfund Remediation Project, Aluminum Company of America (ALCOA), $31,000, November 1997 – December 1999

Equipment Funds for Purchase of Hydrolab DataSonde 4 Water Quality Data Collection Field Instrument, University of Utah Equipment Funds, $7,750, August 1997.

Relationship Between Water and Sediment Quality in the Jordan River, Utah Research Foundation, $6,100, July 1997 – December 1998.

Faculty Computer Upgrade Funds, Utah Technology Initiative, $15,250, July 1997.

Determination of Sedimentation Properties of White Rock Lake Sediments, Carter-Burgess Consultants, Dallas Texas, $5,000, April 1997.

Update and Enhancement of the ADDAMS Modules SETTLE, DYECON, D2M2, and PSDDF, USAE Waterways Experiment Station, $88,975, June 1997 – June 1998 (partial funding of $23,000).

Wetlands Ecology and Ecology of the Wetlands/Transition Buffer Zones, Field and Laboratory Research, unspecified amount, subcontractor to Louis Berger & Associates, East Orange, NJ, March 1997 - March 2002.

Faculty Computer Upgrade Funds, Utah Technology Initiative, $9,500, July 1996.

Wetland Creation Using Dredged Sediments in Tiger Pass, LA, U.S. Army Research Office, $13,000, August – December 1996.

Faculty Assistance for Educational Technology and Distance Education, Instructional Technology Starter/Mentor Program, July 1996 - June 1997, $5,800 (co-PI with Dr. Peter T. Martin).

Protocol for Aerobic Digestion, Central Davis County Sewer District, $3,634, Jan. - Sept. 1996 (co-PI with R.W. Okey).

Assessment of Drinking Water Quality Problems and Concerns along the U.S./Mexico Border, Southwest Center for Environmental Research and Policy (SCERP), $45,000, June 1995 - June 1996.

Development of a Model to Estimate Sediment Resuspension and Contaminant Release During Dredging Operations, USAE Waterways Experiment Station, $43,000, May - December 1995.

Sediment Retention Processes in Wetland Systems, AASERT Program, Army Research Office, $140,000, July 1994 - June 1997.

Preparation and Assimilation of Materials for a Wetlands Engineering Design Manual, USAE Waterways Experiment Station, $60,000, January 1994 - September 1996.

Improvement of Reservoir Water Quality by Constructing Barriers, Wetlands, and Sediment Traps, Omaha District, US Army Corps of Engineers, $19,000, April 1994 - December 1994.

GRANTS & FUNDED PROJECTS

Initial Development of an Automated Procedure for Sediment Resuspension and Contaminant Release Calculations, USAE Waterways Experiment Station, $8,600, August - September 1993.

Sediment Resuspension and Contaminant Release During Dredging Operations, USAE Waterways Experiment Station, $25,501, January - December 1993.

Travel Grant for Presentation and Participation in 1992 International Environmental Dredging Symposium, Erie County, NY, $800, September 1992.

Housing, per diem, and materials grant for participation in Constructed Wetlands for Wastewater Treatment Workshop, National Science Foundation Faculty Enhancement Program, Colorado State University, July 1992 and July 1993.

Documentation and Testing of the ADDAMS (Automated Dredging and Disposal Alternatives Management System) Modules - SETTLE and DYECON, USAE Waterways Experiment Station, $20,191, May - September 1992.

Review and Synopsis of Existing Literature and Ongoing Studies Involving Wetlands Engineering for Enhancement, Restoration, or Creation Activities, USAE Waterways Experiment Station,$20,704, May - September 1992.

Enhancement of Cumberland River Optimization Model and Preparation of User's Guide, USAE Waterways Experiment Station, $30,800, September 1991 - December 1992.

GRADUATE STUDENTS (COMPLETED)

Doctor of Philosophy

Chung-Hwan Je, December 1998, *Suspended Sediment Transport Considering Fine-particle Flocculation,* University of Nevada- Reno, Reno, NV.

David J. Kinnear, December 2002, *Hydrodynamic Modeling of Return Activated Sludge Density in Secondary Clarifiers*, Vice President and Wastewater Technical Director, HDR, Inc., Charlotte, NC.

Pei-Yao Wu, May 2003, *Partitioning and Transport of Mercury due to Sediment Resuspension*, Industrial Technology and Research Institute, Taiwan.

Mamunur Rashid, August 2003, *Optimal Expansion of Sewage Collection Systems*, RBF Consultants, Irvine CA. (Southern Indiana University)

Youngik Choi (co-chair with K. Johnson), May 2005, *Ammonia Nitrogen Removal In Lagoon Systems*, Silla University, Pusan, Korea.

Hua Xu (co-chair with A. Hong), December 2005, *Integrated Chemical and Biological Treatment of Persistent Bioaccumulative and Toxic Compounds*, Post-Doc, Purdue University.

GRADUATE STUDENTS (COMPLETED)

Master of Science (thesis)

Matt Myers, December 2005, *Oxidation-Reduction Potential as a Means Of Controlling Effluent Ammonia Concentration In An Extended Aeration Activated Sludge System*, CH2M Hill, Salt Lake City, UT.

Jed Hansen, May 2002, *Dynamic Modeling of TSS Release from Cutter Suction Dredges*, Law School, University of Utah.

John Cook, May 2002, *Dynamic Programming for Optimal Selection and Placement of BMPs for Stormwater Management and Quality*.

Tom Borrowman, December 2001, *Dynamic Modeling of Far-field TSS Transport from Bucket Dredging Operations,* Research Civil Engineer, USAE Engineer Research and Development Center, Vicksburg, MS..

Jaeheon Lee, December 2001, *Flocculent Settling Behavior of Dilute Kaolin Suspensions Under Non-quiesent Conditions, Ph.D. Student, University of Utah.*

Sandy Rhea, May 2001, *Optimal Wastewater Collection System Expansion*, Environmental Engineer, CH2M Hill, Salt Lake City, UT.

John Richardson, May 2000, *Accelerated Biogasification of Solid Waste and Partitioning of Pb and Cd in pH-controlled 2-phase Anaerobic Fermentation Process*, Environmental Engineer, WESTECH Equipment Corp., Salt Lake City, UT

Sarah McIllroy, December 1998, *Optimal Selection and Placement of BMPs for Stormwater Management and Quality*, Environmental Engineer, EWP Engineering, Salt Lake City, UT

Brad Rasmussen, June 1998, *Calibrating Water Quality Models for Water Distribution Systems*, Co-owner, Aqua Engineering, Bountiful, UT.

Tim Heyrend, August 1996, *Biological Arsenic Removal from Mining Wastes,* Environmental Engineer, Utah Division of Water Resources, Salt Lake City, UT

Dave Overbey, December 1995, *Use of Barriers to Protect Reservoirs from Excessive Sedimentation* Environmental Engineer, URS Greiner Woodward-Clyde, Omaha, NE

Tim Crockett, December 1993, *Modeling Near-field Sediment Resuspension in Cutterhead Suction Dredging Operations*, Environmental Engineer, HDR Engineering, Omaha, NE

Jennifer Rock (co-chair with Dr. Jeff Robins), August 1993, *Nitrate Removal from a Synthetic Groundwater Using a Constructed Wetland*, Environmental Engineer, Scott Air Force Base, IL

Master of Engineering (project report)

J. Gardner Olsen, December 2005, *Hydraulic and Water Quality Model for Finished Water in the Salt Lake City Aqueduct*, Metropolitan Water District for Salt Lake and Sandy .

Julie Cobleigh, December 2005, coursework only.

GRADUATE STUDENTS (COMPLETED)

Master of Engineering (project report) - continued

Terry Warner, December 2005, coursework only, Brown and Caldwell, Salt Lake City, UT.

Amy Thatcher, May 2005, coursework only, US Bureau of Reclamation, Salt Lake City, UT.

Jeff Lachowski, December 2004, *Engineered Vegetation Covers for Waste Rock Management: Analysis of the Bingham Canyon Waste Rock Dumps*, Kennecott Copper.

Michael Baghoomian, December 2004, *Automated Hazardous Waste Management System for USAF,* Northrop Grumman Mission Systems, Salt Lake City, UT.

Travis Higby, August 2004, coursework only.

Randy Rettig, May 2003, *GIS System for Greens Bayou Sediments*

Merrit Neff, December 2001, *Hydrologic Evaluation of Legacy Highway Wetlands*.

Christopher Cutler, December 2001, *Non-monetary Benefits of Upper Colorado River Water Storage,* Environmental Engineer, US Bureau of Reclamation, Salt Lake City, UT

Victoria Voloshina, May 2001, Effect Of Biopac® on High-Strength Sludge Digestion, Bowen Collins & Associates, Draper, UT.

Phyllis Roberge, December 2000, *Optimal Operation of Irrigation Gates in the SLC Canal*, Environmental Engineer, Stantek Consulting Engineers, Salt Lake City, UT.

Russell Davis, August 2000,*Comparison of Steady-State and Transient Simulations of Groundwater Capture Zones*, Environmental Engineer, US Army Corps of Engineers, Washington, DC.

Amy Cutler, May 2000*, Rigorous Comparison of the CE-QUAL-W2 and BETTER Water Quality Models for Reservoir Water Quality Assessments*, Environmental Engineer, US Bureau of Reclamation, Salt Lake City, UT.

Pat Limpadke, August 1999, *Comparative Evaluation of Wastewater Screens*, Environmental Engineer, Ministry of the Environment, Thailand.

David Booth, May 1999, *Hydrologic Modeling of Saline Wetlands,* CH2M Hill, Twin Falls, ID.

Susan Choi, December 1997, *Performance Evaluation and Design of Aerobic Digestion Systems*, Divinity student, San Francisco, CA

Loic Monguillon, August 1996, *More Realistic Estimates of Fine Sediment Transport*, Environmental Engineer, Air France, Paris, France.

Orest Lechnowski, August 1994, *Remediation Technologies for Contaminated Sediments*.

Kathy Willcuts, August 1993 (dual degree in Civil Engineering and Public Administration), *Public Policy Impacts on Water Resources Management*, Vice President, The Schemmer Associates, Omaha, NE.

COURSES TAUGHT

Undergraduate Courses

Environmental Engineering I	Environmental Engineering II
Fluid Mechanics/Fluids Laboratory	Hydrology
Senior Design	Water and Wastewater Treatment
Intro to Civil & Environmental Eng.	

Undergraduate/Graduate Courses

Aquatic Chemistry	GIS for Civil Engineers
Water Resources Engineering	Solid & Hazardous Waste Eng.
Water Resources Development	Water Distribution Systems

Graduate Courses

Hazardous Waste Site Remediation	Water Resources Planning
Numerical Analysis	Surface Water Quality Modeling

Systems Analysis Applications in Environmental and Water Resources Engineering

Water Quality and Pollution Control

UNIVERSITY SERVICE

University Committees

- Executive Committee, Environmental Engineering Graduate Program, 1995 – present.
- Development Committee, Environmental Certificate Program, 1998 – present.
- Associate Director, Southwest Center for Environmental Research and Policy, October 1994 – September 1995.
- Admissions Committee, *Environmental Engineering Graduate Program*, University of Utah, 1994 – present.

College of Engineering Committees

- College Computer Committee, 1995 - 2000

Departmental Committees

- Chair, Department Chair Search Committee, October 2005 – present.
- Chair, Environmental Faculty Search Committee, 2004-05.
- Chair, Water Resources Faculty Search Committee, 2002-03. (Steve Burian)
- Chair, Environmental Faculty Search Committee, 2001-02. (M. Siddiqui)
- Faculty Advisor, University of Utah ASCE Student Chapter, 1999 – 2002.
- Computer Committee, member 1994 – present (Chair 1995 – 2000)
- Scholarship Committee, 1994 – 1996; 1998-1999
- Curriculum Committee, 1995–1997
- Geotechnical Faculty Position Search Committee, 1999-2000 (Steve Bartlett)

UNIVERSITY SERVICE

- Scholarship Committee, Civil and Environmental Engineering, 1998 – 2002.
- Chair, Water Resources Faculty Search Committee, 1998-99. (Sanja Perica)
- Transportation Faculty Search Committee, 1997-98. (Pedro Romero)
- Geotechnical Faculty Position Search Committee, 1995-96 (Scott Merry)
- Departmental Representative, *Engineering College Council*, 1996 - 1999.
-
- Advisory Committee, Center for Infrastructure Research, University of Nebraska-Lincoln, July 1993 – August 1994.
- Engineering 2000, Committee on Environmental Engineering, University of Nebraska-Lincoln, 1994.
- Faculty Search Committee, Environmental Engineering, University of Nebraska-Lincoln, 1992.
- Geotechnical Engineering Faculty Search Committee, 1995. (no hire)
- Computer Committee, Civil Engineering, University of Nebraska-Lincoln, 1992 – 1994.
- Admissions Committee, Civil Engineering, University of Nebraska-Lincoln, 1992 – 1994.
- Ad Hoc Space Committee, Civil Engineering, University of Nebraska-Lincoln, 1992 – 1993.

EXPERT CONSULTING ACTIVITIES

Corr Cronin Michelson Baumgardner & Preece LLP, *Evaluation of Project Data and Operational History, General Metals vs. Bean Dredging*, September 2005 – 2007.

Parsons Brinkerhoff (Orlando), *Beneficial Uses of Phosphorus-laden Lake Sediments*, August 2005 – 2007.

TAMS/EarthTech (for New Jersey Department of Environmental Protection), *Passaic River Remedial Dredging Pilot Study*, October 2004 - 2007.

TAMS/EarthTech (for EPA), *Evaluation of Remedial Alternatives for Hastings on Hudson Superfund Project*, October 2004 - present.

US Department of Justice, *Evaluation of Dredging Options for the AK Steel RCRA Site (Expert Report)*, 2005 – 2006.

GB Biosciences & Fulbright and Jaworski (Jeffery S. Wolff, Attorney), *Arbitration Support for Cost Allocation of Remedial Activities in Greens Bayou),* January – October 2004.

Parsons, *Evaluation of Remedial Alternatives for Onondaga Lake*, October 2003 - present.

ONYX Separations Division & Boies, Schiller, & Flexner, LLP (Bruce Weil, Attorney), *Evaluation of Desanding Operations at Turkey Creek)*, September 2003 - January 2004.

Court-ordered Mediation of Remedial Alternatives (Expert Report), GB Biosciences, May - December 2003.

Development of Dredging Performance Standards for Hudson River Superfund Project, US Environmental Protection Agency Region 2 (through Malcolm Pirnie, Inc.), January 2003 - May 2004.

Evaluation of Dredging Options for the Metal Bank Superfund Site (Expert Report), US Department of Justice, October 2003 - August 2004.

Evaluation of Dredging for Remediation of the Upper Hudson River, US Department of Justice, September 2002 – present.

EXPERT CONSULTING ACTIVITIES

Modeling the Fate and Transport of PCB's in the Upper Hudson River for Remedial Alternatives, US EPA Region 2, November 2000 – November 2001.

Project Control Companies, Inc., *Expert Panel to Identify and Develop Alternatives for Remediation of PCB Contaminated Sediments in the Lower Fox River*, Appleton Papers, 2001 - 2003.

Anchor Environmental, Inc., *Evaluation of Water Quality Impacts from Dredging Contaminated Sediments*, confidential client, 2001.

Roy F. Weston, Inc., *Design and Operation of Mare Island CDFs for Unsuitable Dredged Sediment Disposal*, on-going.

URS-Greiner Woodward Clyde, San Francisco, CA, *Sediment resuspension and contaminant transport estimates for dredging activities associated with the Airport Expansion Project*, 2001.

Management of Environmental Resources, *Peer Review of SLRID Superfund Design Alternatives*, Duluth, MN, 2002 - 2004.

EXPERT CONSULTING ACTIVITIES

ERM Southwest, Houston, TX, *Remediation of DDT Contaminated Sediments*, Confidential Client, March 2000 – September 2000.

GAI Consultants, Pittsburgh, PA, *Environmental Evaluation of Hudson River Crossings for Natural Gas Pipeline*, October 1999.

Western Wetlands, Inc., Heber City, UT, *Review of Hydraulic and Hydrologic Design of Duchesne River Mitigation Plans*, 1999.

Baseline Hydrology, Park City, UT, *Constructed Wetland and Land Application Potential for Phosphorus Removal from a Summit County Wastewater Treatment Plant Discharge*, 1999.

USAE Waterways Experiment Station, *Final Revisions to Wetland Engineering Handbook*, 1999.

Gilson Engineering, Draper, UT, *Conceptual Design Development for Riverton Secondary Water System*, 1998.

Anchor Environmental, Seattle, WA, *CDF Design to Meet Water Quality Standards, Stryker Bay, MN Superfund Site*, May 1998.

Radian Corporation, Houston, TX, *Establishment of a Water Quality Monitoring Program for Contaminated Sediment Removal Operations*, November 1997.

EVS Consultants, Seattle, WA, *Estimates of Sediment Suspension for Dredging Operations in Oakland Inner Harbor*, October 1997.

USAE Waterways Experiment Station, *Evaluation of Tiger Pass Study Data*, 1997.

EA Engineering, Science, and Technology, Baltimore, MD, *Evaluation of Patented Technology for Treating New York Harbor Sediments*, February 1997.

Parsons-Brinkerhoff Corporation, Winter Park, FL, *Remediation Strategies for Contaminated Lake Sediments*, unspecified Canadian location, client settled with Environment Canada without remediation, July 1996.

DEPOSITIONS & TESTIMONY

Testimony in the matter of *General Metals of Tacoma, Inc. and Arkema, Inc. vs. Bean Environmental, LLC and Bean Dredging, LLC*, United States District Court, Western District of Washington at Tacoma, February 13, 2007.

Oral Deposition in the matter of *General Metals of Tacoma, Inc. and Arkema, Inc. vs. Bean Environmental, LLC and Bean Dredging, LLC*, United States District Court, Western District of Washington at Tacoma, October 23, 2006.

Testimony in the matter of *GB Biosciences and ISK Magnetics vs. Occidental Chemical Corporation*, Private Arbitration Proceeding, September 20, 2004.

Oral Deposition in the matter of *GB Biosciences and ISK Magnetics vs. Occidental Chemical Corporation*, Private Arbitration Proceeding, August 19, 2004.

Oral Deposition in the matter of *ONYX Industrial Services vs. St. John's River Water Management District*, 7th Judicial Circuit Court, Putnam County, FL, December 11, 2003.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)
	)
SOUTHERN NUCLEAR OPERATING COMPANY	) Docket No. 52-011-ESP
	)
(Early Site Permit – Vogtle Electric Generating Plant)	) ASLBP No. 07-850-01-ESP-BD01
_____	)

DECLARATION OF SHAWN PAUL YOUNG

I, Shawn Paul Young, do hereby declare as follows:

1. My name is Shawn Paul Young, Ph.D. I am currently a visiting Lecturer of Fisheries Management at the University of Idaho, Moscow, Idaho. I also currently hold Adjunct Faculty status at Clemson University, Clemson, South Carolina. I was previously a visiting Assistant Professor of Fisheries Biology at Purdue University, West Lafayette, Indiana. My current business address is 106B Natural Resources Building, Fish and Wildlife Resources, University of Idaho, Moscow, ID 83844. I submit this declaration as a private consultant to the Intervenors in this matter.

2. My professional and educational experience is summarized in the updated curriculum vitae attached to this declaration. I received a B.S. in Environmental Studies from Northland College; an M.S. in Aquaculture, Fisheries, and Wildlife Biology from Clemson University; and a Ph.D. in Fisheries and Wildlife Sciences from Clemson University. I have eleven years of experience researching the effects of human activities on fisheries and aquatic ecosystems, including six years of experience studying fisheries in the Savannah River Basin. In addition to

my professional qualifications, I am an avid outdoorsman – fishing, hunting, and enjoying nature in every manner since my early childhood.

3. I have in publication, in press, and in review twenty-seven peer-reviewed articles relevant to fisheries and aquatic ecology. I have been consulted by public, state, federal, and academic sectors in the subject area of fish and aquatic ecology. I have presented scientific presentations at numerous professional meetings, academic seminars, and citizen fishing association functions.

4. I am familiar with the application of Southern Nuclear Operating Company ("SNC") for an Early Site Permit (an "ESP") at the Vogtle Electric Generating Plant (the "VEGP") site. I have reviewed excerpts of the Final Environmental Impact Statement (the "FEIS") prepared by the staff of the Nuclear Regulatory Commission (the "NRC"), including those sections describing water intake, water consumption, and thermal discharge into the Savannah River associated with the proposed additional nuclear power generating units (the "New Units"), and the subsequent potential impacts of such New Units on the fish assemblage of the Savannah River.

5. I am providing this affidavit in support of Intervenors' motion to admit new or amended contentions. The opinions and conclusions I express in this declaration are my own and should not be attributed to any academic institution. This declaration sets forth my scientific opinion that the FEIS (including the information cited therein) does not provide adequate data or analysis to properly evaluate the potential effects of the New Units on fishery resources of the Savannah River. I have applied my knowledge and experience to the scenarios and data explained in the FEIS, and I believe my opinions and conclusions to be true and correct.

6. The opinions and conclusions set forth in previous affidavits I have submitted in connection with SNC's ESP application, supporting Intervenors' previously admitted

environmental contentions, remain unchanged. Regrettably, the FEIS contains the same insufficiencies in data and logic which I opined upon in connection with the Draft Environmental Impact Statement (the "DEIS"). The NRC staff still has not provided a current detailed data set of Savannah River fish, including information regarding (1) life history stages of each species occurring near VEGP, (2) respective migration timing of each species, (3) distribution patterns of each species in the immediate vicinity of VEGP, and (4) population numbers. Moreover, the recent ichthyoplankton sampling data to address entrainment continues to be unavailable. Without the Savannah River fish and ichthyoplankton data (as further explained in the following paragraphs of this declaration), the FEIS conclusion that impacts due to entrainment, impingement, and thermal discharge will be small or minor is inappropriate and scientifically unsubstantiated.

7. In addition, as was the case with the DEIS, the FEIS provides limited background information and over-simplifies concepts in river ecology in an effort to support the conclusions of the NRC staff. The FEIS also fails to provide the comprehensive discussion required to properly evaluate the impacts from current operations at VEGP and from construction and operation of the New Units.

8. The Academy of Natural Sciences of Philadelphia (the "ANSP") surveys continue to be used to support the NRC staff conclusion that VEGP has had no appreciable effects on Savannah River fish. In a previous affidavit that I submitted in connection with SNC's ESP application, dated November 11, 2007, I explained in detail why ANSP surveys are not an adequate indicator of VEGP impacts (including impacts of the New Units) to the entire fish assemblage. My conclusions and opinions set forth in that affidavit regarding the adequacy of ANSP surveys remain unchanged. Briefly again, because ANSP surveys capture mainly small resident fish

species, with sampling occurring on a very limited basis, these surveys fail to (i) collect adequate data on diadromous fish species, and (ii) collect sufficient data to evaluate larger, main channel species such as sucker species and catfish species.

9. The FEIS (2-81) does not adequately describe the ichthyoplankton community near VEGP in its discussion regarding ichthyoplankton distribution. While the FEIS states that American shad were the most dominant ichthyoplankton in the river, its discussion regarding the American shad is limited. In fact, the FEIS merely states that American shad eggs were concentrated along the bottom of the water column, and then concludes – because of such concentrations – that the current and future operation of the VEGP will result in only minor impacts. In reaching this conclusion, the NRC staff fails to discuss other factors which could affect American shad egg distribution, and thus VEGP's impacts on ichthyoplankton. By contrast, such impacts were considered when Paller (1995) in a study of the horizontal distribution of American shad eggs in the drift at two main intakes for the Savannah River Site ("SRS"). Paller found a higher abundance of American shad eggs along the Georgian bank, and stated that the study results revealed "the importance of site specific assessments of ichthyoplankton distribution near existing or proposed water intakes using statistical designs that permit sensitive resolution of spatial patterns." I agree with Paller, and assert that specific ichthyoplankton studies are required to determine the current and future impact of VEGP on ichthyoplankton populations. It should be noted that the discussion in the FEIS regarding oxbow habitat has no relevance to evaluating impacts on the ichthyoplankton population.

10. The FEIS sets forth certain information regarding the six fish species in decline and considered most imperiled and/or most important to Savannah River fisheries (FEIS, 2-81 – 2-91); however, very little information is provided regarding causes for such population decline.

In order to accurately evaluate impacts of the construction of the New Units and operation of the VEGP (including the New Units) on these fish species, causes for population decline must be more fully articulated. In addition, chapter 2 of the FEIS does not contain a sufficient discussion regarding other fish species at risk of population decline as a result of construction of the New Units and operation of VEGP (including the New Units).

11. Although the proposed dredging required for construction of the New Units (including dredging required to re-open the shipping channel) will likely have very large and severely negative impacts on the aquatic species located in the Middle, Lower, and estuarine Savannah River, these impacts are insufficiently assessed and analyzed. Freshwater mussels, shortnose sturgeon, Atlantic sturgeon, striped bass, robust redhorse, and other catostomids, catfish species, and numerous benthic organisms may be affected by the dredging.

12. Such dredging may (i) disrupt food web dynamics, affecting the aforementioned species, including the endangered shortnose sturgeon (Shortnose Sturgeon Recovery Team 1998) and rare robust redhorse (which are benthic feeders), and (ii) affect spawning success of some of the aforementioned species, including the striped bass. In fact, previous dredging activities have been cited as a cause for the decline of numerous Savannah River fish (Duncan et al. 2003) such as Atlantic sturgeon (Atlantic Sturgeon Review Team 2007). Dredging may also degrade chemical aspects of water quality and re-suspend contaminants, which contaminants may then in turn be bioaccumulated by mussels and other organisms (Bellas et al. 2007). Further, previous dredging has been identified as a major cause for freshwater mussel decline (Ricciardi and Rasmussen 1999). The EIS mentions the potential for benthic organism (i.e. the freshwater mussel) relocation, yet surprisingly provides no detail concerning this potentially disastrous

proposal. Relocations of freshwater mussels have had variable success (Cope and Waller 2006) – with some relocation attempts resulting in 100% mortality (Killeen et al. 1998).

13. With the large-scale dredging, a thorough freshwater mussel survey for the entire affected area should be completed. The last survey conducted by the U.S. Fish and Wildlife Service in 2006 (FEIS, 2-76) was incomplete, as it failed to survey a forty-four mile segment around VEGP. Further, because each mussel species has specific fish hosts and habitat requirements, a thorough discussion of each mussel species' life history is also required. Unfortunately, the FEIS does not contain sufficient information to adequately assess and analyze the impacts of the construction of the New Units and operation of the VEGP (including the New Units) on these freshwater mussels.

14. The assessment of cumulative impacts on aquatic resources from the construction and operation of the New Units is lacking adequate analysis, reasoning and detail. First, the NRC staff states that "natural" stressors will contribute to cumulative impacts from operation of the New Units (FEIS, 7-21). This statement disingenuously portrays nature as the culprit for the decline of fisheries and general aquatic health, instead of human activities (including operation of VEGP). Second, the NRC staff contends that because the southeastern United States suffers from periodic drought, and because aquatic species have the ability to tolerate these natural temporary reductions in habitat, such species can withstand operation of four units at VEGP. Accordingly, the NRC staff concludes that the cumulative impacts of the New Units will be minor (FEIS, 7-22). This conclusion does not hold merit as aquatic animals have the ability to withstand natural seasonal cycles of flow without compounding effects from anthropogenic stressors. Anthropogenic effects (including operation of VEGP) will increase and maintain added stress that will be exacerbated during periodic drought. Natural resilience does not equate

into resilience to human activities. Third, the NRC staff's explanation of how ichthyoplankton population size and productivity vary between "oxbows"[1] and "straight" portions is grossly oversimplified. The ichthyoplankton community, while passively drifting with the river flow, moves through both "oxbows" and "straight" sections. A substantial portion of the drift community will not simply occupy a small limited habitat within the "oxbows" or "straights", but will drift substantial linear distances across multiple river segments. This drifting must be considered when evaluating the cumulative impacts across time and space within a river basin, as well as the localized impacts. Inexplicably, the NRC staff fails to consider it. Fourth, the NRC staff cites conclusions made by Paller et al. (1986) and Sprecht (1987) that SRS operations (resulting in entrainment during water withdrawals and thermal discharge) have had minor effects on the Middle Savannah River Basin (FEIS 7-22, 23). Then, the NRC staff asserts that VEGP has had minor or no observable impacts in the past, and predicts that it will continue to have minor or no observable impacts in the future. Such assertions and predictions are wholly unsubstantiated. As stated in a previous affidavit, Marcy et al. (2005) identifies SRS and VEGP as direct causes to decline of the Middle Savannah River Ecosystem. Fifth, the FEIS fails to consider the cumulative impacts the construction and operation of the New Units will have on each individual aquatic species. Instead, the FEIS lumps all species together, and purports to analyze the impacts from an "aquatic ecological perspective." Such an analysis is inaccurate and insufficient – because activities may affect each species differently, the impact of each activity must be evaluated on a species-by-species basis.

15. The FEIS (7-23) examines cumulative impacts to aquatic biota under "normal" operation scenarios (operation at average capacity during average river flow). However, the cumulative

[1] Because the river does not enter the floodplain under current flow regulation, true oxbows are no longer accessible. Therefore, I assume "oxbows" refer to meanders.

impacts from four unit operation should also be evaluated for the worst case scenario (operation at maximum capacity during severely reduced flow). Extreme drought may severely impact fish and aquatic organisms and needs to be considered. Moreover, an evaluation of both normal operation conditions and worst case conditions would reveal chronic and acute effects, all of which may substantially impact fish and aquatic organism populations. In fact, the impacts on fish and aquatic organism populations during extreme (worst case) conditions are at least as harmful as long-term impacts associated with normal operation conditions. Paller (1992) supports the proposition that direct and cumulative impacts of additional units must be evaluated for worst case flow scenarios (in addition to "normal" scenarios) at water intake structures, and concludes that "[e]ntrainment at SRS intakes is greatest when periods of high river water usage coincides with low river discharge. American shad and striped bass are the two species of greatest concern because of their recreational and commercial importance and because they produce drifting eggs and larvae vulnerable to entrainment."

16. The Hydraulic Zone Influence study was conducted while water intake was only at 56% capacity during a limited range of flows. For a complete and accurate analysis, the modeling should also include the impact at full capacity under different flows.

17. The FEIS completely fails to evaluate cumulative impacts from the multitude of water users in the Middle Savannah River Basin. Duncan et al. (2003) discuss the need for adequate and natural flow regimes to improve status of Savannah River fish populations, in particular the six species of main interest discussed on pages 2-81 – 2-91. Increased water withdrawal, thermal discharge, and construction from the New Units, together with increased withdrawals and discharges by other users, will impede such natural flow regimes and thus negatively impact

many Savannah River organisms. The FEIS simply does not provide the information required to determine the magnitude of such impacts.

I declare under penalty of perjury that the foregoing is true and correct.

Date: September 22, 2008

DECLARANT:

[Executed in Accord with 10 CFR 2.304(d)]

Shawn Paul Young
106B Natural Resources Building
Fish and Wildlife Resources
University of Idaho
Moscow, ID 83844

Literature Cited

Atlantic Sturgeon Status Review Team. 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

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Dr. Shawn P. Young

106B Natural Resources Building
Fisheries and Wildlife Resources
University of Idaho
Moscow, ID 83844

Office: (208) 885 - 6001
Cell: (765) 427 - 3997
syoung@uidaho.edu

EDUCATION

PhD Fisheries Sciences. May 2005. Clemson University. Clemson, SC.
MS Fisheries Sciences. August 2001. Clemson University. Clemson, SC.
BS Environmental Studies. May 1996. Northland College. Ashland, WI.

PROFESSIONAL EXPERIENCE

Lecturer	University of Idaho	Aug 2008 - Dec 2008
Visiting Scientist	University of Iceland	July 2008 - Aug 2008
Visiting Assistant Professor	Purdue University	Aug 2007- May 2008
Postdoctoral Researcher	Clemson University	Oct 2006 - Aug 2007
Consultant	At-will	Jan 2005 - Present
Biologist/Facility Manager	Clemson University	Jun 1999 - May 2006
Fisheries Technician	Idaho Fish and Game	Apr 1997 – June 1999

TEACHING EXPERIENCE

Visiting Assistant Professor of Fisheries and Aquatic Sciences (Aug 2007 – May 2008)
Department of Forestry and Natural Resources; Purdue University, West Lafayette, IN

FNR 546 - Fish Ecology: Lectures discuss various topics including adaptations to life in aquatic habitat, biogeography, environmental biology, reproduction, life history strategies/niche selection, behavior, and population dynamics.

FNR 545 - Fisheries Management (Fall 2007): Lectures discussed principles, techniques and models to manage recreational and commercial fisheries. Topics included history and legislation, gear types, sampling methods, data acquisition and analysis, age and growth, population structure in terms of effort / catch / mortality / yield, and strategies for restoration of depleted fish populations.

FNR 501 - Limnology: Lectures discuss the properties of water and the physical, chemical, and biological processes of inland waters. Examples of the interdisciplinary nature of limnology to other fields of study such as fisheries, forestry, agriculture, and water resource management will be introduced.

FNR 371 – Watershed Hydrology Practicum: Field exercises and seminar will discuss watershed hydrology. The topics will emphasize the inter-relationships between terrestrial, riparian and aquatic systems including water budgets, nutrient transport and cycling, and energy flow.

FNR 103 - Introduction to Environmental Conservation (Fall 2007): Lectures encompassed ecological, political, and social aspects of environmental issues such as energy production and consumption, waste

management, land use/agriculture, air pollution, toxicology, and water resources.

Lecturer – Fisheries and Aquatic Ecology (Fall 2005 – Spring 2007)
Department of Forestry and Natural Resources; Clemson University, Clemson, SC

WFB 840 Fish Ecology (Spring 2007; Team-taught course): My lectures discussed environmental biology, biotic interactions, trophic cascading, migrations/behavior, and fish community assemblages.

ENR 302 Natural Resource Measurements (Spring 2006; Team-taught course w/ lab): My lectures focused on aquatic survey methods and techniques. Lecture/Lab topics included bio-telemetry; water quality / environmental monitoring; capture and tagging methods for fish and aquatic invertebrates; population estimation of fish and aquatic invertebrates; and stream habitat surveying.

WFB 300 Wildlife and Fisheries Biology (Fall 2005; Team-taught course): My lectures focused on introductory fish taxonomy; marine and freshwater fish ecology; and fish physiology and environmental biology.

RESEARCH EXPERIENCE:

Post-Doctoral Researcher (November 2006 – July 2007)
Department of Forestry and Natural Resources; Clemson University, Clemson, SC.

My research focused on fish ecology and behavior in altered river-systems. I conducted research on anadromous and resident fish species in the Apalachicola River to determine Alabama shad spawning population size, behavior/movement during spawning migration, and passage at lock-and-dam facilities; and also, age, growth, and ecological description of catostomid species. I also conducted studies of freshwater mussels to evaluate tagging methods, movement after relocation, and behavior in fluctuating flow regimes. *(please refer to Publications)*.

Adjunct Professor – Fisheries/Aquatic Ecology/Aquaculture (August 2005 – Present)
Department of Biological Sciences; Clemson University, Clemson, SC.

Committees:

Age, growth, and fecundity of Alabama shad in the Apalachicola River. Thesis. T. Ingram. 2006.

Population estimate of spawning Alabama shad in the Apalachicola River. Thesis. P. Ely. 2007.

Genotype-specific spawning behavior of striped bass in the Apalachicola River. Thesis. M. Noad. 2007.

Paleochannel delineation of the Neuse River, North Carolina. Thesis. B. Wrege. 2007.

Research Biologist/Facility Manager (June 2000 – May 2006)
Aquatic Animal Research Laboratory; Clemson University, Clemson, SC.

I conducted research and managed facilities at a leading fisheries/aquaculture research laboratory. Our research specialized in identifying factors that affect fish and aquatic invertebrate physiology, behavior, and population dynamics. I conducted research on habitat requirements of marine, estuarine, anadromous, and freshwater species at the larval, juvenile, and adult life-history stages. *(please refer to Publications and Presentations)*. I also assisted with the research and preparation of the following:

- Using mixed-ion supplementation in Pacific white shrimp culuture. 2007. Thesis. K. Parmenter.
- Multi-scale habitat associations of selected primary burrowing crayfish. 2006. Dissertation. S. M. Welch.
- Low-salinity resistance of juvenile cobia (Rachycentron canadum). 2006. Thesis. K. L. Burkey.
- Responses of Pacific white shrimp (Litopenaeus vannamei) to water containing low concentrations of total dissolved solids. 2005. Thesis. A. D. Sowers.

- Responses of hybrid striped bass exposed to waterborne and dietary copper in fresh- and saltwater. 2003. Dissertation. G. K. Bielmyer.
- Ecology and culture of Procambarus acutus acutus. 2003. Dissertation. Y. Mazlum.
- Effects of environmental and dietary factors on tolerance of Nile tilapia Oreochromis niloticus to low temperature. 2002. Dissertation. H. L. Atwood.
- Low-temperature tolerance of southern flounder Paralichththys lethostigma: effect of salinity. 2000. Thesis. W. E. Taylor.

Graduate Research Assistant (June 1999 – May 2005)
SC Cooperative Fish and Wildlife Research Unit; Clemson University, Clemson, SC.

My dissertation and thesis utilized several telemetry field studies to identify seasonal migration patterns, daily movement patterns, and seasonal habitat selection in relation to reservoir limnology/ hydroelectric generation; sources and magnitude of mortality; temporal and spatial patterns of mortality; and, potential to successfully live-release striped bass angled during fishing tournaments. *(please refer to Publications and Presentations)*. Through graduate coursework, I also acquired extensive knowledge of fisheries science and management; physiology, ecology and conservation of aquatic organisms; limnology and hydrology; and experimental statistics *(please see transcripts).* I also assisted with the following:

- Reproductive ecology and seasonal migrations of robust redhorse (Moxostoma robustum) in the Savannah River, Georgia and South Carolina. 2006. Dissertation. T. B. Grabowski.
- A behavioral comparison of hatchery-reared and wild shortnose sturgeon in the Savannah River, South Carolina-Georgia. 2003. Thesis. D. Trested.
- Diel movement of hatchery-reared and wild shortnose sturgeon in the Savannah River, South Carolina-Georgia. 2003. Thesis. T. E. Griggs.
- Movement of migrating American shad in response to flow near a low head lock and dam. 2003. Thesis. S. T. Finney.
- Population size and movement of American shad at New Savannah Bluff Lock and Dam. 2002. Thesis. M. M. Bailey.
- Seasonal and diel movement of largemouth bass in a South Carolina stream. 2001. Thesis. T. A. Jones.
- Habitat utilization by striped bass in Lake Murray, South Carolina. 2001. Thesis. J. J. Schaffler.

Fisheries Technician (April 1997 - May 1999) Idaho Dept of Fish & Game; Bonners Ferry, ID

I conducted research on the effects of hydroelectric generation on behavior and survival of salmonids (rainbow trout and bull trout), burbot, and white sturgeon in the Kootenai River, ID-MT. Major responsibility was to conduct large-scale radio-telemetry and trapping studies to acquire knowledge of seasonal movements, migratory behavior, and recruitment.

CONSULTING: Aquatic Ecology / Fisheries Expert

Southern Alliance for Clean Energy, Atlanta/Savannah, GA (March 2008 - Present): I provide expert review and affidavit opinion on the environmental impact pertaining to potential impacts of nuclear expansion on the Tennessee River, AL.

Turner Environmental Law Clinic, Emory University; Atlanta, GA. (November 2006 – Present): I provided review and affidavit opinion on the environmental impact pertaining to potential impacts of nuclear expansion on the middle Savannah River, GA/SC. Also, I provided review on draft petition to designate critical habitat for the endangered goldline darter and blue shiner.

Southern Environmental Law Center, Charlottesville, VA. (January 2005 – August 2006): I provided scientific review and affidavit opinion of environmental pertaining to potential impacts of nuclear expansion on the North Anna/Pamunkey River, VA.

PUBLICATIONS:

Fish Ecology and Management:

1. Grabowski, T. B., **S. P. Young**, L. A. Libungan, A. Steinarsson, and G. Marteinsdottir. (*in progress*). Evidence of phenotypic plasticity and local adaption in metabolic rates between components of the Icelandic cod (*Gadus morhua* L.) stock.

2. Ely, P. and **Young, S. P.**, and J. J. Isely. (*in press*). Population size and relative abundance of Alabama shad reaching Jim Woodruff Lock and Dam, Apalachicola River, Florida. Submittal: North American Journal of Fisheries Management.

3. Ely, P. and **Young, S. P.**, and J. J. Isely. (*in revision*). Passage of spawning Alabama shad at Jim Woodruff Lock and Dam, Apalachicola River, Florida. Submittal: Transactions of the American Fisheries Society.

4. **Young**, **S. P.**, P. Ely, M. Noad, and J. J. Isely. (*in review*). Age, growth, and relative abundance of skipjack herring in the Apalachicola River, Florida.

5. **Young**, **S. P.**, P. Ely, T. Grabowski, and J. J. Isely. (*in review*). Age, growth, fecundity, and reproductive strategy of catostomids in the Apalachicola River, Florida. Submittal: Ecology of Freshwater Fish.

6. **Young, S. P**. and J. J. Isely. (*in review*). Striped bass habitat selection strategies to maximize metabolic scope under different limnological conditions. Submittal: Transactions of the American Fisheries Society.

7. **Young, S.P.**, P. Ely, T. Grabowski, and J. J. Isely. (*in review*). Discovery of highfin carpsuckers in the Apalachicola River, Florida. Submittal: Southeastern Naturalist.

8. Welch, S. M., **S. P. Young,** and N. T. Grzych. (*in review*). Historical inland migration of several diadramous fishes in South Carolina waters. Submittal: Southeastern Naturalist.

9. **Young, S.P.**, T. A. Ingram, J. J. Isely, and J. J. Schaffler. (*future work*). Use of otolith microchemistry to determine juvenile outmigration timing and adult repeat spawning of Alabama shad in the Apalachicola River, Florida.

10. **Young, S. P.**, and J. J. Isely. (*future work*). Comparison of CPUE and size-selectivity of electrofishing and angling of riverine clupeids.

11. **Young, S. P**. and J.J. Isely. 2007. Summer diel behavior of striped bass using tailwater habitat as summer refuge. Transactions of the American Fisheries Society 136: 1104-1112.

12. **Young**, **S. P.**, and J.J. Isely. 2006. Post-tournament live-release survival, dispersal, and behavior of adult striped bass. North American Journal of Fisheries Management 26: 1030-1033.

13. **Young**, **S. P.**, and J.J. Isely. 2004. Temporal and spatial estimates of adult striped bass mortality from telemetry and transmitter return data. North American Journal of Fisheries Management 24: 1112-1119.

14. **Young, S. P.** and J.J. Isely. 2002. Striped bass annual site fidelity and habitat utilization in J. Strom Thurmond Reservoir, South Carolina-Georgia. Transactions of the American Fisheries Society. 131: 828-837.

15. Isely, J. J., **S. P. Young**, T. A. Jones, and J. J. Schaffler. 2002. Effects of antenna placement and antibiotic treatment on loss of simulated transmitters and mortality in hybrid striped bass. North American Journal of Fisheries Management. 22: 204-207.

Fish physiology and aquaculture:

16. Burkey, K. B., **S. P. Young**, J. R. Tomasso, and T. I. J. Smith. 2007. Low-salinity resistance of juvenile cobia. North American Journal of Aquaculture 69: 271-274.

17. **Young, S. P.**, J.R. Tomasso, and T.I.J. Smith. 2007. Survival and water balance of black sea bass held in a range of salinities and calcium-enhanced environments after abrupt salinity change. Aquaculture 258: 646-649.

18. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Resistance of cobia, *Ranchycentron canadum*, juveniles to low salinity, low temperature, and high environmental nitrite concentrations. Journal of Applied

Aquaculture 15: 191-195.

19. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Information on selected water quality characteristics for the production of black sea bass, *Centropristis striata*, juveniles. Journal of Applied Aquaculture 15: 183-190.

20. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2003. Effect of temperature and salinity on survival, growth, and condition of juvenile black sea bass. Journal of the World Aquaculture Society 34: 398-402.

21. Atwood, H. L.; **S. P. Young**, J. R. Tomasso, and T.I.J. Smith. 2001. Salinity and temperature tolerances of black sea bass juveniles. North American Journal of Aquaculture 63: 285-288.

Aquatic invertebrate conservation:

22. **Young, S. P**. and J. J. Isely. (*in revision*). Tag retention, relocation probability, and mortality of passive integrated transponder and dummy transmitter tagged *Elliptio complanata* in a South Carolina Piedmont stream. Submittal: Journal of Molluscan Studies .

23. **Young, S. P**. and J. J. Isely. (*in revision*). Behavioral response of the freshwater mussel *Elliptio complanata* to fluctuating water levels. Submittal: Journal of North American Benthological Society.

24. **Young, S. P**. and J. J. Isely. (*in progress*). Behavior of translocated freshwater mussels *Elliptio complanata* in a South Carolina piedmont stream.

Aquatic invertebrate physiology and aquaculture:

25. Parmenter, K. and Bisesi, J., **S. P. Young**, J. R. Tomasso, and C. L. Browdy. (*in press*). Survival and growth of pacific white shrimp, *Litopenaeus vannamei*, postlarvae in a variety of mixed-salt environments comprised of multiple ion ratios. Submittal: Journal of the World Aquaculture Society.

26. Sowers, A. D. and **Young, S. P.,** M. Grosell, C. L. Browdy , and J. R. Tomasso. 2006. Hemolymph osmolality and cation concentrations in *Litopenaeus vannamei* during exposure to low concentrations of dissolved solids: Relationship to potassium flux. Comparative Biochemistry and Physiology 145(2): 176-180.

27. Sowers, A. D.**,** D. M. Gatlin, **S. P. Young**, J. J. Isely, C. L. Browdy, and J. R. Tomasso. 2005. Responses of *Litopenaeus vannamei* (Boone) in water containing low concentrations of total dissolved solids. Aquaculture Research 36: 819-823.

28. Sowers, A. D. and **Young, S. P.,** J. J. Isely, C. L. Browdy , and J. R. Tomasso. 2004. Nitrite toxicity to *Litopenaeus vannamei* in water containing low concentrations of sea salt or mixed salts. Journal of the World Aquaculture Society 35: 445-451.

29. Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and C. L. Browdy. 2003. Survival and growth of pacific white shrimp, *Litopenaeus vannamei*, postlarvae in low salinity and mixed-salt environments. Journal of the World Aquaculture Society 24: 518-523.

SELECTED PRESENTATIONS:

Young, S.P. 2007. Thermal biology of fish. Penn State University. State College, PA.

Young, S.P. 2007. Population estimates and passage of Alabama shad at Jim Woodruff Lock and Dam, Apalachicola River - Florida. Purdue University. West Lafayette, IN.

Young, S.P. 2006. Behavioral thermoregulation and metabolic scope of striped bass in various aquatic environments. Austin Peay University. Clarksville, TN.

Young, S.P. 2006. Behavioral thermoregulation and metabolic scope – Lecture for comparative anatomy and physiology. Clemson University. Clemson, SC.

Young, S.P. and J.J. Isely. 2005. Post-tournament live-release survival, dispersal, and behavior of adult striped bass. American Fisheries Society annual meeting. Anchorage, AK.

Young, S.P. 2005. Behavioral thermoregulation by striped bass. Lake Superior State University. Sault-sainte Marie, MI.

Young, S.P. and J.J. Isely. 2005. Striped bass ecology and management. Clarks Hill Striped Bass Anglers Association. Augusta, GA.

Young, S.P. and J.J. Isely. 2005. Post-tournament live-release survival, dispersal, and behavior of adult striped bass. Trout Unlimited. Upstate South Carolina Chapter.

Young, S.P. and J.J. Isely. 2004. Temporal and spatial estimates of adult striped bass mortality from telemetry and transmitter return data. Annual meeting of the American Fisheries Society. Madison, WI.

Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Effect of temperature and salinity on survival, growth, and condition of juvenile black sea bass. 28th Annual Larval Fish Conference, Early Life History Section, American Fisheries Society. Clemson, SC.

Atwood, H.L.; **S.P. Young**, J.R. Tomasso, and T.I.J. Smith. 2004. Resistance of cobia juveniles to low salinity and low temperature. 28th Annual Larval Fish Conference, Early Life History Section, American Fisheries Society. Clemson, SC.

Young, S.P. 2004. Learning in Fishes: from three-second memory to culture. Department of Biological Sciences. Clemson University.

Young, S.P. 2003. Life skills training for hatchery fish: Social Learning and Survival. Department of Biological Sciences. Clemson University.

Young, S.P. 2003. Mechanisms for learning during early life stages of fish: Imprinting, Homing, and Con-specific Learning. Dept of Biological Sciences. Clemson University.

Young, S.P. 2002. Strain-specific characteristics to manage sub-populations of fish species. Department of Biological Sciences. Clemson University.

AWARDS:

- Animal Research Committee Excellence Award. 2004. Clemson University. $2,000
- Animal Research Committee Excellence Award. 2003. Clemson University. $2,000
- Outstanding Classified Employee Award. 2003. Clemson University. $1,000
- Employee Performance Award. 2003. Clemson University. $1,000

PROFESSIONAL MEMBERSHIP:

- American Fisheries Society
- North American Benthological Society
- World Aquaculture Society

REFERENCES:

Research and future potential:

Dr. Jeff Isely (Graduate Advisor)
Associate Professor
SC Cooperative Fish &Wildlife Research Unit
Clemson University, Clemson, SC
(864) 656-1265
(864) 506-6070
jisely@clemson.edu

Dr. Joe Tomasso (Past Supervisor)
Department Chair
Department of Biology
Texas State University – San Marcos, TX
(512) 245-4886
jt33@txstate.edu

Dr. Quenton Fontenot
Peer, Assistant Professor of Biology
Department of Biological Sciences
Nicholls State University, Thibodaux, LA
(985) 449-7062
Quenton.Fontenot@nicholls.edu

Dr. Tim Grabowski
Peer, Assistant Research Professor
Institute of Biology
University of Iceland
(011) -354-525-4280
tbg@hi.is

Teaching:

Dr. Robert Swihart
Department Chair and Professor
Dept of Forestry and Natural Resources
Purdue University, West Lafayette, IN
(765) 494-3590
rswihart@purdue.edu

Dr. Patricia Layton
Department Chair
Dept of Forestry and Natural Resources
Clemson University, Clemson, SC
(864) 656-4829
playton@clemson.edu

Environmental Consulting:

Rick Parrish or Morgan Butler, Staff Attorney
Southern Environmental Law Center
201 West Main Street, Suite 14
Charlottesville, VA 22902
(434) 977 – 4090

Larry Sanders, Staff Attorney
Turner Environmental Law Clinic
Emory University School of Law
1301 Clifton Road
Atlanta, GA 30322
(404) 712-8008

Sarah Barczak, Safe Energy Director
Southern Alliance for Clean Energy
428 Bull Street, Suite 201
Savannah, GA 31401
(912) 201-0354

SAVANNAH RIVER BASIN

DROUGHT CONTINGENCY PLAN

U.S. ARMY ENGINEER DISTRICT, SAVANNAH

MARCH 1989

SYLLABUS

The Savannah River Basin Drought Contingency Plan has been developed to address the operation of the three principal Corps of Engineers impoundments on the Savannah River and their effects on the downstream portion of the river, and to assist the States of Georgia and South Carolina in drought contingency planning in their portions of the Savannah River Basin. It will also be useful to the State of Georgia in notifying water users in all other river basins in Georgia during a drought.

In 1986 through 1989, the worst drought in recent history created severe water shortage conditions over extensive areas of the Southeastern United States. At the three Corps impoundments on the Savannah River, Hartwell, Richard B. Russell, and J. Strom Thurmond (formerly Clarks Hill), inflows were the lowest recorded this century.

The severity of the drought created conditions which stressed the traditional management concepts followed in regulating the individual Corps impoundments and the interbasin system approach which integrated water management of the three lakes. Concerns and conflicts over competing water uses intensified as drought conditions became more severe and lake levels continued to fall. During 1986, the Savannah District developed a Short-Range Drought Water Management Strategy to address the worsening water shortage conditions in the Savannah River Basin. That document served as a guide for using the remaining storage in the Corps operated Savannah River impoundments for the duration of the drought. The short-range strategy also served as a prelude to the development of a long-term drought strategy. This manual presents that long-term strategy. Six water-use priorities were identified and evaluated under different management scenarios: Fish and Wildlife Management, Hydropower, Navigation, Recreation, Water Quality, and Water Supply.

The difficulty in accurately defining the beginning of a drought as it is occurring hampers the ability to make appropriate management responses. It is desirable to have an indicator or triggering mechanism to initiate management action before a crisis occurs.

The indicator that has been chosen for this plan is lake level. Although it does not account for meteorologic factors, as do some indicators, it has the advantage of simplicity. Using lake levels for a triggering mechanism is readily understandable by the public, and easily implemented requiring no complex computations.

A significant development under this plan is the establishment of the Savannah River Basin Drought Coordination Committee (SRBDCC) composed of representatives of the Corps of Engineers and the States of Georgia and South Carolina. This will provide for improved communication and information exchange among the agencies involved.

This drought contingency plan is an attempt to balance the negative impacts of the drought. We recognize the competing interests among project purposes - fish and wildlife management, hydropower, navigation, recreation, water quality and water supply - and the possibility that they may not be fully satisfied.

This is a dynamic plan, subject to change as warranted by additional information. Among the items that may be cause for reconsideration are: additional experience with the current drought, further studies of salinity intrusion in Savannah Harbor, changing water supply needs, improvements to water intakes, and the uncertain future operational plan at the Savannah River Plant.

U.S. ARMY CORPS OF ENGINEERS

SAVANNAH RIVER BASIN

DROUGHT CONTINGENCY PLAN

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SAVANNAH RIVER BASIN
DROUGHT CONTINGENCY PLAN

BACKGROUND

Drought created severe water shortage conditions over extensive areas of the Southeastern United States in 1986 through 1989. The drought was the worst in recent history for the Southeast. At most impoundments in the region the drought conditions resulted in pool elevations declining to record or near record low levels. Impoundments operated by the U.S. Army Corps of Engineers were especially "hard-hit" due to the various competing uses for which these lakes are managed. At the three large Corps impoundments on the Savannah River (Hartwell, Richard B. Russell, and J. Strom Thurmond Dams and Lakes), inflows were the lowest recorded this century.

The severity of the drought created conditions which stressed the traditional management concepts followed in water management of the three lakes. Concerns and conflicts over competing water uses intensified as drought conditions became more severe and lake levels continued to fall. During 1986, the Savannah District developed a Short-Range Drought Water Management Strategy to address the worsening water shortage conditions in the Savannah River Basin. That short range plan served as a guide for using the remaining storage in the Corps' operated Savannah River impoundments for the duration of the drought.

This document, the Savannah River Basin Drought Contingency Plan, has been developed to address the operation of the three principal Corps impoundments on the Savannah River and their effects on the downstream portion of the river, and to assist the State in notifying water users in all other river basins in Georgia during a drought.

The action levels presented here have been modified from the previous plan in response to comments received from state and local agencies and the public. The number of levels at which releases are reduced has been lowered from four to two. The 6300 cfs and 5400 cfs outflow levels have been abolished. The 4500 cfs level has been raised to elevation 324 ft msl at Thurmond, 654 ft. msl at Hartwell, in the summer and 322 ft msl at Thurmond, 652 ft. msl at Hartwell, in the winter. The 3600 cfs level has been lowered to elevation 316 at Thurmond and 646 at Hartwell. The winter-summer variation of the action levels has been changed to coincide with the operational rule curve.

The result of this is to initiate significant action at an earlier point in the drought. By delaying the initiation of the 3600 cfs level, many of the water quality concerns are alleviated.

The purpose of the variation in the 4500 cfs level is that historic pool records show a number of years where the pool temporarily dips

to the 322-324 level in the winter then quickly refills. The more severe dry periods begin earlier in the year and the actions are not effected by the variation in the curve.

SAVANNAH RIVER BASIN

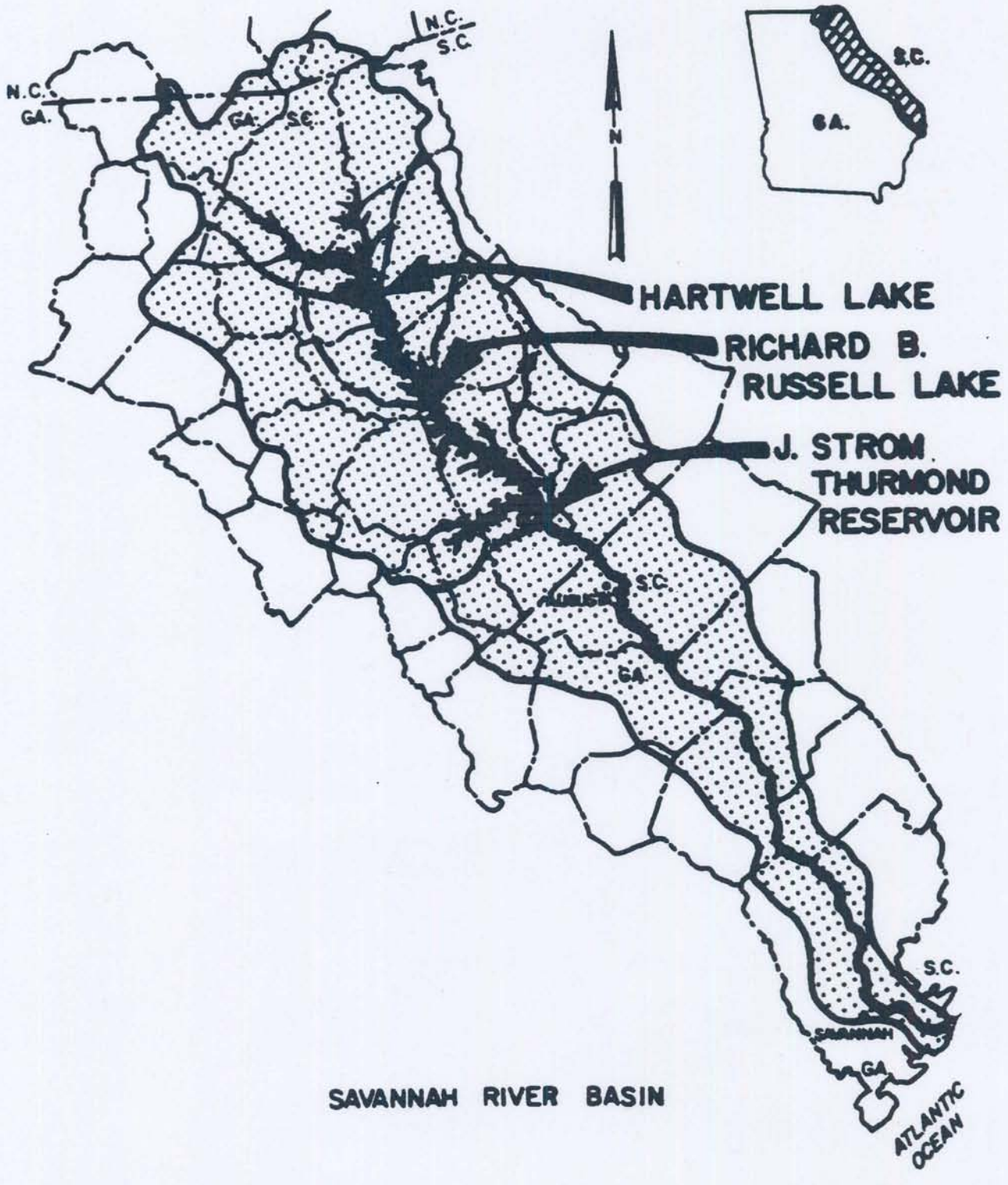
Basin Description. The Savannah River Basin is a long, relatively narrow basin, with the longer axis lying in a northwest-southeast direction as shown on Figure 1. Major drainage basins in the State of Georgia for which the Savannah District has permitting responsibilities are shown on Figure 2. The Charleston District has permitting responsibilities as shown on Figure 3. The maximum length of the basin is about 250 miles and the maximum width about 70 miles. The total area of the basin is 10,579 square miles, of which 179 square miles are in North Carolina, 4,530 square miles in South Carolina, and 5,870 square miles in Georgia. The Savannah River is formed by the confluence of the Seneca and Tugaloo Rivers, which have their headwaters on the southern slopes of the Blue Ridge Mountains in North Carolina just north of the boundary with South Carolina and Georgia. The river meanders in a southeasterly direction through the Piedmont Plateau and Coastal Plain and with its tributaries forms the boundary between Georgia and South Carolina from the North Carolina state line to the Atlantic Ocean.

Several principal streams make up the Savannah River system. The Tallulah and Chattooga Rivers unite to form the Tugaloo River; Twelve Mile Creek joins the Keowee River to form the Seneca River. The upstream Little River, South Carolina, enters the Keowee River about 5.6 miles above its mouth. The confluence of the Tugaloo and Seneca Rivers, known as The Forks, is the beginning of the Savannah River proper and is now submerged by Hartwell Lake. Broad River and Little River enter the Savannah River into J. Strom Thurmond Reservoir from the west about 54 and 24 miles above Augusta, respectively. Downstream Little River and Stevens Creek enter the Savannah River on the east about 38 and 9 miles above Augusta, respectively. Horse Creek enters the river from the east about 2 miles below Augusta, and Brier Creek from the west about 109 miles below Augusta. The length of the Savannah River from The Forks to the mouth is about 312 miles. Approximately 45 miles of the lower river are influenced by tidal action.

Drainage Area Addressed By Strategy. The Savannah River is the major river within the basin and, of its 312 miles, the entire length is now regulated by three Corps of Engineers projects, each with appreciable storage. The three lakes, Hartwell, Russell, and Thurmond, form a chain of lakes approximately 120 miles long.

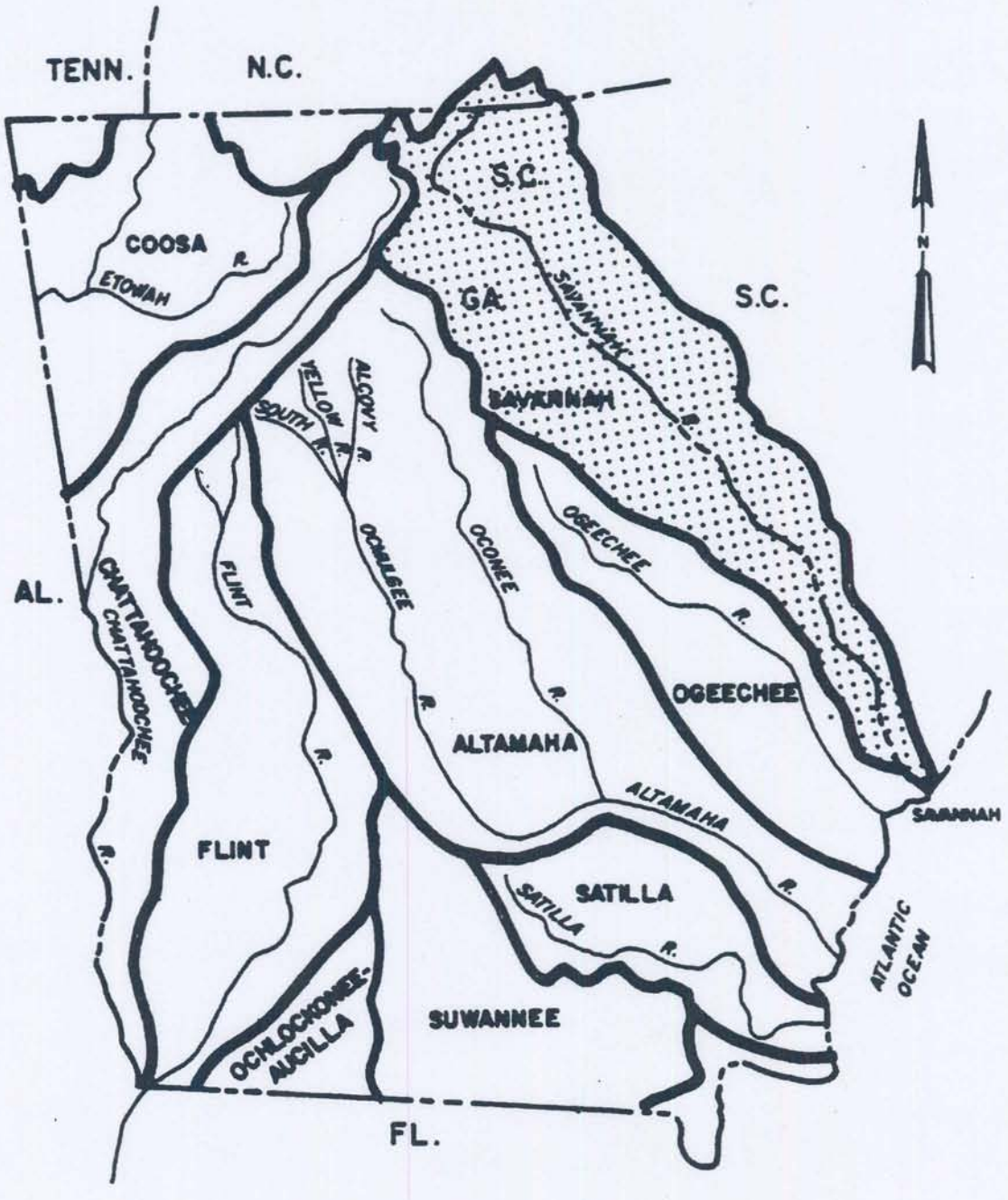
J. Strom Thurmond Reservoir. The J. Strom Thurmond Dam and Reservoir, completed in 1954, was the first multiple-purpose project to be completed in the comprehensive plan of development for the Savannah River Basin. It is located 22 miles upstream from Augusta. U.S. Highway 221 crosses the dam.

Richard B. Russell Lake. Authorized for construction by the 1966 Flood Control Act as the Trotters Shoals Dam, the Richard B. Russell Dam and Lake project was the third multiple-purpose project to be built in the Savannah River Basin. It was completed in 1986.



SAVANNAH RIVER BASIN

FIGURE 1



LEGEND

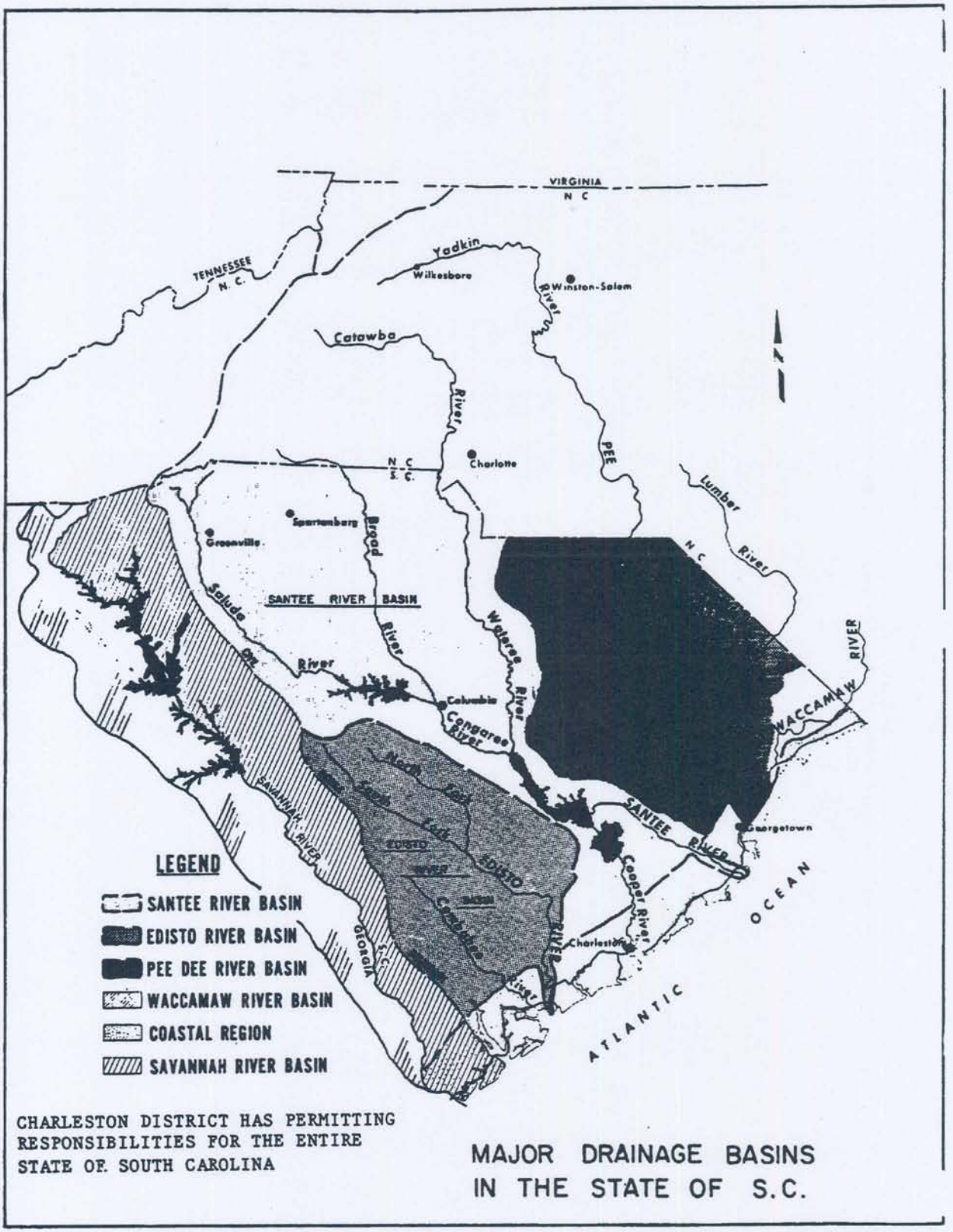
MAJOR RIVERS

MAJOR DRAINAGE BASINS

NOTE:
SAVANNAH DISTRICT HAS PERMITTING RESPONSIBILITIES FOR THE ENTIRE STATE OF GEORGIA.

MAJOR DRAINAGE BASINS IN THE STATE OF GEORGIA

FIGURE 2



CHARLESTON DISTRICT HAS PERMITTING RESPONSIBILITIES FOR THE ENTIRE STATE OF SOUTH CAROLINA

MAJOR DRAINAGE BASINS IN THE STATE OF S.C.

FIGURE 3

The dam is located on the Savannah River 275.1 miles above its mouth, 63 miles above Augusta, and about 16 miles southeast of Elberton, Georgia. Pumped storage was authorized for the Russell project and, with the 300,000 kilowatts of pumped storage, it will be capable of providing more peaking power than J. Strom Thurmond and Hartwell projects combined.

Hartwell Lake. The Hartwell Dam and Lake project is on the upper Savannah River, 89 miles above Augusta, Georgia, and 7 miles below the confluence of the Tugaloo and Seneca Rivers, which form the Savannah. It was the second multiple-purpose project to be completed in the Savannah River Basin. Construction started in October 1955. Filling of the reservoir began in February 1961 and was completed in 1962.

Table 1 gives the drainage areas at the three projects along the Savannah River.

Table 1

Drainage Area Above Specific Locations
On The Savannah River
Savannah River Basin = 10,579 sq. mi. (GA, S.C., & N.C.)

Location	Drainage Area (Square Miles)	Accumulative Percentage of Savannah River Basin
Hartwell Dam	2,088	20
Richard B. Russell Dam	2,837	27
J. Strom Thurmond Dam	6,144	58
Mouth	10,579	100

PROJECT PURPOSES AND RESERVOIR REGULATION

General. The Savannah District's water control management activities consist of the overall management of the Corps' three multiple-purpose projects located on the Savannah River above Augusta, Georgia.

The first project, J. Strom Thurmond, was completed in 1954 with an installed capacity of 282,000 KW. The second, Hartwell Dam, was placed in operation in 1962 with four 66,000 KW and minimum provisions for a fifth unit. This additional 80,000 KW installation was completed in November 1983, bringing the total installed capacity at Hartwell to 344,000 kilowatts. Richard B. Russell was the third project constructed and 300,000 KW of conventional installation was placed in operation in January 1986. An additional 300,000 KW of pumped storage generating capacity is planned.

J. Strom Thurmond and Hartwell are regulated and managed according to established operating guides or rule curves. These curves determine optimum elevations for yearly operations (as shown on Figures 4 and 5).

The lakes are maintained as near to the full pool level as possible from April through September. In October through December the target pool levels, or guide curves, gradually fall to 4 feet below the full conservation pool level. This provides an additional amount of flood control storage during the spring months. The drawdown is a result of the low inflows normally received during the fall months combined with the required outflow necessary to produce hydropower and provide for water quality and water supply purposes. The storage depleted by the winter drawdown is replenished by the spring runoff, returning levels to full power pool in April. A constant guide curve has been adopted for Richard B. Russell Lake because it has only 5 feet of conservation storage, and no flood storage drawdown is necessary.

These curves serve only as guides. Actual operation may vary somewhat depending on meteorologic conditions, power demand, water quality, flood control and recreation considerations.

Fish and Wildlife Management. The Savannah District, in cooperation with the States of Georgia and South Carolina, manages the fish and wildlife resources at the Federal reservoirs in the Savannah River Basin. Management decisions are based on the supply and demand for these resources as reflected in surveys. Lake elevations are maintained at a constant level during the spawning season. Stocking programs are determined according to creel surveys. Food plot and hunting programs are developed to control wildlife populations and provide public use of gamelands.

Flood Control. Hartwell, Richard B. Russell, and J. Strom Thurmond Lakes each have 5 feet of flood control storage with top of flood control pool at elevation 665.0, 480.0, 335.0 respectively. The combined storage is 810,000 acre-feet. Since 1954, when the J.

Strom Thurmond Project was completed, the system has prevented over $30,000,000 in flood damages.

Hydropower Operations. All power produced at Federal projects (except TVA and St. Stephens) in the states of Georgia, South Carolina, North Carolina, Virginia, Florida, Kentucky, Tennessee, West Virginia, and Alabama is marketed by the Southeastern Power Administration (SEPA).

SEPA combines the three Savannah District projects with seven projects in the Mobile District to form the Georgia-Alabama System. Hydropower may be supplied by any combination of projects within the ten-plant system. The three Savannah District projects produced 1,261,314 megawatt-hours of energy during Fiscal Year 1987 (FY 87). This amounted to 44 percent of the total Georgia-Alabama System output.

Navigation. The authorization of the Hartwell and J. Strom Thurmond Projects includes navigation on the lower Savannah River as a project purpose. During the early operation of J. Strom Thurmond and Hartwell Lakes (1953-1972), there was navigation traffic on the river from Augusta to Savannah. By the late seventies, waterborne commerce was limited to the transportation of oil to Augusta by the Koch Oil Company. In 1979, Koch discontinued their shipping operations. Since that time, except for limited movements of construction related items, no commercial shippers have used the river. Maintenance dredging of the river was discontinued in 1979. The lock at the New Savannah Bluff Lock and Dam (NSBL&D) is being operated with advanced notice of 24 hours by the city of Augusta for limited lockage of recreational boat traffic; boats may be locked through during business hours Monday through Friday. The lock and dam also serves as a reregulation structure for the flows out of Stevens Creek Dam. The cooperation of South Carolina Electric and Gas Company is needed during low flow periods regarding reregulation at Stevens Creek Dam.

A 5800 cfs flow from J. Strom Thurmond Dam was authorized to provide a 9 foot navigation channel. At present, minimum flows from J. Strom Thurmond Dam are based on the flow required by downstream water users.

Recreation. Although not identified as a project purpose in the authorizing legislation for the Hartwell Project, recreation is considered to be a project purpose under authority of Section 4 of the Flood Control Act of 1944 and the Federal Water Project Recreation Act of 1965 (PL 89-72). Recreation was recently added as a project purpose at J. Strom Thurmond Lake. There were more than 22 million visitors during 1987 at J. Strom Thurmond Lake and Hartwell Lake combined. Both of these lakes were among the ten most visited Corps of Engineers lakes in the United States. Russell Lake has recreation as a project purpose and is already experiencing considerable use even though the recreation facilities will not be complete until early 1991.

Water Quality. Like all deep water lakes in the southeast, J. Strom Thurmond, Hartwell, and Richard B. Russell thermally stratify in the warm summer months. During this time the water, circulated by the wind and thus rich in dissolved oxygen, is confined to the top 30 feet of these lakes. The dissolved oxygen in the lower layer of the lakes is gradually depleted by chemical and biological processes. Since the turbine intakes at these projects draw water from the lower portion of the lakes, the releases have progressively lower dissolved oxygen levels during the summer months.

Dissolved oxygen, temperature, conductivity, oxidation reduction potential (ORP), and pH measurements are recorded for the releases at each reservoir on a continuous basis. These measurements are then transferred by a computer via telephone linkage to the Savannah District office. This data is reviewed to insure water quality parameters are met at the various reservoirs. Additional measurements are made of lake elevation, dam discharge, and rainfall from a 54 gage network.

Dissolved oxygen problems are solved at the Richard B. Russell project with a diffused oxygen injection system. This system, installed during construction of the project, oxygenates the reservoir releases so that dissolved oxygen is maintained at or above six parts per million. The high cost of installing similar systems at the completed J. Strom Thurmond or Hartwell projects is prohibitive. At these projects turbine aeration could increase dissolved oxygen up to two parts per million if necessary, although it would reduce turbine efficiency.

Minimum flows from J. Strom Thurmond Dam are based on the flow required by downstream water users. The Department of Energy's Savannah River Plant (SRP) has three operating nuclear reactors and uses water (approximately 945 cfs) from the Savannah River for cooling. A large percentage of the water is returned to the river after cooling. Low flow tests conducted during the 1980-81 drought established 3600 cfs as the minimum acceptable flow for a one reactor operation. Due to changes in their operations, the SRP now has a minimum desired flow of 4880 cfs to ensure a three-reactor operation and 4,130 cfs for a two-reactor operation.

In the lower Savannah River, salinity levels are continuously measured by four punch-tape type recording gages. The recording charts are removed every 2 weeks by the U. S. Geological Survey, processed and the results are sent to the Corps' Savannah District approximately 10 days later. The four gages are located at: (1) the I-95 bridge, 1.2 miles downstream of Abercorn Creek, (2) the intake to the Luknow Canal on Little Back River, which supplies fresh water to the Savannah National Wildlife Refuge, (3) inside the Luknow Canal near the downstream gate, and (4) the U. S. Highway 17 Houlihan Bridge on Front River.

Salinity data is collected manually on a routine basis whenever high tides and low river flows warrant. This data is used to determine the extent of saltwater penetration in Front, Middle and Little Back Rivers during adverse conditions and is immediately available for analysis.

Water Supply. The Savannah River is the source of water supply for 64 domestic and industrial users, of which 20 withdraw directly from the lakes. Total withdrawals amount to approximately one billion gallons per day. Several water supply intakes are located in the New Savannah Bluff Lock and Dam pool, and several downstream users depend on releases from the dam. The largest downstream users are the Department of Energy's Savannah River Plant and the Georgia Power Company's Plant Vogtle nuclear facility. At the lower end of the basin, fresh water intakes and canals are maintained by the Beaufort-Jasper Water Supply Authority, the city of Savannah Municipal and Industrial Plant, and the Savannah National Wildlife Refuge.

WATER SHORTAGE INDICATOR

The inability to define the beginning of a drought as it is occurring hampers the ability to make appropriate management responses. It is desirable to have an indicator or triggering mechanism to initiate management action before a crisis occurs.

The indicator that has been chosen for this plan is lake level. Although it does not account for meteorologic factors as do some indicators, it has the advantage of simplicity. Using lake level as a water shortage indicator is readily understandable by the public, and easily implemented, requiring no complex and time consuming computations. It must be stressed that these action levels will serve as a guideline, but that extraordinary and/or unforeseen conditions could justify delaying or accelerating the management action.

The levels at which action is taken are shown in Table 2 and Figures 4 and 5. When the pool elevation at either Hartwell or Thurmond reaches these specified levels, we will take the prescribed action. The Russell pool level is not used as a trigger mechanism because of the limited drawdown at that project. At the action levels, the trigger elevation will initiate a series of actions that will culminate in the reduction of releases from the projects. It should be recognized that the reductions will not necessarily be instantaneous with the trigger level being reached, but rather flows will be reduced after a 2 week notification. The 2 week lag between reaching an action level and implementation of the reduction is to provide the time necessary for coordination and notification of water users.

TABLE 2
Hartwell Action Levels

*Level	APR 18- OCT 15 (ft-msl)	** DEC 1 - JAN 1 (ft-msl)	Action
1	656	655	Public Safety Information
2	654	652	Reduce Thurmond discharge to 4500 cfs, reduce Hartwell discharge as appropriate to maintain balanced pools (See page 16)
3	646	646	Reduce Thurmond discharge to 3600 cfs, reduce Hartwell discharge as appropriate to maintain balanced pools
4	625	625	Continue Level 3 discharge as long as possible, thereafter Outflow = Inflow

*Level as shown on Figure 4.
**Lake elevations for the periods January 1 to April 18 and October 15 to December 1 are linearly interpolated from this data as shown in Figure 4.

TABLE 2 (continued)
Thurmond Action Levels

*Level	May 1 - Oct 15 (ft-msl)	** Dec 15 - Jan 1 (ft-msl)	Action
1	326	325	Public Safety Information
2	324	322	Reduce Thurmond discharge to 4500 cfs
3	316	316	Reduce Thurmond discharge to 3600 cfs
4	312	312	Continue Level 3 discharge as long as possible, thereafter Outflow = Inflow

*Level as shown on Figure 5.
**Lake elevations for the periods January 1 to May 1 and October 15 to December 15 are linearly interpolated from this data as shown in Figure 5.

Hartwell Reservoir Action Levels

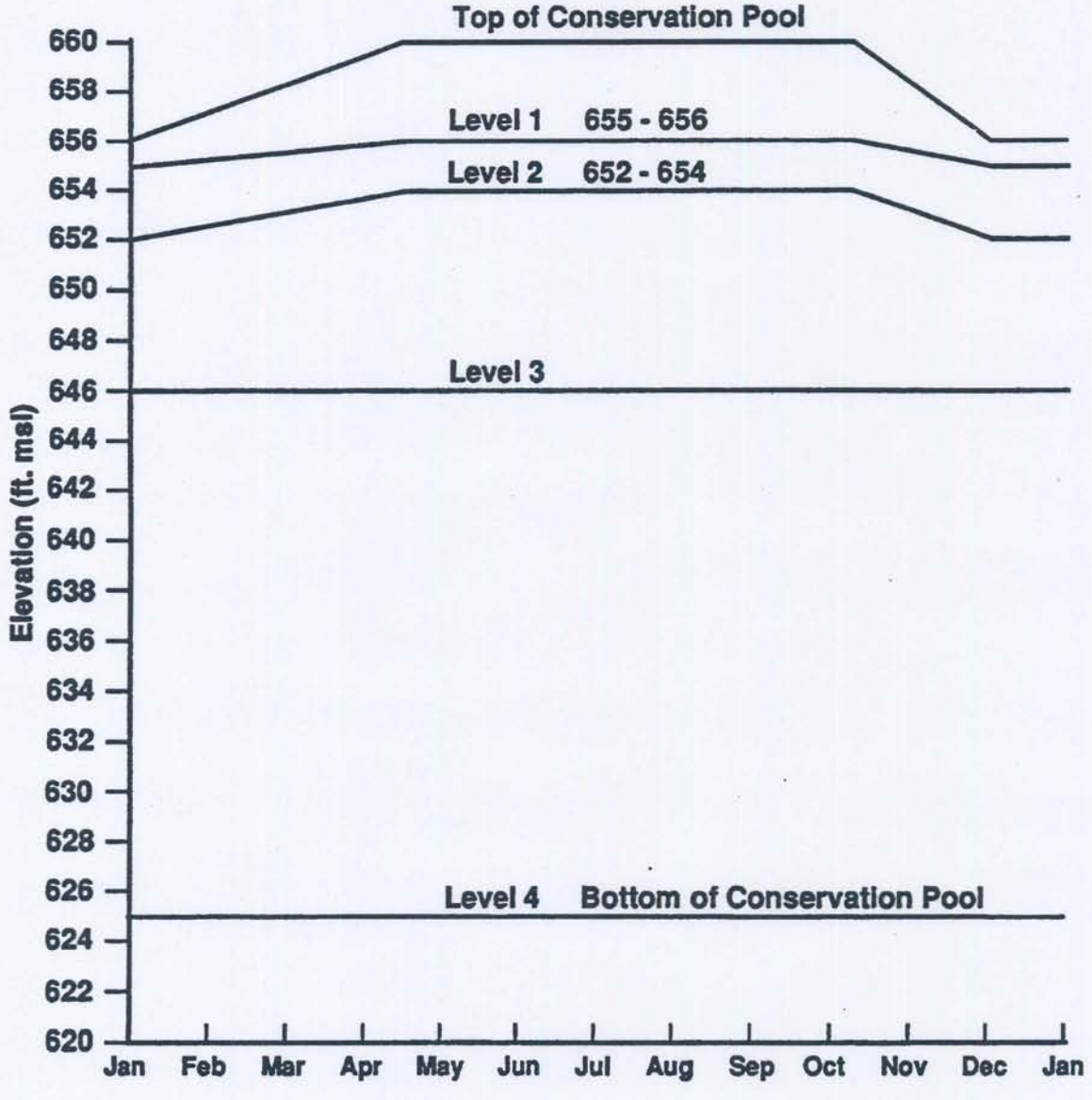


Figure 4

TABLE 2 (continued)
Thurmond Action Levels

*Level	May 1 - Oct 15 (ft-msl)	** Dec 15 - Jan 1 (ft-msl)	Action
1	326	325	Public Safety Information
2	324	322	Reduce Thurmond discharge to 4500 cfs
3	316	316	Reduce Thurmond discharge to 3600 cfs
4	312	312	Continue Level 3 discharge as long as possible, thereafter Outflow = Inflow

*Level as shown on Figure 5.
**Lake elevations for the periods January 1 to May 1 and October 15 to December 15 are linearly interpolated from this data as shown in Figure 5.

Hartwell Reservoir Action Levels

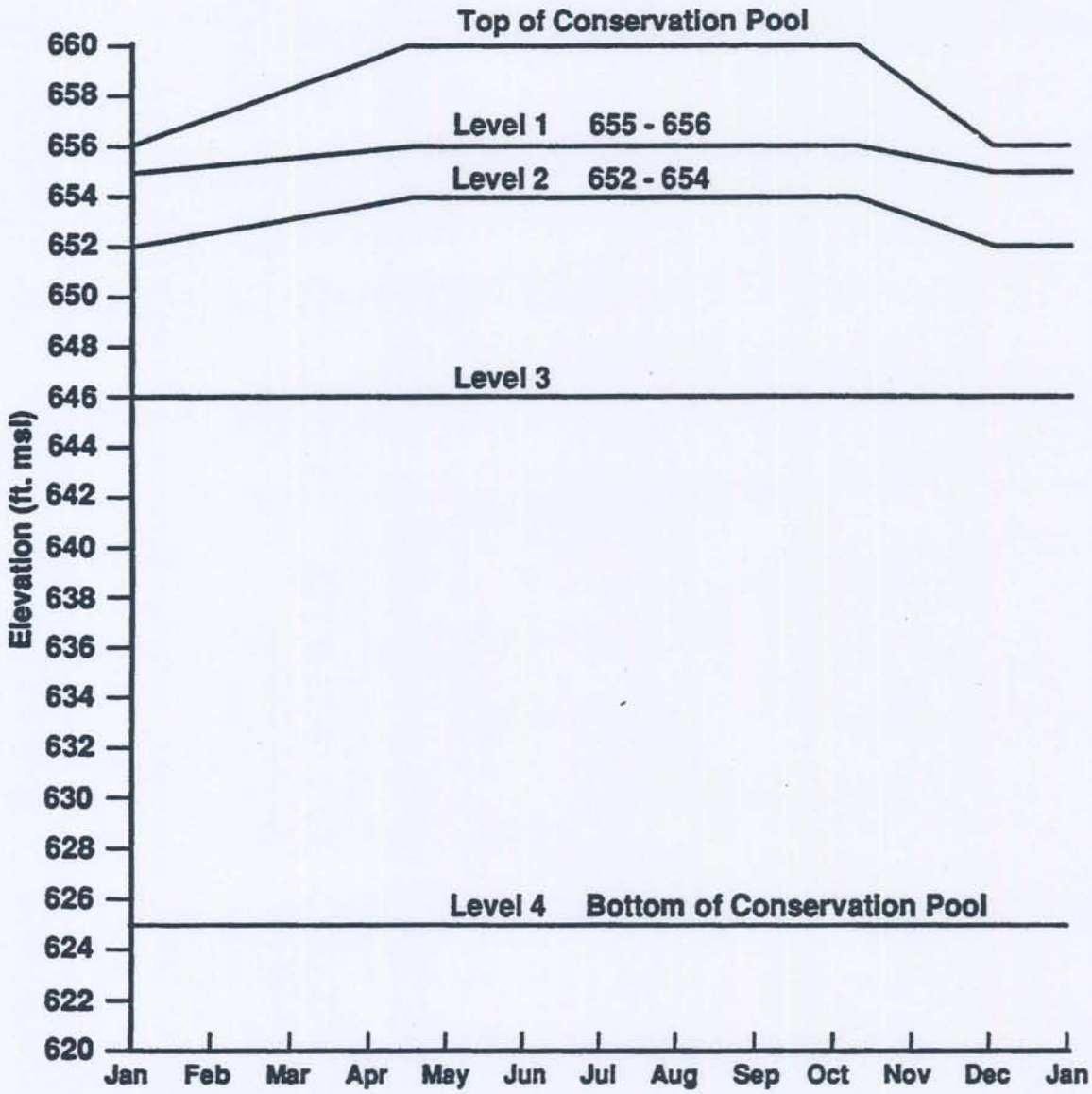


Figure 4

Thurmond Reservoir Action Levels

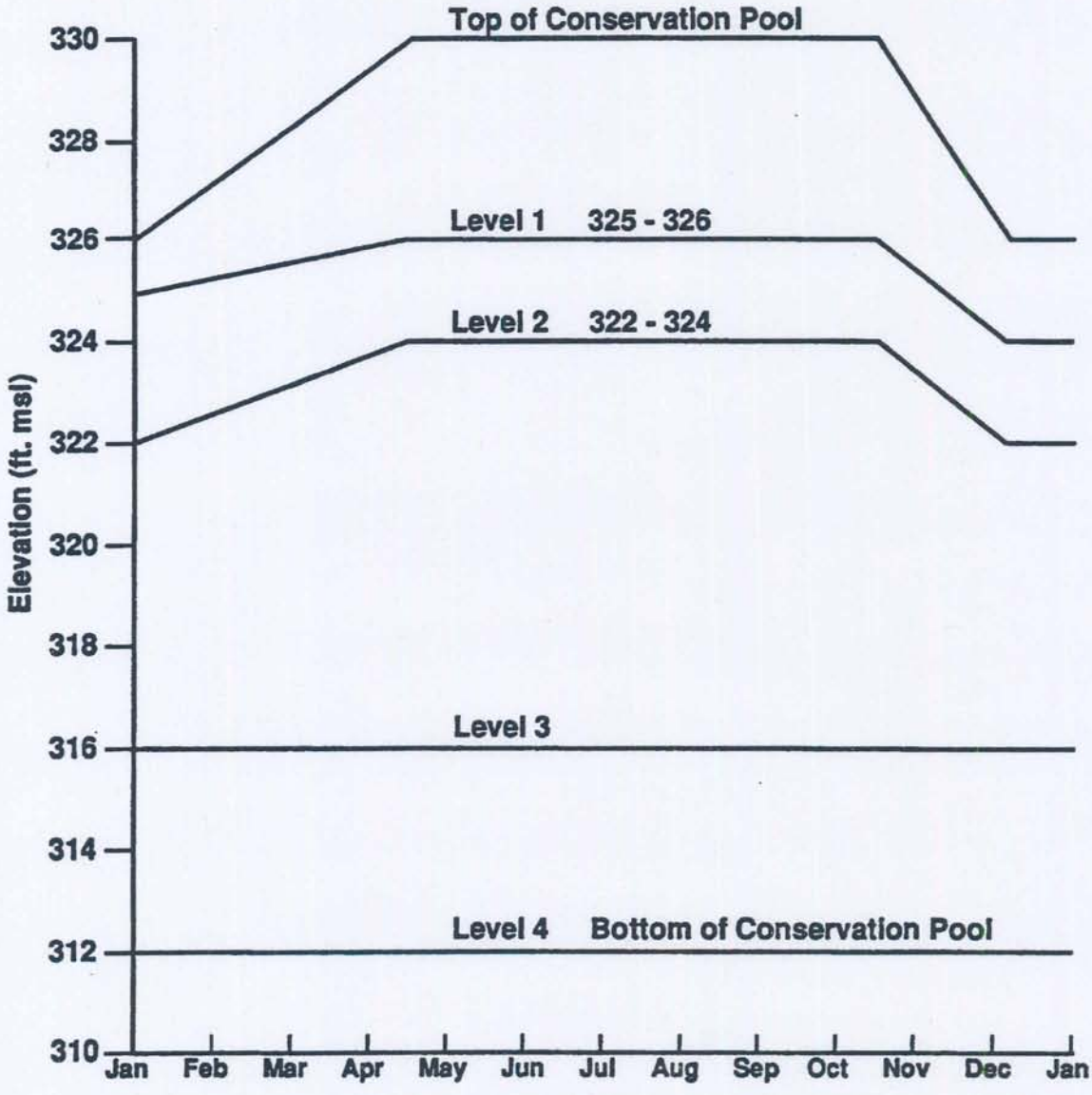


Figure 5

Objectives. The following are objectives of the drought management plan:

o - The reservoir levels should not be drawn below the bottom of the conservation pool (625.0-Hartwell, 470.0-Russell, 312.0-Thurmond).

o - A minimum release of no less than 3,600 cfs at J. Strom Thurmond should be maintained for downstream users.

o - Make use of most of the available storage in the reservoirs during the drought-of-record. They should not be drawn down entirely, though, as a contingency against a drought that exceeds the drought of record.

o - Maintain project capacity throughout the drought.

o - Maintain releases required to meet state water quality standards from J. Strom Thurmond for as long as possible without jeopardizing water supplies.

o - Minimize impacts to recreation during recreation season, which is generally regarded as being from the first of May through Labor Day.

WATER USE PRIORITIES

Six water use priorities were identified and evaluated: Fish and Wildlife Management, Hydropower, Navigation, Recreation, Water Quality, and Water Supply. The Hydropower objective is to meet SEPA monthly system energy contract commitments and at-site capacity requirements. The "Water Quality" and "Fish and Wildlife" priorities require a release of 4,500 cfs from J. Strom Thurmond. This is the 7 day-10 year low flow (7Q10) that is the basis for the protection of fish and wildlife resources and the issuance of downstream discharge permits. To meet "Water Supply" objectives requires a release of 3,600 cfs from J. Strom Thurmond to provide the minimum flow necessary at downstream water supply intakes. The objective for "Recreation" is to minimize drawdown of the reservoirs during the recreation season. The "Navigation" release from J. Strom Thurmond is 5,800 cfs. At the present time there is no commercial navigation in this reach of the Savannah River, and this priority was eliminated from further consideration. If commercial navigation is reestablished, this drought contingency plan will be revised accordingly.

INFLOWS AND OPERATION

The previous drought-of-record for the Savannah River Basin occurred from 1954 through 1956. The drought of 1986-89 appears to have surpassed the 1954-56 drought in intensity. The 1986-88 period was chosen as a basis for the inflows to the reservoir projects to analyze the various operational alternatives. Estimates of weekly average inflows to the reservoirs, through 1987, were obtained from the Southeastern Power Administration (SEPA). Average weekly inflows for 1988 were computed from project operations records. Flows were routed and effects of reservoir operation simulated by use of computer program HEC-5, Simulation of Flood Control and Conservation Systems.

Each lake has a specific amount of storage that was designed to be used to supplement natural flow during times of low inflow. This conservation storage, or design drawdown, was determined during the design phase of the projects. The design drawdown or conservation storage at J. Strom Thurmond is from 330.0 to 312.0 feet msl. At Hartwell Lake the design drawdown is from 660.0 to 625.0 ft. msl. The design drawdown at Richard B. Russell Lake is only 5 feet, from 475.0 to 470.0 ft. msl.

In the simulation model used for this study, the pools at Thurmond and Hartwell Lakes are drawn down equally for the first 15 feet, to elevations 315.0 and 645.0, respectively. During this same period the Russell pool is drawn down to 471.0. The rationale was to maintain approximately equal recreation opportunities at each lake. Hartwell, the uppermost lake, is more difficult to refill when drought conditions diminish, due to its smaller drainage area. Below the first 15 feet, Hartwell Lake, which would still be 20 feet above the minimum conservation pool, would contribute a larger share of the flow than the other projects. J. Strom Thurmond would have 3 feet of conservation storage left at that point, while Russell Lake would have only 1 foot remaining. Therefore, as flow from Thurmond is reduced, flows from Hartwell and Russell are also cut back proportionately in order to maintain a balance among the pools. At lower lake levels, balancing of pool levels among the reservoirs becomes increasingly difficult as the relative importance of local meteorologic conditions increases.

Resumption Of Normal Operation. As drought conditions in the basin improve, reductions in releases will have the desired effect of refilling the lakes to normal full conservation pool (or Rule Curve). Some conservation measures can be expected to remain in effect as the pools refill. If releases had been reduced as far as 3,600 cfs at Thurmond Dam, then the return to normal operation would not occur until the normal full pool was approached.

This plan was selected for its ability to maintain minimum discharges from J. Strom Thurmond Reservoir and lessen the possibility of drawing the lakes below their minimum conservation pools. The

plan balances the interests of those concerned with the lake elevations above J. Strom Thurmond Dam with the interests of those concerned with the streamflow in the Savannah River channel below J. Strom Thurmond Dam.

Impacts. With discharge from J. Strom Thurmond Dam reduced to 4500 cfs, hydropower generation at the three projects would be reduced 30-40% on an annual basis. Further reduction of discharge to 3600 cfs would result in approximately a 50% reduction in generation. Dependable capacity would be maintained. Water supplies would be sustained, although some users may need to make modifications to their intake structures or perform maintenance on intake canals. Operation of the Savannah River Plant reactors depends on cooling water obtained from the Savannah River. Low water levels could have serious consequences for national security.

Water quality would be affected more in the river downstream of J. Strom Thurmond Dam than within the lakes. Within the lakes, temperatures may increase slightly due to less cold water releases from the upstream reservoirs and less reservoir volume to be warmed by the air and sun. Grasses and other vegetation would grow on the exposed lake banks during the drought. After the lake recovers, this would provide temporary improved habitat for small fish. Previous droughts have resulted in increased recruitment populations the year following the drought. Droughts of more than one year in duration have resulted in decline in fish populations.

Downstream of the Thurmond Dam, flow could drop below that needed to assure water quality standards are met during the period of time that the release from Thurmond is maintained at 3,600 cfs. Increased water temperatures will result downstream from Savannah River Plant releases. The assimilative capacity of the river could be significantly reduced. The greatest impact is during the summer months, when dissolved oxygen levels are at their lowest. Some waste discharges may have to be discontinued or water quality standards will be violated. Lower flow in the river will allow the salinity wedge in the Savannah Harbor to move upstream and possibly threaten the fresh water supply of the Savannah National Wildlife Refuge.

Recreation in the lakes would be severely impacted during a drought equal to the 1954-56 event, or the 1986-89 event. Boat ramps and docks would be out of water. Exposed tree stumps and sand bars could pose a potentially serious threat of personal injury to visitors or property damage to boats continuing to use the lakes. Some picnic and camping areas will be unsightly as there would be a large mud flat separating them from the lake.

Commercial navigation in Savannah Harbor should not be affected. There is presently no commercial navigation above Savannah Harbor. Low water in the river would limit navigation by pleasure craft in the Augusta vicinity.

IMPLEMENTATION OF PLAN

A number of sequential actions would be required at each level as shown on Table 3. The two-week lag between reaching an action level and implementation of the flow reduction provides the time necessary to implement the drought water management strategy. These efforts will include coordination with the States of Georgia and South Carolina through the Savannah River Basin Drought Coordination Committee (SRBDCC), the establishment of a public information program, monitoring of conditions within the basin, and evaluation of other actions which may be required to fully implement the strategy.

Public Information Program. The Public Affairs drought action plan is activated in stages keyed to the management action level. The first notification will take place as lake levels begin to drop below normal levels for a given time of year. First news releases will deal primarily with water safety-related issues, particularly if water levels begin dropping during peak recreation periods.

News releases will be issued in conjunction with any official public notices or correspondence concerning water shortage emergencies or alerts, drought alerts, or notification of public meetings. It is imperative that the District coordinate all public notifications internally before a public release is made. The Public Affairs Officer will speak for the District concerning all policies and procedures instituted during a drought or water shortage emergency. Lake Resource Managers will confine comments to the news media to subjects related to operational aspects of the respective lakes.

During a prolonged water shortage the Public Affairs Office will issue weekly update news releases and will seek opportunities to broaden public awareness through radio and television public service announcements or paid advertising, if deemed necessary. The Public Affairs Office will establish a "Drought Hot Line" that will allow news media access to information on District activities on a continuing 24 hour-a-day basis during prolonged droughts.

Environmental Considerations. Operation and maintenance of each of the projects within the Savannah River basin are covered by an existing Environmental Impact Statement. While regulation of the reservoir levels and releases are included as important features of the normal operation of these projects, the extreme low flow conditions of a drought require that traditional water management activities be reassessed as reflected in the Drought Water Management Strategy. An Environmental Assessment (EA) has been integrated in this report evaluating this management strategy. A Finding of No Significant Impact (FONSI) is included as Appendix K. A Public Notice will be issued advising the public and other agencies of the final report and FONSI availability. The evaluation of the low water conditions in the Operation and Maintenance Manual Environmental Impact Statement for Clark Hill Lake, was based on the 1925-27 critical dry period. Releases from Clark Hill were to provide a flow of 5,800 cfs at the Butler Creek Gage except for a

Table 3
Savannah River Basin Management Actions

*Pool Level		District Management Action	District **Action Office
Level 1	1.	Notify District Drought Management Committee.	EN
	2.	Issue news release to notify Congressional interests and members of public of anticipated worsening conditions.	PA
	3.	Begin inspecting designated navigation channel for hazards.	OP
	4.	Inspect beaches, boat ramps and post signs where appropriate.	OP
	5.	Begin informal discussion with SAD/SEPA regarding reduced generation.	EN/OP
	6.	Notify lake concessionaires and park lessees concerning possible worsening conditions.	OP
	7.	Be alert for worsening conditions.	EN
Level 2	1.	Recommend Thurmond release reduced to 4,500 cfs.	DMC
	2.	Coordinate action with SRBDCC.	EN
	3.	Coordinate action with SAD.	EN
	4.	Notify Division Engineer 2 wks. prior to reduction.	DE
	5.	Issue news release.	PA
	6.	Public notice to water users and local agencies.	OP
	7.	Process intake modification permits on emergency basis	OP
	8.	Coordinate with Congressional delegations	DD-X
	9.	Monitor status of water intakes	OP
	10.	Reduce Thurmond release to 4,500 cfs pursuant to final decision by DE.	EN
	11.	Weekly status report to DE	EN
	12.	Increase monitoring of beaches and boat ramps.	OP
	13.	Continue to advise lake concessionaires and park lessees of projected lake levels.	OP
	14.	Continue water patrols to identify and mark navigation hazards in designated navigation channels.	OP
	15.	Continue to extend boat ramps where appropriate.	OP
Level 3	1.	Recommend Thurmond release reduced to 3,600 cfs.	DMC
	2.	Coordinate action with SRBDCC.	EN
	3.	Coordinate action with SAD.	EN
	4.	Notify Division Engineer 2 weeks prior to reduction.	DE
	5.	Issue news release.	PA

TABLE 3 (CONT)

	6. Public notice to water users and local agencies	OP
	7. Coordinate with Congressional delegations	DDX
	8. Reduce Thurmond discharge to 3,600 cfs pursuant to final decision by DE.	EN
	9. Weekly status report to States.	PD
	10. Coordinate with in-lake withdrawers to lower intakes so lakes can be drawn below minimum conservation pool, if required.	EN/OP
	11. Continue to advise lake concessionaires and park lessees of projected lake levels.	OP
	12. Continue water patrols to identify and mark navigation hazards in designated navigation channels.	OP
	13. Continue to extend boat ramps where appropriate.	OP
Level 4	1. Analyze results of Action 10 of Level 3.	
	2. Continue level 3 release rate as long as possible.	
	3. Coordinate action with SRBDCC.	EN
	4. Coordinate action with SAD.	EN
	5. Notify Division Engineer.	DE
	6. Issue news release.	PA
	7. Public notice to water users and local agencies.	OP
	8. Coordinate with Congressional delegations.	DDX

*See Table 2 and Figures 4 and 5 for explanation of pool levels.

** List of Abbreviations

DE	District Engineer
DMC	District Drought Committee
DD-X	Administrative Officer
EN	Engineering Division
OP	Operations Division
PD	Planning Division
PA	Public Affairs

release of 3000 cfs on weekends. Under the drought management plan, water quality will be maintained by controlling releases at J. Strom Thurmond Reservoir. Releases of 4,500 cfs will maintain the 7Q10 flows at Augusta providing protection of fish and wildlife resources. When J. Strom Thurmond Reservoir reaches level 3, the releases will be reduced to 3,600 cfs as the priority shifts to water supply. A large percentage of the time this would result in less than 5,800 cfs at Butler Creek. The reduced flows would not assure maintenance of water quality standards below Augusta, but would help maintain the lacustrine habitat while providing a stable riverine environment and water supply for downstream users. Appendix B identifies the impacts of the drought water management strategy.

Monitoring. Dissolved oxygen, temperature, conductivity, oxidation reduction potential (ORP) and pH measurements in the releases are recorded at each reservoir on a continuous basis. These measurements are then transferred by a computer via telephone linkage to the Savannah District office. Automated retrieval is also used for lake elevation, dam discharge, and rainfall from a 54-gage network.

Water quality monitoring is more critical downstream at Savannah Harbor as the lower releases from J. Strom Thurmond allow the saltwater wedge in the harbor to move further upstream. Salinity levels are continuously measured by four punch-tape type continuous recording gages. The recording charts are removed about every 2 weeks by the U. S. Geological Survey, the data is processed, and the results are sent to the Corps Savannah District approximately 10 days later. The four gages are located at: (1) the I-95 bridge, 1.2 miles downstream of the Abercorn Creek intake, (2) the intake to the Lucknow Canal, on Little Back River, which supplies fresh water to the Wildlife Refuge, (3) inside the Lucknow Canal near the downstream gate, and (4) the U. S. Highway 17 Houlihan Bridge on the Front River. During critical low water periods, these gages will be supplemented by readings taken by a hand-held probe operated from a boat. These data would be available almost immediately and could be taken several times daily, if necessary. One management option to counteract the advance of the salinity wedge would be to take the Back River tidegate out of operation. This would allow the flood tide waters in Back River to drain out Back River instead of flowing across to and out of Front River, thus shortening the duration of high water in Back River. Reducing the time of high water reduces the extent and duration of saltwater penetration in Back River.

Predictions based on data collected to date indicate salinity levels would reach 0.5 parts per thousand (ppt) at the mouth of Abercorn Creek (river mile 30.2) when river flows are less than 6000 cfs and tide heights exceed 10 feet, mean low water (mlw) at Houlihan Bridge. This is an extremely high tide height, which is never predicted to occur by the National Oceanic and Atmospheric Administration Tide Tables, but could possibly occur with strong northeasterly winds.

The maximum salinity level recorded by the continuous monitor at I-95 (river mile 28.1) since installation in October 1986 has been .28 ppt which occurred during a 9.2 feet mlw tide and a 6040 cfs river flow.

Because the Savannah Industrial and Domestic Water Supply intake is located 1.8 miles above the mouth of Abercorn creek, the salt water wedge will not reach this intake under any forseeable combination of river flows and tide heights.

SAVANNAH RIVER BASIN
DROUGHT COORDINATION COMMITTEE

PURPOSE

The Savannah River Basin Drought Coordination Committee (SRBDCC) will discuss mutual concerns of agencies, organizations, communities, and industries, and exchange information necessary for sound basin actions to be made by the respective agency heads.

In order to make informed and sound decisions in implementing the drought contingency plan for the Savannah River Basin, it is necessary that those affected by water management decisions be given the opportunity to provide input to the decision making process. The following describes the mechanism which will be used to implement the plan.

Successful implementation of the drought contingency plan will require the full and cooperative participation of the Savannah District and the South Atlantic Division of the Corps of Engineers and agencies within the States of Georgia and South Carolina. The involvement of these entities will be through a drought coordination committee. The purpose of the committee will be to coordinate the drought management actions of the States and the Corps by serving as a forum for an exchange of information and ideas. The committee may seek out advice of its members or other individual attendees, but will not seek to obtain consensus advice or recommendations. Committee members will be responsible for reporting individually to the organizations they represent with such advice as they deem appropriate. In no event will the committee be considered an agent of either the states or the Corps. Water control decisions remain the responsibility of the District Commander.

MEMBERSHIP

The Savannah River Basin Drought Coordination Committee shall consist of a representative from each of the following organizations:

ORGANIZATION	OFFICE
Savannah District	Engineering Division
South Atlantic Division	Engineering Division
Georgia	Environmental Protection Division, Department of Natural Resources
South Carolina	Water Resources Commission

RESPONSIBILITIES

The representative from each state on the Drought Coordination Committee will be responsible for coordinating with the appropriate agencies and local governments. Similarly, Corps representatives will be responsible for coordinating with appropriate Federal agencies, private power companies, and lake concessionaires and lessees. Federal agencies which will be most involved in drought water management decisions will be the Department of the Energy's Southeastern Power Administration and the National Weather Service's Southeast River Forecast Center. Coordination will also be maintained with the U. S. Fish and Wildlife Service and the National Marine Fisheries Service to assure that impacts to fish and wildlife resources are considered.

The South Atlantic Division's representative will coordinate with other Corps Districts whose jurisdictional boundaries border the Savannah River drainage basin and whose water regulation activities could be impacted by drought management actions within the Savannah River Basin. Frequent public announcements in the form of "drought bulletins" will serve as an important mechanism for communicating to the various segments of the public the water shortage conditions. The "drought bulletins" will be mutually agreed upon by the committee. It will be the responsibility of each committee member to disseminate the bulletins to those interests which he/she represents.

The SRBDCC will not be empowered with enforcement responsibilities. Such activities will continue to be the responsibility of appropriate state and local governmental entities. Existing state and local drought plans will be implemented as needed, and the committee will encourage governmental entities to undertake appropriate actions at the local level.

Successful implementation of the Savannah River Basin Drought Coordination Committee's recommendations will depend upon efficient and effective internal coordination within the Corps and institutional bodies within each of the States.

MEETINGS

The SRBDCC will meet at least twice a year, to insure that coordination links remain viable. These meetings will normally be held in late April or early May, following the winter and spring flood period, and in August, the beginning of the traditional low water period. These are appropriate times to appraise the conditions of the Federal impoundments within the basin and to develop projections for anticipated future conditions.

Once a significantly dry situation has been determined to exist within either the entire basin or a significant portion of the basin, the Committee will hold a "water shortage appraisal meeting." Any of the four participating parties will have the authority to call this initial meeting. If, based on the information evaluated

at this meeting, it is determined that either the entire basin or a sub-basin may be entering a potential drought period, the committee will declare a "water shortage alert" for the affected region. Following the "water shortage alert" declaration, the committee will meet on an as-needed basis to monitor the status of the water shortage conditions, appraise the success of previous measures and determine appropriate future management measures. The committee will continue to meet monthly until conditions return to normal. Should conditions indicate a continuing trend toward a more severe water shortage, the committee will declare a "drought alert" for the basin. The "drought alert" will remain in effect until the committee collectively determines that the situation has improved. It should be emphasized that prior to issuance of either of these "alerts," the individual SRBDCC members must coordinate these actions within their respective organizations, as well as with other interests which could be affected by the various water shortage management measures.

DISTRICT
DROUGHT MANAGEMENT COMMITTEE

PURPOSE

The District Drought Management Committee (DMC) will review staff recommendations for District actions required during a drought and make recommendations to the District Engineer on appropriate District actions. It will recommend to the District Engineer, the type, content, and timing of information to be provided to the public about the Savannah District's drought responses.

The District Drought Management Committee will be chaired by the Chief, Engineering Division, and vice-chaired by the Chief, Hydrology and Hydraulics Branch.

MEMBERSHIP

The District Drought Management Committee shall consist of a representative from each of the following staff elements: DD-C (Deputy Commander, (Civil)), EM (Emergency Management), EN (Engineering Division), OP (Operations Division), PD (Planning Division), PA (Public Affairs), and RE (Real Estate Division). The branch/section which would represent these elements is as follows:

DD-C	DD-C	Deputy Commander (Civil)
EM	EM-D	Natural Disaster Branch
EN	EN-HA	Hydrology & Hydraulics Branch
OP	OP	Chief, Operations Division
PD	PD-P	Plan Formulation Branch
PA	PA	Public Affairs
RE	RE-MC	Civil Management Section

The Chief of Engineering Division may appoint additional members as necessary to insure broad based input on the committee.

RESPONSIBILITIES

1. The Committee Chairman will be advised of problems by the Chief, EN-H. Members of the District Drought Management Committee shall be notified at the onset of each drought alert phase and be provided information by the Chairman with respect to the drought alert phase.

2. Each member of the District Drought Management Committee is responsible for bringing to the attention of the committee items within the area of responsibility of their own Division/Office.

3. Members of the District Drought Management Committee may request that presentations on specific issues be made to the committee by other District personnel.

4. The District Drought Management Committee may delegate work tasks to individuals in the District with the approval of the committee member representing the individuals' Division/Office.

5. The District Drought Management Committee will recommend to the District Engineer the form, content, and timing of information provided to the public about the District's responses to the drought.

6. The committee will consider information received from the Savannah River Basin Drought Coordination Committee (SRBDCC).

7. The chairman of the District Drought Management Committee will present recommendations of that committee to members of the Savannah River Basin Drought Coordination Committee and to the District Engineer for his approval.

MEETINGS

The District Drought Management Committee would meet on a monthly basis during a drought. The chairman, or in his absence, the vice-chairman, of the District Drought Management Committee will call this meeting. Additional meetings may be called at any time by any member of the District Drought Management Committee to address specific items which need attention before the next scheduled meeting. Minutes of each meeting will be kept by someone appointed by the vice-chairman of the District Drought Management Committee.

Glossary

Acre-foot. The volume of water required to cover one acre to a depth of one foot. (1 acre-ft. = 43,560 cubic feet or 326 thousand gallons)

Confluence. The combining of two streams.

Conservation Pool. Useable storage in the reservoir for fish & wildlife management, hydropower, navigation, recreation, water quality, and water supply purposes designed to be filled during normal and high flow periods for use during low flow periods.

Cubic Feet Per Second (CFS). 1 cfs = 450 gallons per minute.

Drought Contingency Plan. Detailed drought management plan to address current water conditions in the Savannah River Basin, and to serve as a baseline for future situations.

Drought Indicators. Mechanisms which reflect drought conditions and severity. Drought indicators consist of hydrologic indicators such as streamflow, rainfall, reservoir storage levels and groundwater levels, meteorologic indicators such as rainfall, and human-activity indicators which include navigation traffic cutbacks and reductions in hydropower generation.

Drought Response. A response network consists of trigger levels and appropriate management action. Triggers are predetermined standards reflecting drought intensity which induce responses.

Effluent. Waste material discharged into the environment.

Flood Control Pool. Storage above the conservation pool elevation designed to store flood water and reduce flooding downstream.

Guide Curve. (Also rule curve or target pool levels) Guides established to regulate and manage optimum pool elevations for yearly operations at impoundments.

Impoundment. A confined body of water as in a reservoir or lake.

Kilowatt (KW). Equal to 1000 watts.

Megawatt (MW). Equal to 1000 kilowatts or 1,000,000 watts.

Meteorologic Conditions. Atmospheric phenomena and weather of a region.

Minimum Pool Level. The lowest elevation to which the pool is to be drawn.

Normal Pool Level. The elevation to which the reservoir surface will rise during ordinary conditions.

pH. The condition represented by a number, used to express both acidity and alkalinity on a scale whose values run from 0 to 14, with 7 representing neutrality, numbers less than 7 increasing acidity.

Pumped Storage. Reservoir pumps that also serve as generators are installed in the dam. During the night, when cheap surplus power is available, the pumps are run to pump water back upstream into the reservoir. During the midday, when valuable peaking power is needed, the units are reversed and used to generate power with the same water that was pumped back the previous night.

Releases. A determined amount of water that is allowed to pass through or discharged from a dam.

Reregulation Structure. Peaking power plants generally release water only a few hours per day. A reregulation structure is a smaller dam located downstream that is capable of storing the intermittent slugs of water and releasing a continuous flow.

Rule Curve. Same as "Guide Curve."

Thermally Stratify. During the warm months of the year, the sun heats the upper layers of the lake. Since the warm water rises, the surface of the lake continues to warm while the bottom layer stays cold. During the winter months, the upper layers of the lake are cooled. The warmer water on the bottom rises, causing destratification, or "turnover", of the lake.

Triggering Mechanism. An indicator that is put in place to indicate the need to initiate or terminate specific action before a crisis occurs. At the action levels, the trigger elevation will initiate a series of actions that will culminate in the reduction of releases from the projects.

7Q10. The "7-day, 10-year minimum flow" is a statistical parameter which describes the frequency distribution of streamflow values. The calculated 7Q10 value is an estimate of the lowest 7-day average streamflow which would occur an average of once during a 10-year period.

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King, Jeffrey K SAS

From: Okane, Jason D SAS
Sent: Thursday, March 27, 2008 3:24 PM
To: King, Jeffrey K SAS
Subject: Vogel site visit yesterday

Sign in sheet in your inbox with backgound info. General discussion and tour of the site. Issues discussed of concern to Regulatroy and permit process;

1. Need to include/obtain authorization for impacts along new powerline ROW from site to Thomson. They are only hinted at in EA.

2. We could do a permit with a long (10 year) construction period.

3. We would prefer one IP for the entire project

4. We talked at length about the dredging of the savannah for transport of project components, a Corps project, an applicant project and a cost shared project. The applicant was hopeful the Corps could dredge the Savannah Federal Project to old authorized depths for this and other navigational purposes. They stated they were pursuing this path both with the Corps and with elected officials.

5. I clearly expressed my concern that they would want some portion of the project permitted (a portion without independent utility) and we would be unable to authorized it with out a clear under standing of the environmental impacts of the intire project, including how the components would be transported to the site. They understood I wanted to avoid this situation [redacted] Through past conversations, we have also made Richard Morgan, Carol Berstein, David Crosby and Mirian Magwood aware of this possibility.

Talked with Dan Parrott, Bill Bailey and Stan Clark this moring about Southern Company's expectation that the Corps will be handling the deepening of the Savannah river for 100+ barge trips necessary for transportation of various project components (reactors and the like). They were aware of this idea, the need for funding and a Corps PM but until such is authorized and funded our hands are tied. This has reportedly been comunicated to the Sothern Company. An April 7 meeting between Navigation and Southern Company is expected to be postponed to allow more time for OP-NN to analyze condition survey of river. Bailey said environmental evaluation of the dredging of the savannah would likely start out as an EA but would likely, could very well, get pulling into an EIS level eval. I recommend regulatory attend if possible and a copy of this e-mail be put in the file. Tks.

Think that's about it.

Jason O'Kane
Project Manager
Coastal Branch, Regulatory Division
Savannah District, USACE
P.O. Box 889, Sav GA 31402
W: 912/652-5349, F: 912/652-5995
http://www.sas.usace.army.mil/permit.htm