US Army Corps
of Engineers
Wilmington District

WATER CONTROL MANUAL

W. Kerr Scott Dam and Reservoir Project
Yadkin River Basin, North Carolina

June 1993

CESAD-EN-HW (CESAW-EN-H/05 Aug 93) (1110-2-1150a) 1st End
Mr. Edmond/lhk/331-6734/DOC:W-MANUAL.002
SUBJECT: Water Control Manual, W. Kerr Scott Dam and Reservoir

Commander, South Atlantic Division, U.S. Army Corps of Engineers, Room 313, 77 Forsyth Street, SW., Atlanta, Georgia 30335-6801
29 September 1993

FOR COMMANDER, WILMINGTON DISTRICT, ATTN: CESAW-EN-H

1. The subject report is approved contingent to the following comments:

a. Page 4-3, paragraph 4-04b. The word "characteristics" is misspelled in the last sentence.

b. Page 4-26, paragraph 4-12c. The word "industrialized" is misspelled in the third sentence.

c. Page 5-2, paragraph 5-02. The word "data" is used as a plural noun rather than a collective noun throughout the report. The next to last sentence should be revised to read "Data from these monitoring programs are also entered..." This same comment applies to the last sentence in paragraph 6-03d on page 6-4.

d. Page 7-2, paragraph 7-03b. Revised the last sentence to read "The discharge for a stage of 12 feet at Wilkesboro is approximately 9,700 cfs."

e. Page 7-1, paragraph 7-01. Fish and Wildlife is included as an objective of the water control plan for W. Kerr Scott. However, chapter 7 does not include a paragraph on operations for Fish & Wildlife. A paragraph similar to 7-06 should probably be included in Chapter 7 for Fish & Wildlife.

f. Page 7-4, paragraph 7-07c. The title of the paragraph should be changed to "Unplanned Minor Deviations". Also, a paragraph on "Planned Deviations" should be included (See ETL and Falls Lake Water Control Manual).

2. If you have any questions please contact Mr. Kaiser Edmond, CESAD-EN-HW, (404) 331-6734.

FOR THE COMMANDER:

Pat Davis

Encl
wd

C. PAT DAVIS, P.E.
Acting Director of Engineering

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1890
WILMINGTON, NORTH CAROLINA 28402-1890

IN REPLY REFER TO
CESAW-EN-H

5 August 1993

MEMORANDUM FOR Commander, South Atlantic Division, ATTN: CESAD-EN-HW

SUBJECT: Water Control Manual, W. Kerr Scott Dam and Reservoir

Five copies of subject manual are enclosed for approval. The manual was prepared generally in accordance with ETL No. 1110-2-251, Preparation of Water Control Manuals.

FOR THE COMMANDER:

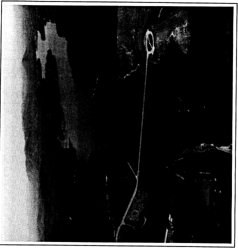
Encl (5 cys)

FOR WILLIAM R. DAWSON, P.E.
Chief, Engineering Division

YADKIN RIVER BASIN, NORTH CAROLINA
W. KERR SCOTT DAM AND RESERVOIR PROJECT

WATER CONTROL MANUAL

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT
JUNE 1993



W. KERR SCOTT DAM AND RESERVOIR
OCTOBER 1981

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in loose-leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current.

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, contact can be made by telephone to personnel of the Hydrology and Hydraulics (H&H) Branch, Wilmington District Office as listed below.

Name	Title	Office Phone (Area Code 910)	Home Phone (Area Code 910)
Max B. Grimes	Chief, H & H Branch Water Control Manager	251-4759	799-4049
Terry M. Brown	Chief, Reservoir Regulation Section (RRS)	251-4761	799-5041
G. Allen Piner	Hydr. Engineer, RRS	251-4762	799-6658
Chris B. Cline	Hydr. Engineer, RRS	251-4760	799-6887
Jan P. Brodmerkel	Hydr. Engineer, RRS	251-4414	259-6234
Dan Emerson	Hydr. Engineer, RRS	251-4490	452-0907

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W. KERR SCOTT DAM AND RESERVOIR PROJECT
YADKIN RIVER BASIN, NORTH CAROLINA

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W. KERR SCOTT DAM AND LAKE PROJECT
YADKIN-PEE DEE RIVER BASIN, NC

PERTINENT DATA

Other names

During the design and construction phases, the project was known as the Wilkesboro Reservoir. In 1963 the dam was completed and placed in operation and the name was changed to honor William Kerr Scott, 1896-1958, former Governor and Senator from North Carolina.

Location of dam

At Latitude 36 08' 04", Longitude 81 13' 30"; in Wilkes County, NC, about 4 miles west of Wilkesboro, North Carolina. This location is about 55 miles west of Winston-Salem, NC, and about 65 miles north of Charlotte, NC. The dam is 5.8 river miles upstream of the USGS stream gage at Wilkesboro, NC, about 26 river miles above Elkin, NC, 132 river miles above High Rock Dam near High Rock, NC, and 388 river miles upstream of the mouth of the Pee Dee River in Winyah Bay near Georgetown, South Carolina.

Purposes

For flood control, water supply, recreation, and low flow releases.

Drainage areas	Square Miles
Yadkin River at Patterson, NC	29 28.8
Elk Creek at Elkville, NC	~~488~~ 48.1
W. Kerr Scott Dam near Wilkesboro, NC	367
Reddies River at North Wilkesboro, NC	89.2
Yadkin River at Wilkesboro, NC	504
Roaring River near Roaring River, NC	128
Yadkin River at Elkin, NC	869
Yadkin River at Enon, NC	1,694
Yadkin River at Yadkin College, NC	2,280
Yadkin River at High Rock, NC	3,973
Pee Dee River at mouth (approximate)	18,500

Elevations	Feet, m.s.l.
Original Spillway design flood	1102.5
July 1992 spillway design flood	1105.2
Standard project flood	1083.0
Flood of record August 1940 computed	1074.5
Top of Dam	1107.5 ←
Base of Dam	965.0 ←
Maximum design pool	1102.5
Top of flood control pool (spillway crest)	1075.0
Top of normal pool (bottom of flood pool)	1030.0
Minimum operative pool	1000.0
Upper clearing limit	1032.0
Guide acquisition line	1047.0
Elevation to which flowage easement obtained	1080.0
Conduit entrance portal invert elevation	965.0 ←
Conduit exit portal invert elevation	960.0
Stilling basin bottom elevation	952.0
Stilling basin end sill elevation	955.5

Elevations -- Continued

Tailwater elevations:	
Original spillway design flood	998.0
July 1992 spillway design flood	999.4
Standard project flood	984.6
Flood of record (August 1940)	973.7
Minimum (125 c.f.s.)	963.0

Reservoir Data

Storage Volumes:	Runoff Inches	Acre-feet
Original spillway design flood (elev. 1102.5)	-	290,000
Latest spillway design flood (elev. 1105.2)	-	328,300
Standard project flood (elev. 1083)	-	190,000
Top of dam (elevation 1107.5)	-	347,300
Maximum design pool (elev. 1102.5)	-	306,000
Top of flood control pool (elev. 1075.0)	-	153,000
Top of normal pool (elev. 1030.0)	-	41,000
Top of minimum operative pool (elev. 1000.0)	-	8,000
Uncontrolled flood storage (1075.0-1102.5)	7.82	153,000
Controlled flood storage (1030.0-1075.0)	5.72	112,000
Water supply storage (1000.0-1030.0)	1.69	33,000
Sediment and conserv. sto. (below 1000.0)	0.41	8,000

Surface areas:	Acres
Original spillway design flood (elev. 1102.5)	7,240
Latest spillway design flood (elev. 1105.2)	7,590
Standard project flood (elev. 1083)	4,835
Maximum design pool (elev. 1102.5)	7,240
Top of flood control pool (elev. 1075.0)	4,000
Top of normal pool (elev. 1030.0)	1,475
Top of minimum operative pool (elev. 1000.0)	675
Counties affected	Wilkes, Caldwell

Length at elevation 1030.0 ft. m.s.l.	Miles
Reservoir, (along Yadkin River)	9.7
Shoreline	55

Dam and Spillway

Type: Earth and rockfill (zoned), with side channel uncontrolled spillway, intake structure, and circular conduit

Length of dam (feet)	1,750
Length of spillway crest (feet)	400
Spillway capacity at elevation 1105.2 (c.f.s.)	199,300
Height of dam (feet)	148

Dam and Spillway -- Continued

Outlet Works:
Intake tower:
Conduit intakes:

Number	2
Size	6 feet wide by 12.25 feet high each
Conduit length (feet)	749.0
Conduit diameter (feet)	12.25
Maximum discharge (approximate) at elevation 1030 (c.f.s.)	5,300

Service Gates:

Number	2
Size	6 feet 9 inches wide by 12 feet 8 inches high each

Emergency Gate:

Type:----- Gravity/electric hoist on a hand-operated trolly hanging from a monorail located on top of the intake tower. Gate is dogged and stored just above the outside plaftorm at elevation 1033 feet m.s.l., on the face of the intake tower.

Number	1
Size	6 feet 9 inches wide by 13 feet 8 inches high

Stilling basin:

Minimum width (feet-inches)	12-3
Maximum width (feet-inches)	54-1

Estimated Natural Streamflow at Dam	c.f.s.
Mean discharge for period 1922-1991	581
Minimum discharge:	
Instantaneous prior to 1963 (September 28, 1954)	72
Daily prior to 1963 (September 18, 1956)	80
Monthly for period 1922-1991 (October 1954)	112
Maximum discharge for period 1922-1991:	
Instantaneous (August 14, 1940)	116,500
Monthly (August 1940)	3,050
Bankfull discharge below dam	5,400

Standard Project Flood

Maximum estimated outflow	29,000
Maximum estimated inflow	193,100

Original Spillway Design Flood

Derivation: Runoff based on analysis of the greatest 48-hour period of Probable Maximum Precipitation storm rainfall from the U. S. Weather Bureau (National Weather Service) Hydrometeorological Report No. 33, using a drainage area of 348 square miles.

Total average rainfall (inches)------------------------------	25.6
Initial loss (inches)---------------------------------------	0.50
Average infiltration rate (inches per hour)-----------------	0.10
Total storm runoff (inches)---------------------------------	21.5
Peak inflow to full reservoir (c.f.s.)----------------------	318,000
Regulated peak outflow (c.f.s.)-----------------------------	183,000

Spillway Design Flood (July 1992)

Derivation: Runoff based on analysis of the greatest 72-hour period of Probable Maximum Precipitation from the National Weather Service Hydrometeorological Report No. 52, using a drainage area of 367 square miles.

Total average rainfall (inches)------------------------------	31.3
Initial loss (inches)---------------------------------------	0.50
Average infiltration rate (inches per hour)-----------------	0.10
Total storm runoff (inches)---------------------------------	24.9
Peak inflow to full reservoir (c.f.s.)----------------------	326,600
Regulated peak outflow (c.f.s.)-----------------------------	206,200

WATER CONTROL MANUAL
W. KERR SCOTT DAM AND RESERVOIR PROJECT
YADKIN RIVER BASIN, NORTH CAROLINA

I. INTRODUCTION

1-01. Authorization of Manual. This manual is submitted in compliance with:

a. ER 1110-2-240, Water Control Management, dated October 8, 1982.

b. EM 1110-2-3600, Management of Water Control Systems, dated November 30, 1987.

1-02. Purpose and Scope. This is the water control manual for the Yadkin River Basin and the W. Kerr Scott Dam and Reservoir project. The purpose of this manual is to provide a description of the basin, forecasts of river stages, regulation schedules, examples of regulation, the method of operation of the Scott Reservoir project, instructions to the damtender and other data pertinent to the Scott Reservoir project.

1-03. Related Manuals and Reports. A list of design memorandums related to the Scott Reservoir project is found in table 1-1.

1-04. Project Owner. The owner of the Scott Reservoir project is the US Federal Government and is operated by the US Army Corps of Engineers, Wilmington District.

1-05. Operating and Regulating Agencies. Responsibility for the functional operations of the Scott Reservoir project for water control purposes lies with the Water Control Manager who is represented by the Reservoir Regulation Section, Hydrology and Hydraulics Branch, Engineering Division, Wilmington District, U.S. Army Corps of Engineers. The Reservoir Regulation Section is responsible for providing the Resource Manager with directives as to gate settings, as well as with data and forecasts of precipitation, pool elevations, downstream discharge rates, and other hydrologic data as needed. The Resource Manager, Construction-Operations Division, is responsible for the physical operation of the Scott Reservoir project. The Natural Resources Management Branch, Construction-Operations Division, provides guidance and assistance to the Resource Manager in regard to the impacts of water control on recreation use, parks, natural resources, boat docks, etc. (See instructions to damtender, exhibit A, in the back of this manual.) Management of the project lands and waters for recreation and wildlife is also the responsibility of the U.S. Army Corps of Engineers, Wilmington District. The Resource Manager carries out the operations and maintenance of all project areas except for 218 acres leased to Wilkes County for Wilkes County Park and 34 acres leased to Wilkes Skyline Marina. Management of the fisheries resources of the reservoir is the responsibility of the North Carolina Wildlife Resources Commission working in conjunction with the U.S. Army Corps of Engineers.

TABLE 1-1

Design Memorandums for W. Kerr Scott Dam and Reservoir

Memorandum Number	Title	Date Submitted	Date Approved
-	General Design Memorandum	31 Dec 58	31 Mar 59
1	Sources of Construction Materials	23 Apr 59	16 Jun 59
2	Relocations -- Cemeteries	30 Apr 59	Jul 59
3	Hydrology	29 May 59	8 Jul 59
4	Reservoir Clearing	29 May 59 (Revised 28 Oct 60)	13 Jan 61
5	Relocations -- Power and Telephone Lines	29 Jun 59	21 Apr 61
6A	Preliminary Master Plan -- Part of the Master Plan	11 Sep 59	14 Oct 59
-	Supplement No. 1	14 Jan 64	17 Apr 64
6B	Master Plan	21 Jul 65	
6B(C1)	Public Use and Access Facilities	2 Oct 61	20 Nov 61
6B(C2)	Public Use and Access Facilities (Appalachia Program -- 1965)	30 Apr 65	14 May 65
7	Dam, Spillway and Diversion Works (Vols. 1 & 2)	23 Sep 59	4 Dec 59
8	Relocations -- Highways and Construction of Access Road	20 Nov 59	23 Dec 59
9	Outlet Works	18 Dec 59	15 Mar 60
9A	Hydroelectric Power -- Part of the Outlet Works	11 Mar 60	4 May 60
10	Administration and Utility Building	22 Mar 62	10 May 62
11	Master Plan Update	May 83	Nov 83

II. DESCRIPTION OF W. KERR SCOTT DAM AND RESERVOIR

2-01. Location. W. Kerr Scott Dam is located on the Yadkin River about 5 river miles upstream of Wilkesboro, NC and about 6 river miles upstream of North Wilkesboro, NC. The dam is about 55 miles west of Winston-Salem, NC and about 65 miles north of Charlotte, NC. The location and extent of Scott Reservoir are shown on plates 2-1 and 2-2. At normal pool elevation, the reservoir lies entirely within Wilkes County. At the top of flood control pool, elevation 1075 feet m.s.l., the upper end of the reservoir would extend about two-thirds of a mile into Caldwell County. The drainage area above Scott Dam encompasses about 367 square miles, over half of which is drained by 4 major tributaries which flow into the Yadkin River from the Blue Ridge Mountains to the north. Another one-fifth of the watershed is drained by 3 tributaries which flow into the Yadkin River from the Brushy Mountains to the south. The Yadkin River itself has its headwaters in the Blue Ridge Mountains. It flows southeast to Happy Valley, NC, then northeast to Scott Dam and beyond. The Scott Reservoir watershed area covers portions of three counties, listed below in table 2-1.

Table 2-1

Percent Coverage of Counties in Scott Reservoir Watershed

County	% Coverage	Square Miles
Wilkes	53.4	196
Caldwell	31.9	117
Watauga	14.7	54
	100.0	367

2-02. Purpose. W. Kerr Scott Dam and Reservoir was authorized for flood control, water supply, recreation, and fish and wildlife.

2-03. Physical Components.

a. Dam. The dam is an earthen structure having a top elevation of 1107.5 feet, m.s.l. and an overall length of 1,750 feet. The height above the streambed is 148 feet. A paved service roadway is provided along the crest of the dam. Plan and section views of the dam and outlet works are shown on plates 2-3 and 2-4.

b. Freeboard. The freeboard allowance for the dam was computed in accordance with the method outlined in the report, "Conference on Determination of Freeboard Requirements for McGee Bend Dam, Angelina River, Texas," dated August 1, 1956. The maximum effective fetch is 1.36 miles. The maximum wind velocity recorded in the area was 57 m.p.h.; however, this represents the fastest recorded mile for a duration of one minute. Wind velocities on the order of 40 to 45 m.p.h., of critical duration, might be reasonably assumed to coincide with the maximum reservoir level that would be attained during the spillway flood.

Adopting 45 m.p.h. and adding 30 percent to compensate for the increase in wind velocities over water, in accordance with the procedure outlined in the above-mentioned report, a design wind velocity of 59 m.p.h. was adopted for Scott Reservoir. Utilizing this velocity, the maximum effective fetch of 1.4 miles, and the enclosures of the McGee Bend report, the significant wave height was determined to be 3.0 feet, wave run-up 1 foot, and the wind tide 0.6 feet, or a total freeboard requirement of 4.6 or 5 feet. This estimate is considered adequate and conservative since the reservoir will be afforded reasonable protection from winds by the neighboring mountains, and the top of the dam will be protected by a paved highway section across the dam. Based on the above criteria and analysis, a freeboard allowance of 5 feet was adopted for the W. Kerr Scott Dam design.

The spillway design flood computation performed at the time Scott Dam was being designed generated a peak reservoir pool elevation of 1102.5 feet, m.s.l. Adding five feet of freeboard, the top of dam elevation was set at 1107.5 feet, m.s.l. Spillway design flood computation methods have been revised since Scott Dam was built. The latest spillway design flood computation yielded a peak reservoir pool elevation of 1105.2 feet, m.s.l. Based on this latest computation, the freeboard at Scott Dam is 2.3 feet.

c. Uncontrolled Chute Spillway. The emergency uncontrolled chute spillway is utilized in the event the reservoir level rises above the top of flood control pool elevation 1075.0 feet, m.s.l. It is located to the left of the dam (looking downstream), as shown on plates 2-2 and 2-3. The spillway crest length is 400 feet. The orientation of the spillway directs floodwaters into a small tributary of Fish Dam Creek. Fish Dam Creek empties into the Yadkin River about 700 feet downstream from the base of Scott Dam. The spillway can pass 176,500 cubic feet per second of floodwaters at the maximum design pool elevation of 1102.5 feet, m.s.l. The spillway rating curve is shown on plate 2-5.

d. Intake Tower -- General. The intake tower is a wet well, reinforced concrete, gated structure. The structure is 149 feet high and at its base 34 feet wide by 45.25 feet long, as shown on plates 2-6 and 2-7. The intake tower is located on the upstream side of the dam as shown on plates 2-3 and 2-4. The invert elevation of the intake tower is 965.0 feet, m.s.l. Below elevation 1080 feet, m.s.l., the tower is divided into two chambers, each of which contains a service gate and a framed slot into which the emergency gate can be lowered. (The project has only one emergency gate.) The service gate openings are 6 feet wide and 12.25 feet high. The emergency gate openings are 6 feet wide and 13 feet high. The emergency gate, which may be used in either chamber, is stored against the upstream face of the intake tower, just above a platform which is at elevation 1033 feet, m.s.l. Between elevations 1080 feet, m.s.l. and 1102.5 feet, m.s.l. is the operating room which houses the service gate hoisting equipment. The operating room floor (at elevation 1080) and the tower roof deck (at elevation 1102.5 feet, m.s.l.) are provided with covered watertight openings for the removal of the service gates and equipment. The emergency gate hoist is mounted on a monorail over-hanging the upstream side of the intake tower roof deck. Along the northwest side of the roof deck is a 5-foot-wide enclosure. The north end of the enclosure contains a separate room where headwater gaging equipment is located. The west end of the enclosure provides access to interior and exterior parts of the tower. A set of stairs leads from the enclosure down to the control room. Two watertight hatches in the floor of the control room lead to each of the wet well chambers below. In each chamber, ladder rungs mounted in the wall lead down, by way of five interior platforms, to elevation 981 feet, m.s.l., where a manhole with a watertight cover provides access to the gate bay just downstream of the service gate. The enclosure also provides access to an exterior platform at elevation 1102.5 feet, m.s.l. that leads to the top of a 73-foot ladder mounted on the northwest face of the intake tower. The ladder leads down to the platform at elevation 1033 feet, m.s.l. where the emergency gate is stored. The intake tower roof deck is connected to the service road on the crest of the dam by a 12-foot-wide access bridge. The remaining sides of the roof deck are enclosed by a 4-foot-high reinforced concrete parapet wall. The access bridge has 3-foot-high steel pipe handrails atop 9-inch concrete curbs along its length on both sides of the roadway for safety. Various features of the intake tower are described in more detail in paragraphs f-m.

e. Approach Channel. The approach channel to the intake tower is shown on plate 2-3, and the approach channel walls are shown in detail on plate 2-8. The south wall of the approach channel is about 141 feet long, with a constant top of wall elevation of 1007 feet, m.s.l. for its entire length. The upstream 84 feet of the wall is a gravity wall; the downstream 57 feet remaining is a cantilever wall. The north wall of the approach channel is 88 feet long, with the top of wall elevation sloping up from 971 feet, m.s.l. at the upstream end to 999 feet, m.s.l. at the intake tower. The upstream 63 feet is a gravity wall and the downstream 25 feet is a cantilever wall.

f. Trash Rack Structure. The trash rack structure has a gross rack area of about 573 square feet and an area-of-bars to area-of-section ratio of about 0.38. The average velocity through the structure for a flow of 5,300 cubic feet per second is 15 feet per second based on net rack flow area and about 9 feet per second based on gross rack area.

g. Service Gates. Two structural steel service gates, one for each gate bay, are located directly below the operating room of the intake tower, about 15 feet upstream of the transition, as shown on plate 2-7. Each gate is stem-connected to its own vertically-mounted hydraulic cylinder hoist located in the operating room, and can be lowered to completely close the gate bay. Clear openings of the gates are 6 feet wide by 12.25 feet high in each bay. The gates have upstream skin plates, downstream seals, and a 45 degree gate lip for hydraulic efficiency. Side and top seals are musical chord-type rubber seals and the bottom seals are rectangular. The skin plate is welded to horizontal structural tee beams. Five 16-inch-diameter wrought steel fixed wheels, fitted with corrosion-resisting steel rims, are mounted on alloy steel axles on each side of the gate. Bronze bushings and stainless steel welded overlays on the axles reduce corrosion and axle friction. The structural steel gate frames and conduit liners protect the water passages from about 0.5 feet upstream of the service gate openings to about 10.5 feet downstream of the openings for a total length of about 12.5 feet. A 4.5-foot by 1-foot air vent from elevation 1086 feet, m.s.l. to the inside of the manhole that is a few feet downstream of each service gate is provided for each gate bay for pressure equalization inside the water passage.

h. Emergency Gate. One structural steel emergency gate is stored against the upstream face of the intake tower above the platform which is at elevation 1033 feet, m.s.l., as shown on plate 2-7. The gate may be lowered into the emergency gate frame in either chamber by means of an electric hoist on a monorail mounted on the intake tower roof deck. The emergency gate frame in each intake bay is located 9.5 feet upstream of the service gate frame. The intake bay clear opening at this point is 6 feet by nearly 13 feet. The emergency gate has downstream seals, a skin plate, and a 45 degree gate lip for hydraulic efficiency. Side and top seals are musical chord-type rubber seals, and the bottom seal is rectangular. The skin plate is welded to horizontal tee beams. Since the gate is designed to close by its own weight, the skin plate is on the downstream side to reduce buoyancy. Five 16-inch-diameter wrought steel fixed wheels are mounted on alloy steel axles on each side of the gate. Roller bearings inside the wheels reduce axle friction. The structural steel emergency gate frames line the water passages from about 0.5 feet upstream of the gate opening to about 2 feet downstream of it for a total length of almost 4 feet.

i. Service Gate Hoists. The service gates are raised and lowered by means of two direct stem-connected hydraulic cylinder hoists located in the operating room. Operating pressure for the cylinder hoists is provided by two vane-type hydraulic pumps arranged such that each pump can operate either gate hoist or both pumps can be used together to operate one or both gate hoists. The hydraulic system was designed to raise the gates at a rate of approximately 1 foot per minute.

j. Emergency Gate Hoist. The emergency gate is raised and lowered by means of an electric hoist on a hand-operated trolley hanging from a monorail mounted on the intake tower roof deck. The electric hoist was designed to have a two speed hoist motion of approximately three and six feet per second, with a working capacity of 15 tons at low speed and 7.5 tons at high speed.

k. Floatwell. A 24-inch diameter steel pipe floatwell is provided in the northern corner of the intake tower. The floatwell extends from elevation 987.5 feet, m.s.l. up to the gaging equipment shelf in the enclosure penthouse atop the intake tower. Equipment to record the water level consists of a mechanical punch tape gage, a GOES satellite data collection platform, and an electric tape gage for verification. Telemetry equipment provides remote access to the latest water level reading by telephone.

l. Access Bridge. Access to the intake tower is provided by a bridge from the service road atop the dam (at elevation 1107.5 feet, m.s.l.) to the intake tower roof deck (at elevation 1102.5 feet, m.s.l.). The bridge is 14 feet wide with a 12-foot-wide roadway. The bridge along its centerline is approximately 276 feet long, and consists of two simply-supported spans of about 126 feet each and a concrete bridge abutment 24 feet long. Concrete curbs, steel pipe handrails, and an entrance gate are provided. The bridge location is shown on plate 2-3. A side view of the access bridge is shown on plate 2-4.

m. Transition Zone. The transition zone of the water passage consist of a 30-foot-long section which connects the two rectangular gate bays of the intake tower to the single circular conduit, as shown on plate 2-7. The transition zone is designed to provide a gradual change in the cross-section of the water passage to minimize negative pressure areas, friction losses, wear and tear on the concrete lining and on the intake tower in general while maximizing the flow capacity. The water passage in the transition zone is 12.25 feet high, and narrows gradually from 17 feet in width at the gate bays to 12.25 feet at the conduit. The 5-foot-thick vertical wall separating the two gate bays narrows gradually to 1 foot in thickness before ending at a point 5 feet upstream of the conduit. Corners of the water passage cross section are gradually rounded along the length of the transition.

n. Conduit. The 12.25-foot-diameter circular conduit is 749 feet long with monolith joints every 30 feet. The slope is approximately 0.7 percent from invert elevation 965 feet, m.s.l. at the downstream end of the transition zone to invert elevation 960 feet, m.s.l. at the outlet portal. The conduit is shown on plate 2-4.

(1) Hydraulic Considerations for Conduit Capacity. The outlet works were designed to discharge 5,400 c.f.s. at the normal pool elevation of 1030 feet, m.s.l. This flow rate was chosen because it is the channel capacity downstream of the dam. According to the conduit rating tables currently in use, a discharge of 5,400 c.f.s. can be released through the conduit with a minimum pool elevation of about 1032.2 feet, m.s.l. This flow rate would allow the full flood pool to be drawn down to normal pool elevation within 2 weeks assuming normal inflows during the drawdown period and floodwater recession at Wilkesboro allowing design discharge releases within a few days after the storm. Discharge capacity is 5300 c.f.s. when the lake is at elevation 1030 feet, m.s.l.

(2) Open Channel Flow. At the time the outlet works were designed, hydraulic characteristic curves were developed for two critical sections. According to this analysis, when both service gates are fully open, the control occurs at the downstream end of the transition zone, where the conduit slope begins. When only one gate is fully open, the control occurs near the downstream end of the pier in the transition section. Tailwater elevations do not produce a backwater effect at the control sections. The conduit starts to flow full with a discharge of about 2,600 c.f.s.

(3) Pressure Flow. With pressure flow in the conduit, control shifts to the outlet portal. Rating curves on plates 2-9 and 2-10 show the relationship between reservoir pool elevation and conduit discharge for various service gate settings.

o. Stilling Basin. Energy dissipation is accomplished by a flared hydraulic-jump type stilling basin with a horizontal apron, baffle blocks, and an end sill, as shown on plate 2-4. The stilling basin connects to the outlet portal with a flared transition which includes circular fillets from the outlet portal to the rectangular section at the beginning of the parabolic drop. The transition section is 25 feet long and has the same slope as the conduit. The nearly 28.5-foot-long parabolic section is followed by a tangent section 12.8 feet long with a slope of 28.6 percent. The tangent section meets the horizontal apron at elevation 252 feet, m.s.l. The apron is 63 feet long with two rows of 3.5-foot-high baffle blocks and a 3.5-foot-high end sill. The width of the stilling basin is 12.25 feet at the outlet portal and increases continuously through the length of the stilling basin, to a width of 54 feet at the end sill. Stoplog slots were provided in the design of the stilling basin for dewatering the conduit. However, they were improperly constructed perpendicular to the flared walls rather than facing each other. Stoplogs were never obtained, and dewatering for inspections has been accomplished by stacking sandbags in the stilling basin or by constructing a temporary dike across the discharge channel.

p. Discharge Channel. The discharge channel conveys outflow from the stilling basin to the Yadkin River, as shown on plate 2-3. It is an earth-lined trapezoidal channel with 2:1 (horizontal:vertical) side slopes which are protected by 3 feet of dumped rock at the upstream end and by grasses planted above elevation 965 feet, m.s.l. on the rest. The discharge channel is about 729 feet in length along its centerline with a bottom elevation of 955.5 feet, m.s.l. at the end sill of the stilling basin. The bottom elevation increases downstream at a rate of 1 foot vertical to 10 feet horizontal until reaching elevation 960 feet, m.s.l., which is the bottom of the natural channel. The discharge channel is 72 feet wide from the end sill of the stilling basin to a point 46 feet downstream of the end sill. The channel then widens gradually, reaching a maximum width of 120 feet at about 189 feet downstream of the stilling basin.

q. Tailwater Rating Curve. The tailwater rating curve, shown on plate 2-11, was developed during the design phase of the Scott Reservoir project. River channel and overbank cross-sections of the Yadkin River between the damsite and the Wilkesboro stream gage (about 5.8 miles downstream of the damsite) were surveyed in 1958. This survey data was used, along with discharges and water surface elevations at the Wilkesboro gage, in backwater computations to determine the tailwater rating curve. A temporary staff gage installed in 1957 at Brown's Ford Bridge about a half mile downstream of the damsite provided stage and discharge readings which were used to verify the backwater computation procedures and assumptions.

r. Instrumentation. Various instruments were installed in the dam embankment or added after completion to monitor conditions in the embankment which could potentially undermine its stability and present a safety problem. Instrumentation of the dam currently consists of 8 settlement markers, 7 precise alignment markers, 11 hydraulic piezometers, 5 open-tube piezometers, and a V-notch weir. Plates 2-12 and 2-13 show the locations of the hydraulic piezometers, alignment markers, and settlement markers. Seismic instrumentation, consisting of 5 strong motion stations and one microseismic station, has been discontinued. The following paragraphs describe the various instruments in more detail. A general evaluation of the data collected can be found in the Periodic Inspection Reports of the Wilmington District Corps of Engineers. A complete evaluation of data collected is documented in the annual instrumentation reports which are submitted to South Atlantic Division Corps of Engineers for review.

(1) Settlement Markers. The locations of the eight settlement markers are shown on plate 2-12. Markers S-1 and S-5 were placed near elevation 1107 feet, m.s.l.; S-2 and S-6 were placed near elevation 1088 feet, m.s.l.; S-3 and S-7 are at elevation 1069 feet, m.s.l.; and S-4 and S-8 are near elevation 1049 feet, m.s.l. These are used to monitor the settlement within the dam embankment. The markers were placed in the embankment during construction, and the initial readings were made in September 1963. They are currently read annually.

(2) Precise Alignment Monuments. The locations of the 7 alignment markers along the upstream side of the service road on the crest of the dam are shown on plate 2-12. They were initially installed in December 1971 along the centerline of the service road. Damage by snow removal equipment prompted a relocation of the markers a bit upstream of the service road in June 1974. The markers are used to monitor horizontal, and in recent years vertical, displacement along the crest of the dam. Usable readings are available back to 1971. The alignment markers are currently monitored annually.

(3) Hydraulic Piezometers. The locations of the 11 hydraulic piezometers are shown on plates 2-12 and 2-13. These were installed in August 1962 and are currently read monthly.

(4) Open-tube Piezometers. Five open-tube piezometers were installed in the toe of the dam in February 1984. These are monitored monthly.

(5) V-Notch Weir. A weir was initially constructed in about 1974 in order to measure flow from a spring at the downstream toe of the dam. This weir was quickly disturbed and overgrown, and no readings were recorded for it. A new weir was constructed in May 1986 and has been monitored monthly since then.

(6) Seismic Instrumentation. A microseismic station was installed near the Resource Management Office in December 1979. This station was decommissioned in 1980 due to repeated equipment problems from lightning. No sustained useful data was collected. Five strong-motion monitoring stations were operated from 1977 until February 1988 when they also were decommissioned due to repeated equipment problems. The "Phase I Seismic Analysis Report" was completed in August 1988 based on data from these 5 strong-motion stations.

2-04. Reservoir. W. Kerr Scott Dam forms a lake which extends about 9.7 miles up the Yadkin River. At the normal pool elevation of 1030 feet, m.s.l., the length of the shoreline is about 55 miles and the reservoir covers an area of about 1,475 acres. Elevation 1030 feet, m.s.l. is the normal operating level of the reservoir throughout the year. At this pool elevation, the reservoir has a mean depth of about 27.8 feet and a maximum depth of about 65 feet. A reservoir map is shown on plate 2-2, area-capacity curves are on plate 2-14, and a cross section of the reservoir showing the various operating pools is on plate 2-15. The total project lands (about 2,279 acres above elevation 1030 feet, m.s.l.) comprise about 1.0 percent of the total watershed area and encompass about 13 miles of the Yadkin River upstream of the dam. All of the project lands are in Wilkes County.

a. Sedimentation and Conservation Storage. At the time Scott Reservoir was designed, investigations by the U.S. Fish and Wildlife Service and the North Carolina Wildlife Resources Commission indicated that the minimum reservoir pool necessary for conservation of fishery values in the reservoir would have a top pool elevation of 1000 feet, m.s.l., containing 8,000 acre-feet of storage of which 7,000 acre-feet could be used for sediment storage. The sediment storage requirement was estimated from sedimentation data from 14 reservoirs in North Carolina that had been surveyed over an average of 10.2 years. The average sedimentation rate of these reservoirs was 0.4 acre-feet per square mile of drainage area per year. Multiplying this sedimentation rate by 348 square miles (the drainage area as it was reckoned at the time) and by a 50-year project life gave an estimate of sediment storage needed of about 7,000 acre-feet. A temporary network of sedimentation and degradation ranges was established at Scott Reservoir in its early years to monitor these processes. A total of 20 sedimentation ranges were located upstream of the dam and 3 degradation ranges were located downstream of the dam, as shown on plate 2-16. Eight of the sedimentation ranges were established and surveyed prior to the initial filling of the reservoir; the remaining 12 were added in 1971. The last sedimentation resurvey was performed in 1978-79 and was reported in a sedimentation resurvey report dated March 1980. This resurvey indicated an average sedimentation rate from 1962 to 1978 of 0.37 acre-feet per square mile of drainage area per year (based on a drainage area of 348 square miles, for comparability to the design sedimentation rate).

b. Water Supply Storage. The water supply storage pool is that part of the reservoir volume between elevations 1000 feet, m.s.l. and 1030 feet, m.s.l., amounting to about 33,000 acre-feet. The County of Wilkes, North Carolina and the City of Winston-Salem, North Carolina jointly entered into a contract with the United States of America on 29 June 1960 whereby they purchased the right to impound water in this pool and to order releases to be made therefrom at any time, provided that such releases, when combined with normal runoff below the dam, will not cause damaging floods. This renewable 50-year contract was activated July 22, 1970, when releases were first ordered under the contract. Since then, various minimum flow release schedules have been used to order releases from the water supply pool. Water stored in this pool also benefits recreational activities at the reservoir. The 33,000 acre-feet of storage in the water supply pool is equivalent to about 1.69 inches of runoff over the drainage area upstream of the dam. The total volume of Scott Reservoir below elevation 1030 feet, m.s.l. is about 41,000 acre-feet.

c. Flood Storage. The flood control storage between elevations 1030 feet, m.s.l. and 1075 feet, m.s.l. is about 112,000 acre-feet. This volume is equivalent to about 5.7 inches of runoff from the drainage area above Scott Dam, and would have completely stored the runoff from the flood of record which occurred in August 1940. The flood control pool was designed to hold 6 inches of runoff from the drainage area above the dam, which at the time of design was reckoned as 348 square miles. Total storage in the reservoir up to elevation 1075 feet, m.s.l. is 153,000 acre-feet. An additional 153,000 acre-feet of surcharge storage exists between elevations 1075 feet, m.s.l. and 1102.5 feet, m.s.l. which provides 7.8 watershed inches of uncontrolled flood storage.

2-05. Wildlife Subimpoundments. There are currently no subimpoundments at Scott Reservoir. Ideal sites for greentree subimpoundments are noticeably lacking due to topography. Efforts are being made, however, to locate at least two or three sites where subimpoundments can eventually be built in order to provide waterfowl food and habitat.

2-06. Real Estate Acquisition. The guide taking line for real estate acquisition was the 5-year flood elevation, 1047 feet, m.s.l. Based on this guideline, a total of 3,754 acres of land was purchased in fee title. The reservoir, at normal pool elevation, covers 1,475 of these acres, while the remaining 2,279 acres lie above elevation 1030 feet, m.s.l. Flowage easements were obtained for the 2,021 acres of land around the reservoir between elevations 1047 and 1080 feet, m.s.l. The flowage easement guide taking line, at elevation 1080 feet, m.s.l., is 5 feet above the spillway crest elevation.

2-07. Public Facilities. Project lands around W. Kerr Scott Reservoir include 16 recreation areas encompassing a total of 1,587 acres, as shown on plate 2-17. Fourteen of these areas are operated by the Corps of Engineers; one area, Wilkes County Reservoir Park, is operated by the County of Wilkes, North Carolina; and one area, Wilkes Skyline Marina, is operated by a private concessionaire. Visitation to Scott Reservoir was over 2.2 million in fiscal year 1992. Recreation opportunities include sightseeing, picnicking, hiking, hunting, fishing, swimming, boating, waterskiing, primitive camping, group camping, tent/trailer camping, softball, baseball, playgrounds, and interpretive programs. Public use facilities include a visitor center, access roads and parking areas, picnic areas with grills, comfort stations, hiking trails, fishing piers (including a small pier for the handicapped), swimming beaches, boat launching ramps, primitive campsites, group camping areas, tent/trailer campsites with electric and water hookups, flush toilets, hot showers, playground equipment, basketball courts, a softball field, amphitheaters, and a vita course for the handicapped.

III. HISTORY OF PROJECT

3-01. Authorization of Project. The flood control plan for the Yadkin-Pee Dee River Basin was authorized by the Flood Control Act of 1946 (Public Law 526, 79th Congress, 2nd session). Section 10 of the 1946 Act contains the following:

> ...That the following works of improvement for the benefit of navigation and the control of destructive flood waters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of War and the supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated...:
>
> ...The project for the construction of four detention reservoirs at the Wilkesboro, Upper Wilkesboro, Reddies Numbered 1, and Reddies Numbered 3 sites is hereby authorized substantially in accordance with plans contained in the report of the Chief of Engineers dated 19 June 1946, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, at an estimated cost of $7,194,000....

The referenced 19 June 1946 report of the Chief of Engineers was published as Senate Document No. 31, 81st Congress, 1st session. Senate Document No. 31 reviews recommendations contained in House Document No. 652, 78th Congress, 2nd session. The plan of improvement in Senate Document No. 31 contemplated a concrete dam with gated outlet at all four of the sites named in the 1946 Act. The reservoirs were planned for flood control only, with no conservation storage. The project document did not specify any requirements of local cooperation.

3-02. Project Modifications.

a. The "Definite Project Report on Reddies River Dam and Reservoir," dated 15 March 1950 found that provision of a single earth fill dam at the Reddies No. 1 site, in lieu of the authorized two concrete dams at the Reddies No. 1 and Reddies No. 3 sites, would 3-1 be just as effective for flood control and would be less costly. That finding was approved by the Chief of Engineers 28 April 1950.

b. The "Review Report on the Yadkin-Pee Dee River and Tributaries, North Carolina and South Carolina, Re: Wilkesboro Reservoir," dated 14 August 1953, concluded that a single earth dam at the Wilkesboro site would be less costly than the two concrete dams on the Yadkin River authorized in the 1946 Act, would be more effective for flood control, and would require less land in the reservoir area. The study was of preliminary examination scope and contemplated a reservoir at the Wilkesboro site with a full pool elevation of 1070 feet, m.s.l. and a total capacity of 145,000 acre-feet, based on the area-capacity data available at the time. The report of the Board of Engineers for Rivers and Harbors dated 26 March 1954 recommended that one reservoir, with storage capacity for flood control at least equivalent to that planned for the authorized Wilkesboro and Upper Wilkesboro Reservoirs, be approved by the Chief of Engineers for construction on the Yadkin River at the Wilkesboro site in lieu of those two reservoirs.

c. On the basis of the aforementioned reports, the Chief of Engineers, in a letter to the Secretary of the Army dated 4 April 1955, approved the substitution of one reservoir at the lower Reddies site for the two authorized reservoirs on Reddies River, and one reservoir at the Wilkesboro site for the two authorized on the Yadkin River.

d. In order to establish economic justification for the Wilkesboro Reservoir on a current basis, a restudy of project benefits and costs was undertaken and the resulting "Report on Restudy of Wilkesboro Reservoir, North Carolina," dated 20 March 1957, was submitted. In recognition of requests by concerned Federal and State agencies for inclusion of storage capacity for low flow regulation and conservation purposes, the restudy report was based on consideration of needs and requirements for water supply, pollution abatement, recreation, and fish and wildlife conservation, in addition to flood control. The project plan contemplated in the restudy was to provide a reservoir with the top of flood control pool at elevation 1070 feet, m.s.l. and a total controlled capacity of 145,000 acre-feet, of which 112,000 acre-feet would be reserved for flood control, 22,000 acre-feet for low flow regulation, and 11,000 acre-feet for sedimentation and conservation (based on area-capacity data in use at the time). The restudy report was approved by the Chief of Engineers on 29 April 1957 with the directive that "preconstruction planning is to proceed in FY 1958, dependent upon appropriations, with this planning to include consideration of flood control and low flow augmentation for water supply, pollution abatement, and fish and wildlife and recreation uses." This was the latest approved plan prior to the undertaking of definite project studies. It included provision for the stated water uses in addition to flood control, and recognized that non-Federal funds may be required in connection with provision for such water uses.

e. Basic topographic data on the dam site and reservoir area which were utilized in preparation of the aforementioned Report on Restudy (1957) and prior reports consisted of field survey data compiled in 1938-39 and plotted on a scale of 1:10,000 with a contour interval of 10 feet. This data was found deficient for preconstruction planning purposes. Aerial photographs of the dam site and reservoir area were flown under contract in February 1956. The dam site photos were on a scale of 1:6,000 and those of the reservoir area were 1:24,000. The aerial photos were used in connection with various aspects of the Report on Restudy, and were subsequently used to prepare topographic maps of the dam site and reservoir area by photogrammetric methods (Kelsh plotters). Third order horizontal control and second order vertical control were established in the field. The dam site was mapped at a scale of 1 inch equals 200 feet and a contour interval of 5 feet; the reservoir area at a scale of 1 inch equals 400 feet and a contour interval of 10 feet. Mapping was done by Piedmont Engineering Service, Greenville, South Carolina under contract with the Corps of Engineers, Charleston District. These maps were utilized in the designs and estimates presented in the General Design Memorandum and subsequent documents.

f. While project purposes, site location, type of dam, type of spillway, and other such major project features remain consistent with the Report on Restudy, top of pool elevations, dimensions of the dam and its appurtenances, and other features such as outlet works design were subject to modification in the General Design Memorandum (December 1958) and again in the subsequent numbered Design Memorandums (April 1959 - October 1960). The text and plates of the numbered Design Memorandums are fairly representative of the as-built project. Table 1-1 lists the Design Memorandums and their submission and approval dates.

3-03. Water Supply Contract. On 29 June 1960, the County of Wilkes, NC, and the City of Winston-Salem, NC, jointly entered into a contract with the United States of America whereby the County of Wilkes and the City of Winston-Salem purchased the right to impound water in W. Kerr Scott Reservoir between elevations 1000 feet, m.s.l. and 1030 feet, m.s.l. and to order releases to be made therefrom at any time, provided that such releases, when combined with normal runoff below the dam, would not cause damaging floods. The contract is a renewable 50-year contract.

3-04. Construction and Impoundment. The construction contract was awarded to Clement Brothers, Inc. in September of 1960. Normal flow of the Yadkin River was obstructed 8 June 1961, and the control gates were closed on 22 August 1962 for reservoir filling to begin. On 19 January 1963, the normal pool elevation of 1030 feet, m.s.l. was reached. In February of 1963, the dam was completed and placed in operation.

3-05. Change of Name. In 1963, the official name of the project was changed by the United States Congress from "Wilkesboro Reservoir" to "W. Kerr Scott Dam and Reservoir" in honor of the former Governor and U.S. Senator from North Carolina.

3-06. Modifications to Regulations. Flood control operations and objectives have remained fairly consistent with that envisioned during the design process. However, low flow release policies have been more variable. In the Design Memorandums, the envisioned low flow target was 320 c.f.s. at the Wilkesboro stream gage. By the time the dam was built, the reservoir pool between elevations 1000 feet, m.s.l. and 1030 feet, m.s.l., from which the envisioned low flow releases were to have been made, was converted to a water supply pool, and the control over releases from this pool was purchased by the County of Wilkes, NC, and the City of Winston-Salem, NC, as described in 3-03. A contract between the County of Wilkes and City of Winston-Salem gives Winston-Salem the authority to request releases from the reservoir on both their behalfs. No releases were ordered by the users until 22 July 1970; and until that time, releases were set equal to inflow to maintain a pool elevation of 1030 feet, m.s.l. during low flow (non-flood) periods. Since then, various release schedules have been used. The latest schedule which has been in effect since March 1989 is shown in table 3-1.

Table 3-1
Low Flow Operation Plan for W. Kerr Scott Dam and Reservoir

Scott Pool Elevation (ft., m.s.l.)	Minimum Flow and Stage at Wilkesboro, NC Flow (c.f.s.)	Stage* (feet)
1029.00 and above	400	2.11
1028.00 - 1028.99	350	2.01
1027.00 - 1027.99	300	1.90
1026.00 - 1026.99	250	1.78
1024.00 - 1025.99	200	1.66
1023.00 - 1023.99	150	1.53
1000.00 - 1022.99	**	**

Note: Minimum discharge from Scott should not be less than 125 c.f.s. at any time, except during inspection and maintenance periods.

*These stage readings are from Rating Table 21 for Yadkin River at Wilkesboro, N.C., and are subject to change.

**In this range, outflow from the reservoir should be set at 125 c.f.s.

3-07. Change of Responsible Corps District. On 1 April 1980 the responsibility for the operation of the W. Kerr Scott Dam and Reservoir project was transferred to the Wilmington District from the Corps of Engineers Charleston District, which constructed the project and operated it prior to that time.

3-08. Regulation Problems and Operating Constraints. There are no major regulation problems or operating constraints. Both service gates are operable over the full range of gate settings, and the design maximum discharge can be released without interference from floodplain encroachment.

3.09. Constraints on Water Supply Use. The water supply contract, signed by the County of Wilkes and the City of Winston-Salem in June 1960, envisioned approximately 33,000 acre-feet of storage between elevations 1000 and 1030 feet, m.s.l. for water primarily intended for future municipal and industrial water supply use. The only constraints on releases from this pool which were mentioned in the contract were that releases can not be ordered if the water supply pool is empty, and releases can not be ordered which would contribute to flooding downstream. Payment for use of this storage is not dependent on the quantity of water released or withdrawn from the pool. In practice, releases have been primarily for low flow water quality improvement, particularly benefiting the Yadkin River near Winston-Salem. All low flow releases which are made from Scott Reservoir are made from the water supply pool. However, low flow water quality releases have been reduced over the years in order to conserve water and to better maintain a reservoir pool elevation conducive to recreational use of the reservoir, which is beneficial to Wilkes County. Recreational use has been much greater than originally anticipated; therefore, the consequences of making releases which significantly draw down the reservoir have likewise increased.

3-10. Related Projects. The planned earth fill dam at the Reddies No. 1 site referred to in 3-02 a and c has not been restudied or pursued.

IV. WATERSHED CHARACTERISTICS OF THE YADKIN-PEE DEE RIVER BASIN

4-01. General. The Yadkin-Pee Dee River Basin (see plate 2-1) covers portions of North Carolina, Virginia, and South Carolina. The basin has a drainage area of approximately 18,500 square miles. The river rises on the eastern slope of the Blue Ridge Mountains and flows to the northeast for approximately 100 miles until it reaches a point near Winston-Salem, NC, and then flows to the southeast for 335 miles until it enters the Atlantic Ocean near Georgetown, SC. The Yadkin-Pee Dee Basin is the second largest in North Carolina and flows through 21 counties. The portion of the basin in North Carolina covers approximately 7,175 square miles and is located in the Blue Ridge and Piedmont Provinces of North Carolina.

The Yadkin River, on which W. Kerr Scott Reservoir is located, lies in the northwestern part of North Carolina. It is bordered on the north by the watershed of the New River, and on the south by the Catawba River drainage basin. It flows through five counties before it joins the Uwharrie River and becomes the Pee Dee River. The Yadkin River has a drainage area of 4,164 square miles at the point where it joins the Uwharrie River. Plate 4-1 shows the principal tributaries of the Yadkin River above High Rock Dam.

The drainage area above W. Kerr Scott Dam is 367 square miles. Plate 4-1 shows the principal streams above the reservoir.

4-02. Topography. The headwaters of the Yadkin River lie within the Blue Ridge Province of the state on the eastern slopes of the Blue Ridge Mountains. This area is characterized by steep stream gradients and deep valleys with narrow flood plains. The majority of the Yadkin River Basin lies in the upper Piedmont region of the state. This province is not as rugged as the Blue Ridge Province, and is characterized by rolling hills, deep valleys, and moderately wide flood plains. Profiles of the Yadkin River are shown on plates 4-2 and 4-3. Pertinent data on the drainage characteristics of the basin are shown in table 4-1.

Table 4-1

Drainage Characteristics of the Yadkin-Pee Dee River

Reach	Elevation of Low Water Surface (feet, m.s.l.)	Distance Between Reaches (miles)	Fall (in Feet) Total	Fall (in Feet) Per Mile	Drainage Area (sq. mi.)
W. Kerr Scott Reservoir	962				367
		6	20	3.5	
Wilkesboro	944				504
		24	77	3.2	
Elkin	868				869
		41	162	3.9	
Enon	705				1,694
		33	68	2.1	
Yadkin College	640				2,280

4-03. General Geology and Soils. The geology of the project area is given below.

a. Geology. The Yadkin River Basin is located, as stated previously, in the Blue Ridge and Piedmont Physiographic Provinces, with the majority of the basin being in the Piedmont Province. The Blue Ridge Province is mostly composed of a complex assemblage of plutonic rocks of Precambrian age typified by granites, mica-gneisses, mica-schists, amphibolites, and ultramafics. The Piedmont Region is generally comprised of schists, gneisses, granites and basic igneous rocks. Some of the subordinate, but significant, rock types in the Piedmont Region are Carolina Slate Belt and Triassic Basin rocks.

The W. Kerr Scott Dam and Reservoir Project is located within the inner belt of the Piedmont Geologic Province between the Blue Ridge and Brushy Mountain Ranges. The general area is underlain by ancient metamorphic rocks of sedi-mentary origin, most of which belong to a broad geologic group known as the Carolina Gneisses. The W. Kerr Scott Dam and Reservoir lies in a subprovince known as the Brevard Shear Zone which is used by some geologists to separate the Blue Ridge Province from the Piedmont.

b. Soils. The Pacolet series soils make up the largest portion of the project lands. This includes the Pacolet Sandy Loam and the Pacolet Clay Soils. The Pacolet soils are well-drained, moderately permeable soils that formed in material weathered mostly from acid and crystalline rocks of the Piedmont uplands. Surface runoff is rapid on this type of soil. Internal drainage is medium. Most of the areas with this type of soil are in forests of pine and mixed hardwoods.

The second largest portion of the area is made up of the Rion series soils. The Rion series consists of deep, well-drained, moderately permeable soils. Surface runoff is moderate on Rion soils. The Rion series is closely related to the Pacolet series, and was formerly included in the Pacolet series. Forests of pine and mixed hardwoods are typical vegetation on these soils.

c. Seismicity. W. Kerr Scott Reservoir is situated in a relatively aseismic region of the North American continental plate. Although relatively aseismic, severe earthquakes have occurred in the region; for example, the earthquake of Cape Anne, Massachusetts in 1775, the Grand Banks 1929 shock, the 1811-12 New Madrid, Missouri quake and the 1886 Charleston, South Carolina event. The Wilmington District published the "Seismological Evaluation Report of W. Kerr Scott Reservoir and Dam" in 1988. Details of the evaluation and recommendations can be found in that report.

d. Groundwater. The Yadkin River Basin is mostly underlain by granite type rocks, gneisses, and schists. These rock types are not very permeable and do not store water well. Therefore groundwater quantities in the basin could be expected to be low.

e. Mineral Resources. A variety of minerals occur in the Yadkin River Basin. Some of the minerals found in the basin are copper, iron, chrysotile, pyrrhotite, pyrite, chalcopyrite, galena, and sillimanite. None of these minerals occur in quantities economic for mining in recent times. Crushed stone and gravel are the only mineral products being produced in significant quantities in the basin.

4-04. Sediment and Erosion.

a. General. Quantities and composition of sediment and other suspended materials vary within the Yadkin River Basin due to the variability of such factors as physiology, slope, drainage, climate, and land use within the basin.

b. Sediment Quantity. Sediment quantities have been measured at several locations in the Yadkin River Basin and the sediment characteristics of these streams have been published by the U.S. Geological Survey. The mean annual suspended-sediment yield, as shown in table 4-2, ranges from 220 to 530 tons per square mile in the Yadkin Basin. The suspended-sediment character-istics at these stations are shown in table 4-3.

Table 4-2

Annual Sediment Yields

USGS Station No.	Station Name	Drainage Area (sq. mi.)	Average Discharge 1970-1979 (c.f.s.)	Average Annual Sediment Yield 1970-1979 (tons/sq. mi.)
02111000	Yadkin River at Patterson	28.8	60	380
02111180	Elk Creek at Elkville	48.1	119	440
02111500	Reddies River at North Wilkesboro	89.2	181	490
02112120	Roaring River near Roaring River	128	219	330
02112250	Yadkin River at Elkin	869	1,630	350
02112360	Mitchell River near State Road	78.8	143	220
02113000	Fisher River near Copeland	128	211	350
02113500	Yadkin River at Siloam	1,226	2,180	390
02113850	Ararat River at Ararat	231	351	430
02115360	Yadkin River at Enon	1,694	2,930	470
02116500	Yadkin River at Yadkin College	2,280	3,550	530

Source: SEDIMENT CHARACTERISTICS OF NORTH CAROLINA STREAMS, 1970-1979, U.S. Geological Survey Open-File Report 87-701, by Clyde E. Simmons, U.S. Department of the Interior, 1988

c. Erosion Quantity. The suspended-sediment discharge rate represents only a portion of the total soil erosion rate in the Yadkin Basin. According to studies by the U.S. Soil Conservation Service and the U.S. Geological Survey, between 20 and 40 percent of the eroded soils appear as suspended-sediment discharge. This is because most of the eroded soils are redeposited either before reaching a stream or after being carried downstream for some distance. Table 4-4 shows the ratio of gross erosion to suspended sediment at sampling stations in the Yadkin Basin.

Table 4-3

Suspended Sediment Characteristics

Station Name	Average Annual Suspended Sediment Discharge 1970-1979 (tons)	Suspended Sediment Concentration Equaled or Exceeded 1 Percent of the Time (mg/l)	Suspended Sediment Concentration Equaled or Exceeded 90 Percent of the Time (mg/l)
Yadkin River at Patterson	11,000	630	5
Elk Creek at Elkville	21,000	480	4
Reddies River at North Wilkesboro	44,000	1,000	5
Roaring River near Roaring River	42,000	870	4
Yadkin River at Elkin	300,000	710	19
Mitchell River near State Road	17,000	300	7
Fisher River near Copeland	45,000	650	7
Yadkin River at Siloam	480,000	710	19
Ararat River at Ararat	99,000	720	8
Yadkin River at Enon	800,000	750	30
Yadkin River at Yadkin College	1,200,000	1,000	28

Source: SEDIMENT CHARACTERISTICS OF NORTH CAROLINA STREAMS, 1970-1979, U.S. Geological Survey Open-File Report 87-701, by Clyde E. Simmons, U.S. Department of the Interior, 1988

Table 4-4

Gross Erosion and Sediment-Delivery Ratio Values

Station	Drainage Area (sq. mi.)	Sediment Discharge (tons/yr.)	Gross Erosion (tons/yr.)	Sediment Delivery Ratio	Predominant Land Use
Yadkin River at Patterson	28.8	11,000	30,000	.37	Rural
Yadkin River at Elkin	869	300,000	1,440,000	.21	Rural

4-05. Climate. The climate of the Yadkin-Pee Dee River Basin is temperate, characterized by warm summers and cold, but generally not severe, winters. The growing season is relatively long and zero temperatures are rare. Details on temperature, rainfall and other climatological data are presented in the following paragraphs.

a. Temperature. The Yadkin River Basin has hot summers and usually not severe winters. Mean maximum July temperatures average approximately 95 degrees and mean minimum January temperatures average approximately 19 degrees. The freeze-free season lasts about 200 days. Temperatures seldom drop to zero during the winter and only

Table 4-5
Temperature Data
(through 1991)(a)

Temperature Station		Period of Record	Years of Record Used	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly Mean	Extreme Recorded Temps.	Average Growing Season (days)(b)
				Monthly Normals of Maximum, Minimum, and Mean Temperature (degrees F)														
Lenoir	Max.	1948-1991	44	67.9	64.7	69.0	77.7	85.8	91.7	93.7	92.0	89.8	77.8	69.3	63.4	79.0	106	185
	Min.			18.6	22.4	25.1	40.5	45.6	53.0	60.6	59.1	51.4	40.3	29.4	23.4	39.1	-18	
	Mean			43.3	43.6	47.1	59.1	69.7	72.4	77.2	75.6	70.6	59.1	49.4	43.4	59.1		
Mount Airy	Max.	1893-1991	99	60.2	60.9	72.2	76.2	84.1	92.2	94.4	91.7	91.7	80.7	69.4	60.0	77.8	105	178
	Min.			16.3	17.2	22.8	36.4	43.8	53.9	55.2	55.2	50.0	33.3	28.0	17.4	35.8	-9	
	Mean			38.3	39.1	47.5	56.3	64.0	73.1	74.8	73.5	70.9	57.0	48.7	38.7	56.8		
High Point	Max.	1948-1991	44	62.0	63.1	67.7	79.0	85.3	91.9	93.5	92.8	87.1	81.7	67.0	63.2	77.8	106	
	Min.			20.5	23.9	26.6	44.2	51.6	59.2	63.6	61.4	55.1	42.5	28.1	22.8	41.6	0	
	Mean			41.3	43.5	47.2	61.6	68.5	75.2	78.6	77.1	71.1	62.1	47.6	43.0	59.7		
Statesville	Max.	1901-1991	91	62.1	64.1	73.7	77.8	86.8	92.4	95.2	91.8	91.0	82.0	71.4	63.2	79.3	105	205
	Min.			15.7	18.0	22.7	37.5	47.1	55.7	60.7	61.4	49.4	36.7	26.2	19.6	37.6	-8	
	Mean			38.9	41.1	47.9	57.7	67.0	74.1	78.0	76.6	70.2	59.4	48.8	41.4	58.5		
Lexington	Max.	1948-1991	44	63.2	65.5	69.5	78.8	89.7	94.2	96.2	92.8	89.8	78.1	67.8	62.7	79.0	107	213
	Min.			19.8	23.0	27.9	41.1	49.8	58.5	63.8	62.3	53.1	38.7	32.7	23.1	41.2	-1	
	Mean			41.5	44.3	48.7	60.0	69.8	76.4	80.0	77.6	71.5	58.4	50.3	42.9	60.1		
Salisbury	Max.	1898-1991	94	66.6	65.7	73.3	78.8	88.2	94.5	96.3	96.6	92.4	83.7	69.5	66.8	81.0	105	207
	Min.			20.5	22.5	27.3	40.9	47.1	57.5	63.3	62.2	53.8	36.2	29.6	21.1	40.2	-11	
	Mean			43.6	44.1	50.3	59.9	67.7	76.0	79.8	69.4	73.1	73.5	49.6	44.0	60.9		
Asheboro	Max.	1933-1991	59	63.3	64.8	74.2	78.3	85.8	91.5	93.8	91.9	88.2	81.5	68.6	63.4	78.8	103	223
	Min.			20.0	24.8	27.5	42.0	49.9	58.1	64.5	63.2	54.9	42.3	32.8	26.1	42.2	2	
	Mean			41.7	44.8	50.9	60.2	67.9	74.8	79.6	77.6	71.6	61.9	51.0	44.8	60.5		
Albemarle	Max.	1933-1991	59	65.0	64.2	74.4	80.2	91.2	94.9	95.9	93.1	86.7	82.6	72.2	66.9	80.6	109	196
	Min.			18.3	22.0	27.6	40.2	49.1	58.7	60.9	59.2	55.2	39.4	30.9	21.5	40.3	-7	
	Mean			41.7	43.1	51.0	60.2	70.2	76.8	78.4	76.2	71.0	61.0	51.6	44.2	60.5		

(a) Based on N.O.A.A. Climatological Data - North Carolina
(b) Average Number of days between last freezing temperature in spring and first freezing temperature in fall for 1951-1980.

occasionally climb above 100 degrees in the summer. This climate permits a long and productive growing season. The mean annual temperature in the basin, determined from 8 stations in and immediately around the basin, is 60 degrees. Mean monthly temperatures range from a low of 41 degrees in January to a high of 78 degrees in July. Extreme temperatures recorded in the basin range from a low of -18 degrees to a high of 109 degrees. Temperature data for selected stations in the basin are given in table 4-5.

b. Precipitation. Precipitation affecting the Yadkin River Basin is recorded at approximately 20 stations in or near the basin. Most of the stations are operated by, or in cooperation with, the National Weather Service. The pertinent data are collected and published by the Service in its climatological bulletins. The average annual precipitation over the Yadkin River Basin is about 45 inches. There is some variation in the mean annual precipitation over different portions of the basin. The upper portion of the basin above W. Kerr Scott receives approximately 53 inches of rainfall per year, while the eastern portions of the Yadkin River Basin receive about 42 inches. Rainfall is generally well-distributed over the basin. The maximum monthly rainfall averages about 4.9 inches and occurs during July. The driest month is November, averaging about 2.9 inches. A study of the rainfall records shows the wettest year of record to be 1901, when the rainfall in the W. Kerr Scott drainage basin was about 88 inches. The driest year of record was 1925, when the rainfall above the reservoir was about 30 inches. Droughts occasionally damage crops throughout the basin and cause water shortages. Snow constitutes only a small portion of the precipitation and does not affect runoff appreciably. The normal monthly precipitation for the drainage basin above W. Kerr Scott damsite is shown in table 4-6. Locations of active climatological stations in the Yadkin-Pee Dee basin are shown on plate 4-4. Maximum and minimum monthly and annual precipitation and precipitation extremes for selected stations in the Yadkin-Pee Dee Basin are shown on tables 4-7 and 4-8.

Table 4-6

Normal Monthly and Annual Precipitation for the Yadkin River Basin above W. Kerr Scott Dam and Reservoir (1931-1989)

Month	Normal Precip. above W. Kerr Scott Dam (inches)	Month	Normal Precip. above W. Kerr Scott Dam (inches)
January	3.62	July	5.08
February	3.99	August	5.30
March	5.10	September	4.69
April	4.25	October	3.94
May	4.80	November	3.77
June	4.79	December	3.76
		Annual	53.09

Source: U.S. Army Corps of Engineers, Wilmington District

Table 4-7

Maximum, Mean, and Minimum Monthly and Annual Precipitation for
Selected Stations -- Yadkin-Pee Dee River Basin, N.C.
(through 1990)

Precipitation Station		Years of Record Used	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
			Maximum, Minimum, and Long-Term Means (in inches)												
Lenoir	Max.	121	9.60	9.00	12.64	9.59	11.50	10.44	10.08	21.78	12.25	13.25	11.85	8.77	68.48
	Mean		3.76	3.97	4.51	3.80	4.29	4.42	4.91	5.28	4.12	3.70	3.15	3.87	49.78
	Min.		0.40	0.36	0.50	0.27	0.20	0.60	0.87	0.56	0.31	0.05	0.18	0.05	29.23
Mount Airy	Max.	102	9.17	9.34	9.62	8.42	9.52	13.00	15.92	16.59	10.55	12.30	7.42	8.89	66.10
	Mean		3.45	3.47	4.11	3.61	4.27	4.10	5.02	4.64	3.85	3.45	2.83	3.57	46.37
	Min.		0.40	0.40	0.86	0.75	1.02	0.49	0.72	0.44	0.19	0.05	0.17	0.28	22.69
High Point	Max.	73	9.70	7.94	9.44	6.64	8.70	9.77	11.11	11.93	13.35	12.35	10.42	6.59	59.58
	Mean		3.60	3.60	4.00	3.42	3.85	3.78	4.67	4.56	3.68	3.08	3.02	2.90	44.16
	Min.		0.72	0.60	1.05	0.68	0.32	0.22	0.63	0.49	0.02	0.23	0.34	0.49	25.28
Statesville	Max.	112	9.31	7.08	10.78	7.55	8.14	10.22	15.46	10.76	10.95	9.79	7.94	7.65	69.00
	Mean		3.85	4.04	4.75	3.48	3.97	4.18	4.57	4.85	3.77	3.51	3.05	3.98	48.00
	Min.		0.05	0.50	1.00	0.35	0.34	0.69	0.25	0.58	0.05	0.03	0.31	0.35	22.92
Lexington	Max.	65	8.71	8.03	9.22	8.94	9.69	11.40	11.28	13.47	9.84	14.00	8.78	7.19	62.30
	Mean		3.65	3.78	4.16	3.42	4.05	4.04	4.63	4.61	3.38	3.13	3.09	3.66	45.60
	Min.		0.21	0.48	1.13	0.36	0.43	0.81	0.71	0.69	0.09	0.21	0.41	0.50	29.59
Salisbury	Max.	103	10.70	8.72	11.66	8.14	8.25	9.02	11.16	13.75	14.44	14.02	7.95	8.13	72.72
	Mean		3.68	3.95	4.38	3.54	3.90	4.20	4.96	4.56	3.52	3.20	2.68	3.68	46.25
	Min.		0.32	0.54	0.97	0.37	0.11	0.10	0.99	0.63	0.00	0.02	0.13	0.43	26.44
Asheboro	Max.	66	8.72	7.52	7.84	7.22	9.70	9.44	13.88	15.08	14.16	9.72	8.74	6.96	68.19
	Mean		3.60	3.59	4.10	3.39	3.88	3.92	5.09	4.83	3.69	3.22	2.84	3.44	45.59
	Min.		0.81	0.62	1.34	0.48	0.06	0.46	1.54	0.47	0.04	0.04	0.31	0.26	27.90
Albemarle	Max.	80	8.28	8.42	11.52	9.99	9.73	11.71	13.69	12.55	15.23	16.15	9.85	9.11	68.36
	Mean		3.87	3.90	4.52	3.68	3.80	4.23	5.26	4.71	4.11	3.09	2.90	3.63	47.70
	Min.		0.60	0.70	1.18	0.67	0.01	0.07	0.59	0.82	0.05	0.37	0.27	0.45	31.23

Table 4-8

Precipitation Extremes - Yadkin River Basin, N.C.
(through 1991)

Precipitation Station	Type of Gage	Complete Years of Record	Station Elevation (ft., m.s.l.)	Maximum Precipitation				Minimum Precipitation			
				Yearly		Monthly		Yearly		Monthly	
				Year	Inches	Month & Year	Inches	Year	Inches	Month & Year	Inches
Lenoir	NR	121	1200	1975	68.48	Aug 1901	21.78	1988	29.23	Oct 1963 & Dec 1973	0.05
Mount Airy	NR	102	1030	1901	66.10	Aug 1901	16.59	1930	22.69	Oct 1963	0.05
High Point	NR	73	900	1936	59.58	Sep 1947	13.35	1925	25.28	Sep 1985	0.02
Statesville	NR	112	950	1936	69.00	Jul 1916	15.46	1986	22.92	Oct 1963	0.03
Lexington	NR	65	760	1906	62.30	Oct 1990	14.00	1986	29.59	Sep 1961	0.09
Salisbury	NR	103	825	1929	72.72	Sep 1928	14.44	1986	26.44	Sep 1985	0.00
Asheboro	NR	66	870	1983	68.19	Aug 1949	15.08	1933	27.90	Oct 1985	0.04
Albemarle	NR	80	610	1867	68.36	Oct 1991	16.15	1940	31.23	May 1936	0.01

Note: R - Recording
NR - Non-Recording

c. Evaporation Data. A National Weather Service Class A evaporation station is operated at W. Kerr Scott Reservoir. The estimated annual evaporation at this station is 38.76 inches. Table 4-9 shows the monthly distribution of average annual pan evaporation at this station. The estimated average lake evaporation for W. Kerr Scott for the period May through October amounts to approximately 22 inches. With the conservation pool at 1030 feet, m.s.l., the loss amounts to about 2,080 acre-feet for the period.

Table 4-9

Monthly Distribution of Average Annual
Pan Evaporation at W. Kerr Scott Reservoir
(Standard N.W.S. Class A Pan)

Month	Average Monthly Evaporation (inches)	Months Recorded during period of record of 1967-1991
January	----	0
February	----	0
March	----	0
April	5.27	13
May	5.65	23
June	6.20	24
July	6.25	24
August	5.73	24
September	4.34	24
October	3.32	17
November	2.00	9
December	----	0
Annual	38.76	

d. Humidity Data. Complete humidity records are available for the National Weather Service station at Charlotte, NC. Table 4-10 shows the average relative humidity at Charlotte for the months of January and July for the period 1965-1989.

Table 4-10

Normal Relative Humidity
at Charlotte, N.C. (1965-1989)
(in Percent)

Month	1:00 a.m.	7:00 a.m.	1:00 p.m.	7:00 p.m.
January	72	78	55	60
July	83	87	57	65

Source: USCOMM-NOAA, Local Climatological Data - 1989 Annual Summary with Comparative Data, Charlotte, NC

e. Wind. Wind records are available for the National Weather Service office at Charlotte, NC. Prevailing winds throughout the Yadkin River Basin are generally from the southwest. Average wind velocity at Charlotte is about 7.4 miles per hour. Winds of high velocity are rare, and in most cases, such winds are associated with hurricanes or tropical disturbances. There have been destructive local windstorms, however, some developing into tornadoes with winds of 100 miles per hour or more. Table 4-11 shows the mean hourly wind velocity for each month, as well as the highest monthly velocity.

Table 4-11

Wind Data
at N.W.S. Station - Charlotte, NC

Month	Mean Speed(b) (mph)	Prevailing Direction(c)	Highest Velocity(a) Speed (mph)	Direction	Date
January	7.9	SW	49	NW	1989
February	8.3	NE	53	NE	1984
March	8.8	S	49	SW	1984
April	8.8	SW	54	NE	1990
May	7.5	SW	46	N	1985
June	6.9	SW	49	S	1987
July	6.6	S	48	NW	1989
August	6.4	NE	77	NW	1990
September	6.7	NE	87	E	1989
October	6.9	NNE	36	N	1987
November	7.2	SSW	51	S	1988
December	7.4	SW	47	NW	1987
Annual	7.4	SW	87	E	1989

(a) Average maximum velocity for a one-minute period, based on records for the period 1954-1989.
(b) Based on records for the period 1950-1989.
(c) Based on records through 1963.

Source: USCOMM-NOAA, Local Climatological Data - 1990 Annual Summary with Comparative Data, Charlotte, NC

4-06. Storm Data.

a. Types of Storms. Storms which produce heavy rainfall can occur during all seasons of the year in the Yadkin Basin. During the summer months, basin-wide storms are generally caused by tropical storms which have tracked inland. These storms generally last from 3-6 days and occur in late summer and early fall. Summer thunderstorms can cause intense rainfall over smaller portions of the basin. During the winter months, heavy rainfall can result from frontal systems which pass through the basin.

b. Storm-Rainfall Frequencies. Rainfall frequency relationships corresponding to various durations of 24 hours or less are given in table 4-12.

Table 4-12.

Rainfall Intensity - Frequency Relationships
(Average for Yadkin River Basin)

Duration (in hours)	Total Rainfall (in inches) 5-Year	10-Year	50-Year	100-Year
1	1.9	2.3	3.0	3.3
6	3.0	3.5	4.5	5.0
12	3.6	4.1	5.2	6.0
24	4.1	4.9	6.0	6.5

c. Storms and Floods of Record. Most of the flood-producing storms in the Yadkin Basin have been the result of tropical hurricanes which have tracked inland either from the Atlantic Coast or from the Gulf of Mexico. They generally lose their high wind velocities as they track inland, but still can cause heavy flood-producing rainfall. Table 4-13 shows floods of record in the basin listed in order of magnitude according to discharge. Descriptions of storms which have produced record or near record flooding in the basin follow.

(1) Storm of 14-16 July 1916. This was one of the greatest storms to occur along the east coast. About the 10th of July, a tropical hurricane which had tracked from the Gulf of Mexico caused heavy rainfall in the mountains of North Carolina. On 14-15 July, a second tropical hurricane, which had tracked across South Carolina and into the North Carolina mountains, resulted in precipitation of up to 16 inches in South Carolina. On the 15th and 16th of July, the storm center passed over Altapass in the mountains of North Carolina, where the 48-hour rainfall totaled 23.20 inches with 22.22 inches falling within a 24-hour period. Extremely heavy rain fell over a large area, including the Yadkin Basin.

(2) Storm of 25-27 September 1929. This storm was the result of a tropical Atlantic hurricane and produced heavy rainfall. The storm was centered in northeastern Georgia where it produced in excess of 19 inches of rainfall. This storm was followed by another tropical disturbance on 30 September-2 October centered over South Carolina, which caused flood-producing rainfall in the Yadkin Basin.

(3) Storm of 10-17 August 1940. This storm was the result of a tropical hurricane. The storm center meandered over eastern North Carolina for approximately 72 hours and caused intense rainfall for approximately 186 hours in some areas. This storm caused the highest flood stages of record in the Yadkin Basin. The maximum gage height at the Wilkesboro gage was 37.6 feet (980.0 ft., m.s.l.) on 14 August. This stage was attained about 9 hours after intense rainfall over the northern portion of the basin. At Yadkin College, NC, where flood stage is approximately 14 feet, the maximum gage height was 33.8 feet about 48 hours after the intense rainfall in the upper portion of the basin.

Table 4-13
Floods of Record at Selected Gage Sites

Yadkin River at Patterson, NC
(Oct 1940-Sep 1988)
Datum of gage at 1211.47 feet, m.s.l.

DA = 29 mi²

Rank	Date: Day	Date: Month	Date: Year	Discharge (c.f.s.)	Gage Height (feet)
1	13	Aug	1940	16,200	12.70
2	7	Aug	1973	12,100	12.80
3	11	Mar	1952	4,930	7.70
4	6	Nov	1977	3,710	7.83
5	15	Jun	1969	3,370	6.60
6	13	Feb	1966	3,300	6.54
7	5	Apr	1957	3,130	6.30
8	6	Sep	1942	2,960	5.93
9	9	Aug	1970	2,750	6.00
10	21	Sep	1979	2,340	6.57

Elk Creek at Elkville, NC
(Oct 1965-Sep 1988)
Datum of gage 1082.40 feet, m.s.l.

DA = 48.8 mi²

Rank	Date: Day	Date: Month	Date: Year	Discharge (c.f.s.)	Gage Height (feet)
1	6	Nov	1977	11,600	9.58
2	15	Jun	1969	8,660	8.33
3	28	May	1973	8,400	8.20
4	21	Sep	1979	6,760	7.43
5	13	Feb	1966	6,560	7.28
6	17	Mar	1973	5,460	6.72
7	17	Oct	1975	4,920	6.41
8	9	Aug	1970	4,900	6.40
9	2	Feb	1983	4,510	6.16
10	13	Mar	1977	4,310	6.02

Reddies River at N. Wilkesboro, NC
(Oct 1939-Sep 1988)
Datum of gage at 978.62 feet, m.s.l.

DA = 89 mi²

Rank	Date: Day	Date: Month	Date: Year	Discharge (c.f.s.)	Gage Height (feet)
1	14	Aug	1940	27,000	22.02
2	17	Oct	1975	9,100	14.07
3	17	Sep	1945	8,780	12.20
4	10	Aug	1970	7,420	12.84
5	11	Mar	1952	7,400	12.52
6	9	Apr	1983	7,340	12.35
7	19	Jul	1941	7,330	11.06
8	6	Nov	1977	7,300	12.70
9	6	Sep	1942	7,200	11.05
10	4	Apr	1974	6,460	12.01

Table 4-13 cont.
Floods of Record at Selected Gage Sites

Yadkin River at Wilkesboro, NC
(Oct 1920-Sep 1988)
Datum of gage at 942.35 feet, m.s.l.

Rank	Date Day	Month	Year	Discharge (c.f.s.)	Gage Height (feet)
1	14	Aug	1940	160,000	37.60
2	2	Oct	1929	29,000	24.00
3	18	Sep	1945	23,200	22.45
4	19	Oct	1937	19,300	22.00
5	17	Oct	1932	19,200	20.94
6	16	Oct	1936	17,100	12.17
7	5	Apr	1957	15,500	11.50
8	30	Sep	1959	15,200	12.30
9	14	Jun	1947	14,200	11.55
10	6	Sep	1942	13,200	12.04

Yadkin River at Elkin, NC
(Apr 1964-Sep 1988)
Datum of gage at 866.03 feet, m.s.l.

Rank	Date Day	Month	Year	Discharge (c.f.s.)	Gage Height (feet)
1	10	Apr	1983	28,700	24.88
2	10	Aug	1970	24,700	23.52
3	21	Jun	1972	24,500	22.64
4	7	Nov	1977	21,900	21.09
5	18	Oct	1975	21,500	20.83
6	22	Sep	1979	21,500	20.81
7	9	Oct	1976	19,800	19.70
8	14	Mar	1975	19,500	19.56
9	19	Sep	1971	18,500	19.38
10	13	Feb	1966	18,200	18.59

Yadkin River at Enon, NC
(Jul 1964-Sep 1988)
Datum of gage at 701.71 feet, m.s.l.

Rank	Date Day	Month	Year	Discharge (c.f.s.)	Gage Height (feet)
1	21	Jun	1972	73,300	27.83
2	10	Aug	1970	71,900	27.69
3	22	Sep	1979	65,100	29.52
4	10	Apr	1983	55,700	27.71
5	1	Mar	1987	50,100	26.45
6	30	Mar	1975	45,200	24.54
7	17	Nov	1964	45,000	25.00
8	9	Nov	1976	44,700	24.45
9	29	May	1984	44,200	25.06
10	13	Feb	1966	43,000	24.60

Table 4-13 cont.
Floods of Record at Selected Gage Sites

Yadkin River at Yadkin College, NC
(Jul 1928-Sep 1988)
Datum of gage at 638.45 feet, m.s.l.

Rank	Day	Month	Year	Discharge (c.f.s.)	Gage Height (feet)
1	15	Aug	1940	80,200	33.75
2	22	Jun	1972	75,200	32.81
3	3	Oct	1929	67,800	29.80
4	23	Sep	1979	60,400	29.68
5	2	Mar	1987	59,700	29.55
6	21	Oct	1937	58,400	27.50
7	12	Aug	1970	57,000	28.95
8	18	Oct	1932	52,200	25.96
9	14	Mar	1963	50,600	26.45
10	20	Jan	1936	47,900	24.92

(4) Storm of 14-18 September 1945. This storm was caused by a hurricane that struck the Florida coast below Miami on the afternoon of 15 September. On 17 September the storm moved northeasterly over eastern South Carolina and central North Carolina. Intense rainfall associated with the storm resulted in the wettest September since 1929 in both North and South Carolina. The maximum precipitation recorded at Rockingham, NC from 12-18 September was 14.79 inches. Precipitation recorded along the Yadkin River was 8.51 inches at Elkin, North Carolina, 9.48 inches at North Wilkesboro, and 10.93 inches at Elkville.

4-07. Runoff. Runoff in the Yadkin River Basin amounts to approximately 42 percent of the annual rainfall. The basin is located in the Piedmont region of the state, which, with its rolling topography, steep gradients, narrow valleys, and predominantly heavy clay soils, is conducive to high rates of runoff. Table 4-14 shows the relationship between rainfall and runoff in the Yadkin Basin.

a. Stream Gage Data. The location of all U.S. Geological Survey stream gage stations currently operational in the Yadkin Basin, as well as all discontinued gages with 10 years or more of record, are shown on plate 4-5. Pertinent data for these gages is given in table 4-15. The natural stream flow hydrograph for the Yadkin River at the W. Kerr Scott damsite from 1921 through 1992 is shown on plate 4-6.

b. High Flows. The maximum flow of record at the damsite was approximately 116,500 c.f.s. and occurred on 14 August 1940. Table 4-16 gives the estimated maximum instantaneous flows at the dam based on flows at the Wilkesboro gage. Table 4-17 shows the maximum yearly, monthly, and daily flows at selected stations in the Yadkin Basin.

c. Low Flows. Although precipitation is generally abundant in the Yadkin Basin, periods of low flow do occur. The most severe and sustained periods of drought usually occur during late summer or fall. Record low flows at the gages on the Yadkin River are shown in table 4-18. Minimum average stream flows for 1 day, 7 days, 1 month, 2 months, 4 months, 6 months, and yearly are given in table 4-19. The 7-day, 10-year low flow at the W. Kerr Scott damsite is 125 c.f.s.

d. Monthly and Annual Flows. As shown by the average discharge values in table 4-15, there is little variation in the mean unit flow throughout the Yadkin River Basin. Values range from 0.91 to 1.86 c.f.s. per square mile. The higher values are generally in the steeper upper portion of the basin. Average monthly runoff at W. Kerr Scott based on flows at Wilkesboro prior to the construction of the dam are shown in table 4-20 for the period 1922 through 1991. The average inflow at the dam is 581 c.f.s. The average flow for the low flow period from June through November is 495 c.f.s., and the average inflow for the rest of the year, from December through May, is 667 c.f.s.

Table 4-14

Average Rainfall and Runoff
Yadkin-Pee Dee River Basin Above W. Kerr Scott Dam
(1940-1989)

Month	Average			Wettest Month		Driest Month	
	Rainfall(1) (inches)	Runoff(2) (inches)	Percent	Rainfall(1) (inches)	Year	Rainfall(1) (inches)	Year
January	3.62	1.98	54.70	7.54	1978	0.93	1971
February	3.99	1.98	49.62	7.19	1960	0.35	1968
March	5.10	2.59	50.78	10.36	1975	1.08	1985
April	4.25	2.33	54.82	9.75	1983	0.55	1986
May	4.80	2.18	45.42	9.45	1975	0.93	1951
June	4.79	1.73	36.12	9.16	1976	0.42	1986
July	5.08	1.63	32.09	11.44	1941	1.22	1976
August	5.30	1.67	31.51	17.90	1940	1.28	1956
September	4.69	1.45	30.92	14.75	1979	0.27	1940
October	3.94	1.56	39.59	10.90	1976	0.12	1963
November	3.77	1.56	41.38	11.05	1977	0.80	1981
December	3.76	1.73	46.01	8.57	1973	0.26	1965
Annual	53.09	22.39	42.17	72.98	1979	37.23	1988

(1) Average rainfall based on weighted rainfall computations of observed precipitation at stations above Scott Dam for period of record 1940-1989.
(2) Average runoff based on natural discharges at Scott damsite for the period of record 1940-1989.

Table 4-15

Stream Gage, Stage, and Discharge Records - Yadkin-Pee Dee River Basin (through 1991)

Stream/Location	Drainage Area (sq.mi.)	Datum of Gage (feet, m.s.l.)	Period of Record From	Period of Record To	Total Years	Maximum Recorded Discharge Stage	Maximum Recorded Discharge cfs	Maximum Recorded Discharge Disch. (cfs/sq.mi.)	Maximum Recorded Discharge Date	Minimum Discharge Disch. (cfs)	Minimum Discharge Date	Average Discharge Disch. (cfs)	Average Discharge (cfs/sq.mi.)
Yadkin River at Patterson	28.8	1211.47	Oct 1939	Present	52	12.70	16,200	562.5	13 Aug 1940	3.0	15 May 1940	49.5	1.72
Elk Creek at Elkville	48.1	1082.40	Oct 1965	Present	26	9.58	11,600	241.2	6 Nov 1977	11.0	5 Jan 1981	99.6	2.07
Reddies R. at North Wilkesboro	89.2	978.62	Oct 1939	Present	52	22.02	27,000	302.7	14 Aug 1940	22	17 Aug 1954	143.2	1.61
Yadkin River at Wilkesboro	504	942.35	Apr 1903	Jun 1909	77	16.22	12,800	25.4	10 Apr 1983	86	4 Dec 1965	840.1	1.67
			Oct 1920	Present									
Roaring River near Roaring R.	128	964.85	Apr 1964	Present	27	22.54	26,600	207.8	17 Oct 1975	31	27 Aug 1988	187.4	1.46
Yadkin River at Elkin	869	866.03	Apr 1964	Present	27	24.88	28,700	33.0	10 Apr 1983	239	31 Aug 1981	1,380	1.59
Mitchell River near State Road	78.8	927.12	Apr 1964	Present	27	16.42	7,470	94.8	22 Sep 1979	16	22 Jul 1986	128	1.62
Fisher River near Copeland	128	913.0	Oct 1931	Present	60	19.61	34,200	267.2	22 Sep 1979	12	30 Aug 1981	182.2	1.42
Ararat River at Ararat	231	880.97	Apr 1964	Present	27	24.46	35,000	151.5	22 Sep 1979	19	29 Aug 1981	309.4	1.34
Little Yadkin River at Dalton	42.8	813.7	Aug 1960	Present	31	20.29	9,400	219.6	22 Sep 1979	1.3	2 Aug 1977	46.4	1.08
Yadkin River at Enon	1,694	701.71	Jul 1964	Present	27	29.52	65,283	43.3	22 Sep 1979	363	31 Aug 1981	2,502	1.47
Muddy Creek near Muddy Creek	178	682.67	Jul 1964	Sep 1979	18	21.26	1,450	8.15	22 Jun 1972	21	6 Oct 1968	233.8	1.31
			Feb 1988	Present									
So. Fork Muddy Crk nr Clemmons	42.2	684	Jul 1964	Sep 1979	18	16.30	2,980	70.6	10 Aug 1970	2.5	20 Aug 1988	48.4	1.15
			Feb 1988	Present									
Yadkin River at Yadkin College	2,280	638.45	Jul 1928	Present	63	33.75	75,200	33.0	22 Jun 1972	110	28 Aug 1988	3,046	1.34
South Yadkin R. nr Mocksville	306	663.62	Oct 1938	Present	53	18.88	11,800	38.6	2 Mar 1987	21	22 Jul 1986	341.3	1.12
Hunting Creek near Harmony	155	734.78	Oct 1950	Present	41	25.05	14,800	95.5	22 Sep 1979	118	8 Oct 1954	206.8	1.33
Second Creek near Barber	118	642.31	Apr 1979	Present	12	16.92	5,280	49.3	16 Apr 1987	4.4	1 Oct 1986	104.5	0.88
North Potts Creek at Linwood	9.62	630.0	May 1979	Sep 1990	11	9.51	1,540	160.1	28 May 1990	0.41	19 Aug 1988	9.7	1.01
Abbotts Creek at Lexington	174	630	Mar 1940	Dec 1957	20	22.12	14,800	85.1	25 Sep 1947	0.4	8 Oct 1954	----	----
			Oct 1988	Present									
Dutchmans Creek near Uwharrie	3.44	340	Oct 1981	Sep 1983	8	7.12	405	117.7	15 Apr 1987	0.01	15 Jul 1986	3.06	0.89
			Oct 1985	Present									
Wiberly Branch near Wilgrove	0.35	675.01	Dec 1984	Present	7	2.59	125	357.1	5 Jul 1987	0	1 May 1986	0.51	1.46
Big Bear Creek near Richfield	55.6	426.62	May 1954	Present	37	15.95	11,100	199.6	22 Aug 1967	0	12 Sep 1954	58.1	1.04
Rocky River near Norwood	1,372	212.91	Oct 1929	Present	62	46.37	105,000	76.5	18 Sep 1945	17	8 Oct 1954	1,345	0.98
Little River near Star	106	409	Apr 1954	Present	37	16.46	10,400	98.1	15 Oct 1954	0.24	4 Oct 1968	111.3	1.05
Pee Dee River near Rockingham	6,863	120.68	Oct 1906	Jan 1912	70	30.80	270,000	39.3	18 Sep 1945	50	2 Dec 1951	7,979	1.16
			Oct 1927	Present									
Jordan Creek near Silver Hill	0.36	385	Sep 1983	Present	8	2.70	-----	-----	17 Jul 1984	0.09	19 Jun 1988	0.27	0.75
Big Shoe Heel Crk nr Laurinburg	83.3	170	Jun 1987	Present	4	4.63	546	6.55	3 May 1989	3.9	1 Aug 1990	----	----
Drowning Creek near Hoffman	183	270	Oct 1939	Present	52	10.29	10,900	59.6	18 Sep 1945	19	11 Aug 1988	256.6	1.40
Big Swamp near Tarheel	229	105	Oct 1985	Present	6	13.14	2,670	11.7	3 Mar 1987	0.43	12 May 1986	177.8	0.78
Lumber River at Boardman	1,228	72.05	Sep 1929	Present	62	10.64	13,400	10.9	24 Sep 1945	66	9 Oct 1968	1,306	1.06

Table 4-16

Maximum Instantaneous Flows - Wilkesboro Gage and Scott Dam

Date	Yadkin River at Wilkesboro: Discharge (c.f.s.)	Yadkin River at Wilkesboro: Gage Heights (ft.)	Estimated Flow at Scott Damsite (c.f.s.)
Aug 1940	160,000	37.6	116,500
Jul 1916	116,000	34.5	84,500
Oct 1929	29,000	24.0	21,100
Aug 1906	26,800	----	19,500
Nov 1906	24,200	----	17,600
Sep 1945	23,200	22.45	16,900

Table 4-17

Maximum Flows at Selected Stations in Yadkin River Basin, North Carolina

(monthly, yearly, daily)

	Stream and Station*													
	Yadkin River at Patterson (1939-1988)		Elk Creek at Elkville (1965-1988)		Reddies R. at N. Wilkesboro (1939-1988)		Yadkin River at Wilkesboro (1920-1988)		Yadkin River at Elkin (1964-1988)		Yadkin River at Enon (1964-1988)		Yadkin River at Yadkin College (1928-1988)	
Month	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year
Jan	132.3	1946	194.0	1978	297.4	1978	1,829.0	1978	3,129.0	1978	5,725.0	1978	7,580.0	1978
Feb	142.6	1960	250.0	1966	386.0	1960	1,769.0	1966	2,729.0	1966	4,925.0	1966	6,661.0	1966
Mar	144.5	1973	307.0	1979	405.3	1975	2,341.0	1975	3,885.0	1975	7,848.0	1975	10,380.0	1975
Apr	164.0	1980	378.5	1980	536.2	1980	2,868.0	1980	4,510.0	1980	7,337.0	1980	9,419.0	1987
May	125.0	1973	290.9	1973	352.9	1973	1,954.0	1973	2,887.0	1973	4,989.0	1973	6,277.0	1984
Jun	118.1	1975	215.5	1975	411.6	1976	1,963.0	1975	2,942.0	1975	5,435.0	1972	7,755.0	1972
Jul	98.9	1941	127.6	1979	334.5	1941	1,179.0	1979	1,909.0	1984	3,330.0	1984	4,622.0	1984
Aug	194.5	1940	245.7	1970	586.5	1940	2,212.0	1970	3,128.0	1970	5,611.0	1970	7,191.0	1970
Sep	135.7	1979	257.0	1979	478.9	1945	1,948.0	1979	2,910.0	1979	5,810.0	1979	7,314.0	1979
Oct	92.7	1977	221.5	1977	309.3	1977	1,593.0	1977	2,770.0	1977	4,741.0	1977	6,392.0	1965
Nov	139.7	1978	365.3	1978	379.3	1978	2,571.0	1978	3,871.0	1978	5,128.0	1978	5,437.0	1978
Dec	98.8	1974	193.1	1974	273.0	1974	1,619.0	1974	2,591.0	1974	4,814.0	1974	5,784.0	1974
Yearly	78.3	1973	154.0	1973	217.6	1973	1,220.0	1973	1,951.0	1973	3,605.0	1973	66,000.0	1972
Daily	2,130.0	1940	4,400.0	1978	7,600.0	1940	7,990.0	1970	21,500.0	1970	48,400.0	1979	75,200.0	1972

*Water Year ending 30 September

Table 4-18

Minimum Flows at Selected Stations in Yadkin River Basin, North Carolina

(monthly, yearly, daily)

	Stream and Station*													
	Yadkin River at Patterson (1939-1988)		Yadkin River at Elkville (1965-1988)		Reddies R. at N. Wilkesboro (1939-1988)		Yadkin River at Wilkesboro (1920-1988)		Yadkin River at Elkin (1964-1988)		Yadkin River at Enon (1964-1988)		Yadkin River at Yadkin College (1928-1988)	
Month	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year	Flow(cfs)	Year
Jan	11.4	1956	22.5	1981	44.5	1956	416.1	1981	617.1	1966	1,051.0	1981	1,354.0	1981
Feb	27.0	1988	53.5	1988	83.7	1947	474.0	1981	846.0	1981	1,572.0	1981	2,060.0	1981
Mar	23.7	1988	47.9	1988	77.3	1940	441.2	1988	744.8	1988	1,443.0	1981	1,798.0	1981
Apr	26.5	1981	51.5	1986	78.3	1986	434.7	1986	736.6	1986	1,390.0	1985	1,691.0	1985
May	20.5	1940	37.3	1988	68.6	1941	410.0	1988	728.8	1988	1,298.0	1988	1,565.0	1986
Jun	13.0	1956	21.7	1988	47.6	1956	292.9	1988	507.1	1988	748.3	1988	1,048.0	1988
Jul	9.04	1988	17.6	1988	43.0	1986	234.5	1988	432.7	1988	654.1	1986	749.0	1986
Aug	9.05	1988	18.9	1988	31.0	1956	193.9	1988	361.5	1988	622.9	1988	707.7	1981
Sep	6.95	1954	24.9	1968	30 8	1954	208.5	1988	415.7	1988	815.0	1988	930.8	1968
Oct	8.45	1955	19.8	1982	34.5	1955	249.0	1982	444.6	1982	853.3	1987	997.8	1987
Nov	9.07	1982	19.8	1982	46.7	1982	258.2	1982	428.3	1982	896.5	1982	1,091.0	1982
Dec	11.8	1956	27.6	1981	49.5	1956	268.3	1982	564.5	1982	1,107.0	1966	1,338.0	1966
Yearly	21.5	1956	43.7	1988	67.5	1956	393.5	1988	698.1	1988	1,332.0	1988	1,591.0	1981
Daily	5.3	1954	12.0	1988	23.0	1954	110.0	1956	246.0	1981	368.0	1981	350.0	1988

*Water Year ending 30 September

Table 4-19

Minimum Average Flows

(Water Year Ending 31 March)

Continuous Period	Yadkin River at Wilkesboro		Yadkin River at Elkin	
	Flow(cfs)	Year	Flow(cfs)	Year
1-day	110	1957	246	1982
7-day	116	1957	257	1982
30-day	130	1955	337	1982
60-day	150	1955	434	1982
120-day	194	1955	482	1982
183-day	235	1956	518	1982
1-Year	353	1989	859	1982

Table 4-20

Estimated Mean Monthly Discharges at Scott Damsite
(in c.f.s.)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG
1922	499	817	1089	875	1232	778	839	580	373	514	337	431	697
1923	543	585	1049	565	669	459	416	361	286	233	301	394	489
1924	679	432	595	768	575	419	950	358	739	577	426	787	610
1925	840	535	521	434	419	267	242	186	167	175	252	214	354
1926	614	575	401	478	262	228	118	502	278	235	357	615	388
1927	329	331	265	251	348	362	301	268	186	295	373	427	311
1928	550	559	507	649	734	678	610	1651	1771	677	514	480	782
1929	481	790	1192	679	751	610	555	412	475	1248	876	737	734
1930	621	561	623	465	394	315	228	269	269	233	327	392	391
1931	410	231	354	676	539	344	326	324	172	160	186	387	343
1932	751	506	501	469	529	404	249	453	214	875	744	899	551
1933	712	731	660	841	939	412	389	255	297	235	231	215	492
1934	257	271	779	805	339	305	262	291	364	446	437	619	432
1935	994	602	868	751	528	336	634	407	466	326	446	396	563
1936	1231	763	877	1141	538	403	339	382	253	1138	399	610	674
1937	1641	861	643	576	602	665	324	334	421	1263	586	484	700
1938	506	454	547	422	461	598	926	672	377	250	435	352	501
1939	471	1304	796	604	459	515	474	523	267	230	217	254	504
1940	235	437	359	435	287	401	344	3053	630	342	428	580	630
1941	440	342	429	444	261	242	1067	372	224	194	247	432	393
1942	411	602	772	375	767	795	384	504	775	361	327	650	560
1943	783	736	694	793	754	467	832	406	284	244	338	312	553
1944	480	684	928	638	513	355	347	250	434	556	312	338	486
1945	495	616	484	569	482	294	339	283	1219	473	429	682	529
1946	1132	793	790	548	610	378	374	261	208	252	264	248	487
1947	625	338	507	475	305	767	471	359	266	874	1031	482	542
1948	452	875	948	890	567	487	503	639	483	359	835	895	660
1949	758	786	738	865	957	618	859	1534	769	655	706	542	817
1950	543	698	661	481	730	533	547	518	748	435	412	811	593
1951	439	691	741	916	485	573	377	319	232	204	292	558	484
1952	416	656	1197	732	504	360	252	331	246	191	275	281	453
1953	496	883	1014	466	388	371	249	190	204	168	178	336	409
1954	623	579	572	435	454	274	167	179	920	112	205	342	403
1955	230	441	503	704	321	242	377	215	133	148	153	141	299
1956	133	389	392	600	312	160	211	112	163	242	269	295	272
1957	366	330	695	554	1212	583	934	398	276	839	607	925	647
1958	844	800	782	848	1150	1014	664	500	440	293	306	287	660
1959	543	501	399	460	733	452	494	325	328	764	886	536	535
1960	681	737	1672	1224	1345	895	638	513	658	606	490	388	821
1961	369	473	882	778	1046	670	719	563	648	416	313	458	612
1962	908	754	841	888	1167	639	913	567	403	375	512	512	707
1963	483	405	1482	530	503	388	347	258	257	192	281	263	450

Table 4-20 (Continued)

Estimated Mean Monthly Discharges at Scott Damsite (Continued)
(in c.f.s.)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG
1964	621	598	664	730	460	314	368	418	420	993	582	640	568
1965	603	949	1107	872	578	476	438	549	326	537	314	293	585
1966	324	1364	673	530	724	394	270	364	535	423	581	497	550
1967	546	515	665	386	419	358	421	406	329	339	372	649	451
1968	675	499	716	580	534	500	355	307	222	562	385	416	480
1969	471	725	734	828	543	1131	441	591	509	507	612	784	655
1970	629	666	587	700	539	409	307	1588	420	570	627	432	623
1971	482	885	713	564	777	479	531	461	598	847	839	775	661
1972	819	695	693	719	1076	1082	566	431	384	365	462	707	666
1973	686	1089	1489	1384	1400	964	689	1133	537	517	470	1200	963
1974	932	928	774	1301	790	821	694	866	836	449	448	558	781
1975	695	844	1789	902	1063	1387	707	496	676	962	714	623	905
1976	826	630	575	641	586	1025	476	373	377	1226	760	699	683
1977	464	458	1014	1102	580	523	343	332	582	444	2016	749	716
1978	1290	690	1118	785	927	573	512	616	403	291	308	440	664
1979	810	922	1467	1122	848	754	853	552	1461	851	1210	719	963
1980	844	600	1202	1996	942	749	584	379	348	341	337	289	717
1981	252	515	423	368	685	593	298	190	262	202	184	285	353
1982	492	933	519	584	506	698	527	434	289	315	460	776	542
1983	632	1248	1365	1973	1113	802	517	367	327	485	504	1060	863
1984	593	940	860	1123	1129	665	734	716	401	355	360	349	685
1985	385	597	382	422	374	283	303	599	251	255	973	473	440
1986	357	457	571	343	388	251	182	238	356	225	424	803	383
1987	550	761	1312	1494	761	698	601	316	396	260	362	405	658
1988	442	380	312	466	297	193	137	152	226	161	284	214	271
1989	291	346	661	397	635	573	949	427	955	1062	998	725	670
1990	952	1392	1223	750	815	520	572	1009	470	1591	663	775	893
1991	972	730	1087	1391	1222	798	643	439	359	300	323	529	733
AVG	609	669	792	736	670	544	494	509	451	483	487	526	581
MAX	1641	1392	1789	1996	1400	1387	1067	3053	1771	1591	2016	1200	1692
MIN	133	231	265	251	261	160	118	112	133	112	153	141	173

4-08. Water Quality. The North Carolina Division of Environmental Management (NCDEM) puts out a biennial report on water quality in North Carolina. Water quality monitoring in the Yadkin-Pee Dee River Basin in North Carolina includes 61 stream monitoring stations. The following paragraphs are based on a summary of the monitoring in the 1988-1989, 305(b) report.

a. Stream Classification by Best Usage. All of the streams in the Yadkin-Pee Dee Basin in North Carolina are classified for use as water supply or classified for use to support aquatic life and either primary or secondary recreation. Several of the streams in the upper headwaters of the Yadkin Basin are designated as trout streams and are protected for natural trout propagation and for survival of stocked trout.

b. Ability to Meet Stream Classification Standards. Of the total 5,781 stream miles in the basin, 62 percent fully support their designated uses, 24 percent partially support their uses, 5 percent do not support their uses, and 9 percent were not evaluated.

c. Causes and Sources of Stream Degradation. The major cause of stream degradation in the Yadkin-Pee Dee Basin is sediment, which accounts for about 38 percent of the stream degradation. The sources of sediment and other pollutants are mostly nonpoint sources, accounting for 84 percent of the total degraded stream miles in the Yadkin-Pee Dee Basin, with the major nonpoint source being agriculture, which causes 47 percent of the total degraded stream miles in the basin.

d. Lakes. Of the 28 lakes in the North Carolina portion of the Yadkin-Pee Dee Basin which are monitored by the NCDEM, 25 fully support their designated uses. Lake Lee, while being among those lakes which currently support their designated uses, is hypereutrophic and support-threatened. Hamlet City Lake is only partially supporting of its designated uses due to aquatic macrophytes, particularly pondweed, water shield, water lily, and primrose. The Abbotts Creek Arm of High Rock Lake is non-supporting due to mercury. Long Lake is non-supporting of its uses due to severe siltation and weed problems; however, restoration is underway.

4-09. Channel and Floodway. Discharge relationships for various stream gage locations are shown on plates 4-7 through 4-13.

a. Above Wilkesboro. The Yadkin River basin above the damsite is a mountainous area of 367 square miles bounded on the north by the crest of the Blue Ridge Mountains and on the south by the crest of the Brushy Mountains. The entire watershed, with the exception of a narrow valley between the two mountain ranges, is a system of ravine-like slopes producing rapid runoff, with the result that storm runoff reaches a crest and recedes in a short time after the occurrence of a storm. The drainage area of the Yadkin River above Wilkesboro is 504 square miles. The main stem of the Yadkin River in the 25-mile reach between Patterson and Wilkesboro has valley slopes of 6 to 10 feet per mile, and is bordered throughout most of its length by a flood plain which varies in width from 1500 feet near Wilkesboro to 300 or 400 feet in various locations. A notable exception is a reach about 3 miles long in which there is no appreciable flood plain development. The channel capacity below Scott Dam is 5,400 c.f.s. at a point about 3 miles below the dam. Upstream of Patterson, the river assumes the characteristics of the tributaries. The tributary streams, in their lower reaches, have valley slopes ranging generally between 20 and 40 feet per mile; in the headwater areas and in sub-tributary streams, valley slopes are from 50 to more than 150 feet per mile. Tributaries on the north side of the river having headwaters in the Blue Ridge Mountains have particularly steep slopes with stream gradients as high as 500 feet per mile, and flow through steep valleys having little or no flood plain. These tributaries include Buffalo Creek, Elk Creek, Stony Fork Creek, and Lewis Fork Creek, all of which enter the Yadkin River above the Scott damsite. Tributaries on the south side of the river having headwaters in the Brushy Mountains, a mountain range of much less elevation than the Blue Ridge Mountains, have correspondingly less severe stream gradients. Flood plains along these tributaries are narrow and discontinuous; they generally range from 50 to 300 feet in width, and their continuity is broken at intervals of 1000 to 3000 feet by reaches where the streams are confined in steep canyon-like gorges. These tributaries include King Creek, Beaver Creek, and Warrior Creek above the Scott damsite, and Moravian Creek between Scott Dam and the city of Wilkesboro, NC.

b. Between Wilkesboro and Elkin. The Yadkin River drainage area in this reach is bounded by the Blue Ridge Mountains to the north and the Brushy Mountains to the south. In this reach, the Yadkin River has an average slope of 3.2 feet per mile. The flat flood plain varies in width from 500 to 4,500 feet. The land adjacent to the flood plain rises abruptly at 1,000 feet per mile. Tributaries to the Yadkin River in this reach include Reddies River, Mulberry River, Rock Creek, Roaring River, Bugaboo Creek, Little Elkin River, and Elkin River, all from the north, and several smaller creeks from the south including Cub Creek, Fishing Creek, Brier Creek, Grays Creek, and Swan Creek.

c. Between Elkin and Enon. The Yadkin River drainage area in this reach is bounded by the Blue Ridge Mountains to the north and west, the Dan River Basin to the east, and the headwaters of downstream Yadkin River tributaries to the west. In this reach, the Yadkin River has a slope of 3.9 feet per mile. All four of the main tributaries in this reach enter the Yadkin River from the north. Three of these, Mitchell River, Fisher River, and Ararat River, have headwaters in the Blue Ridge Mountains, which are not so altitudinous in this area as they are in the headwaters of the tributaries upstream of Elkin. The fourth main tributary, the Little Yadkin River, enters the Yadkin River near Donnaha, near where the Yadkin River turns to the south.

d. Between Enon and Yadkin College. The Yadkin River drainage area in this reach is bounded by the Dan River Basin to the east and the headwaters of downstream Yadkin River tributaries to the west. The Yadkin River has a slope of 2.1 feet per mile in this reach. A few miles south of Enon, Logan Creek and Deep Creek enter the Yadkin River from the west. About 5 miles north of Yadkin College, Muddy Creek, whose tributaries drain the Winston-Salem area, enters the Yadkin River from the east.

e. Between Yadkin College and High Rock Dam. The Yadkin River drainage area in this reach is bounded by the Cape Fear River Basin to the east and by the Catawba River Basin to the west. Three main tributaries drain into the Yadkin River from the west upstream of High Rock Lake. These are Dutchmans Creek, South Yadkin River, and Grants Creek. The South Yadkin River has a drainage area of 907 square miles, making it the largest Yadkin River tributary. Its headwaters are in the Brushy Mountains and its tributaries drain the city of Statesville, NC. Grants Creek drains part of the city of Kannapolis and, along with Town Creek, drains the city of Salisbury, NC. Town Creek flows into High Rock Lake from the west. Swearing Creek and Abbotts Creek flow into High Rock Lake from the east and drain Lexington, NC. Abbotts Creek also drains Thomasville, NC and part of High Point, NC.

f. Flood Damage Centers Affected by W. Kerr Scott Reservoir. Estimated average annual flood control benefits of the W. Kerr Scott project over the anticipated life of the project total $13.4 million per year (Oct. 1990 price level). Flood control benefits are measurable as far downstream as the confluence of the Yadkin and the South Yadkin Rivers. However, about 92 percent of the flood control benefits are in Wilkes County, and most of these benefits occur in the Towns of Wilkesboro and North Wilkesboro. A breakdown of damage prevention by type shows 61 percent of the total flood control benefit is to industries and public utilities, and less than one percent to residences. Agricultural benefits account for about 2 percent of the total benefits. The remaining 5 percent is split between transportation facilities, farm buildings, and utilities.

W. Kerr Scott Reservoir reduces total annual damages along the Yadkin River by about 88 percent (27 percent of crop damages and 91 percent of non-crop damages). The principal damage centers are the Towns of Wilkesboro and North Wilkesboro, which are located across the Yadkin River from each other about five miles downstream from the dam. Extensive development is located within the flood plain. Without the reservoir, expected annual damages in this area would be about $12.8 million. With the reservoir in place, expected annual damages are reduced to about $0.5 million. According to the estimated 1990 census, the population of North Wilkesboro is 3,384, and the population of Wilkesboro is 2,573. The reduction in flood peak elevation at North Wilkesboro due to the operation of W. Kerr Scott is 10 feet for a 10-year flood and 16 feet for a 100-year flood.

4-10. Upstream Structures. There are no water control structures in the W. Kerr Scott drainage basin which could significantly impact inflow to Scott Reservoir.

4-11. Downstream Structures. Scott Dam operations affect Yadkin River stages as far downstream as High Rock Lake. There are no major dikes, levees, or hydropower projects in this reach which are significantly impacted by Scott Dam operations. High Rock Dam is the only major water control structure in, or on a tributary to, this reach affecting streamflow in the Yadkin River. The drainage area above High Rock Dam is 3,970 square miles, and the total capacity of the lake is 255,000 acre-feet. The dam and lake are used primarily for hydropower, which was first put in operation 7 November 1927.

4-12. Economic Data.

a. Population. The Yadkin River Basin is comprised of 13 North Carolina counties which are wholly or partly in the basin. The population of the basin is about 1.0 million. These figures represent about 15 percent of the state's population. Population in the basin is projected to be about 1.2 million by the year 2010. Table 4-21 lists the populations of principal municipalities in or adjacent to the Yadkin River Basin, and of counties which lie wholly or partly within the basin.

Table 4-21

Population of Principal Municipalities and Counties in the Yadkin River Basin

Municipality	1990	1980	1970	1960
North Wilkesboro	3,384	3,260	3,357	4,197
Wilkesboro	2,573	2,335	2,038	1,568
Elkin	3,790	2,858	2,899	2,868
Winston-Salem	143,485	131,885	133,683	111,135
High Point	69,496	63,380	63,229	62,063
Statesville	17,567	18,622	20,007	19,844
Salisbury	23,087	22,677	22,515	21,297
Lexington	16,581	15,711	17,205	16,093
Thomasville	15,915	14,144	15,230	15,190
Lenoir	14,192	13,748	14,705	10,257
Yadkinville	2,525	2,216	2,232	1,644
Mocksville	3,399	2,637	2,529	2,379
County	**1990**	**1980**	**1970**	**1960**
Watauga	36,952	31,666	23,404	17,529
Wilkes	59,393	58,657	49,524	45,269
Caldwell	70,709	67,746	56,699	49,552
Surry	61,704	59,449	51,415	48,205
Yadkin	30,488	28,439	24,599	22,804
Stokes	37,223	33,086	23,782	22,314
Forsyth	265,878	243,683	215,118	189,428
Davie	27,859	24,599	18,855	16,728
Davidson	126,677	113,162	95,627	79,493
Rowan	110,605	99,186	90,035	82,817
Randolph	106,546	91,728	76,358	61,497
Stanley	51,765	48,517	42,822	40,873
Montgomery	23,346	22,469	19,267	18,408

b. Land Resources. There are approximately 2.66 million acres of land within the Yadkin River Basin. About 30 percent of this land is in row crops, 60 percent is forested, 5 percent is in pasture, and 5 percent is urban. Of the cropland acreage, corn makes up approximately 57 percent, soybeans make up 9 percent, tobacco is about 8 percent, pastureland 19 percent and about 7 per-cent remains idle each year. Receipts from farm milk in the basin were about $554 million in 1988.

c. Industry. Manufacturing employs about 170,000 people in the Yadkin River Basin (1988), which is 32 percent of the basin's job force. Manufacturing pays nearly 50 percent of the wages earned in the basin (1988). Forsyth County, where the City of Winston-Salem is located, is particularly indus-trialized, employing over 42,000 industrial workers in 1988. Major industries in the Yadkin River Basin produce textile-mill products, furniture and fixtures, industrial machinery and equipment, apparel and other textile products, electronic and other electrical equipment, food and kindred products, and chemicals and allied products. The basin also produces lumber and wood products, rubber and miscellaneous plastics products, and tobacco products. Many other industries besides these also have local and regional importance.

d. Domestic and Industrial Water Supply. Approximately 298,000 people in the Yadkin River Basin rely on surface water for daily water supply. The average water use in the basin for domestic and industrial water supply is about 35 million gallons per day (MGD) based on 1987 figures. Table 4-22 shows the municipalities and industries which withdraw water from the Yadkin River.

Table 4-22

Yadkin River Water Supply Users Below W. Kerr Scott

Municipality	Source Of Supply	Withdrawal (MGD) 1987	Population Served or Nearest Town
Wilkesboro	Yadkin River	3.80	2,500
North Wilkesboro	Reddies River	1.90	3,500
Town of Elkin	Big Elkin Creek	1.00	3,000
Town of Jonesville	Yadkin River	0.23	1,800
King District WA	Yadkin River	1.12	15,000
Winston-Salem	Yadkin River	15.00	182,000
Davidson Water, Inc.	Yadkin River	6.32	88,300
Town of Denton	Yadkin River	.60	1,080
	TOTAL	29.97	297,180
Industry			
Abitibi Price Corp.	Yadkin River	1.00	Roaring River, NC
Chatham MFG	Big Elkin Creek	3.50	Elkin, NC
Cunningham Brick Co.	Yadkin River	0.01	Welcome, NC
	TOTAL	4.51	

e. Flood Damages. The following paragraphs present estimates of flood damages occurring in the Yadkin River Basin to help provide an estimate of the flood control benefits expected to result from the operation of W. Kerr Scott Reservoir. The estimates are based on a complete survey of the flood plain development and on data obtained from interviews with county agricultural agents, industrial plant engineers and managers, real estate agents and city and county officials whose jurisdictions or interests are affected by the flood problem. Data obtained from other field studies included high water marks and typical flood plain and stream channel cross sections.

(1) Damage Estimating Methods Used. Damage to urban and industrial development, roads, railroads, and some classes of rural property, such as buildings, ditches, farm roads, and fences, does not vary significantly with the season of the year. For this reason, flood damages to these properties were estimated by using the "Flood Peak Damage Integration Method" which correlates nonseasonal flood damage (to buildings, etc.) to the frequency of flood peak stages. On the other hand, the severity of crop damage is dependent upon the season of the year in which a flood occurs, with the greatest damage being caused by those floods occurring during the period between planting and harvesting. The agricultural damage program used to evaluate crop damage statistically accounts for the variation in damages depending on the time of year.

(2) Division of Flood Plains. To facilitate flood damage evalu-ation, the Yadkin River is divided into 4 reaches. Damages in each reach were related to stage measurements at a reach index station. Division of the damage reaches was made in such a way as to provide an accurate and practical relationship of topographic, hydrologic, and flood damage factors between the index stations and their corresponding reaches. The limits of these flood damage reaches and the locations of the index gaging stations are shown on plate 4-14. The natural 100-year flood plain area is estimated to be 26,000 acres.

(3) Flood Damage Categories. For estimating purposes, flood damage losses are grouped into two major categories: crop losses and non-crop losses. Crop losses considered include losses to croplands and pastures. Non-crop losses include losses to public utilities; industrial, commercial, and residential properties (including auxiliary buildings); transportation facilities; and utilities. Tangible physical losses were estimated for each type of damage, including content damages where applicable.

(4) Stage or Peak Discharge Curves. Damage appraisals were made for each of many types of flood damages, which were then grouped into the two major categories of crop and non-crop damages and related to the index station stage measurements for each applicable reach. Curves of these relationships are used to estimate flood damages caused by floods and in determining damages prevented by W. Kerr Scott Reservoir. These curves are shown on plates 4-15 and 4-16.

f. Inundation Due to Dam Break. Inundation maps of a dam break study prepared by the Wilmington District for the W. Kerr Scott Project are on file in the District Emergency Management Office. Table 4-23 shows various locations on the Yadkin River below W. Kerr Scott with predicted arrival times, peak times, and maximum elevations occurring if W. Kerr Scott Dam were to fail. The following dam failure criteria were used in the study.

(1) Initial pool elevation of W. Kerr Scott at 1075 feet, m.s.l. (top of flood control pool).

(2) Breach fully developed in 1.5 hours with 20 percent of the dam removed.

Table 4-23

Inundation at Various Locations after Dam Failure

Location	County	Miles Below Dam	Arrival Time (hrs.)	Peak Time (hrs.)	Maximum Elevation (ft., m.s.l.)
Browns Ford Road	Wilkes	0.50	<.25	2.25	1034
U.S. 421 bypass	Wilkes	3.41	.75	3.25	1027
USGS Gage at Wilkesboro N.C. 18/U.S. 421-A	Wilkes	5.81	1.00	3.75	1023
N.C. 115	Wilkes	7.12	1.25	4.00	1018
Confluence with Mulberry Creek	Wilkes	9.10	1.50	4.25	1011
Confluence with Fishing Creek	Wilkes	13.17	1.75	4.50	997
S.R. 2327 at Roaring River, N.C.	Wilkes	15.87	2.00	5.25	982
Confluence with Big Bugaboo Crk.	Wilkes	19.16	2.50	6.50	970
S.R. 2303 at Ronda, N.C.	Wilkes	22.75	2.75	7.00	959
Confluence with Little Elkin Creek	Wilkes	27.03	3.25	7.25	944
USGS Gage at Elkin-Jonesville U.S. 21	Yadkin	29.76	3.75	7.75	930
Interstate 77	Yadkin	31.40	4.00	8.00	919

V. DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations.

a. Facilities. The precipitation plotting map found on plate 4-4 shows the location and type of precipitation reporting stations within the Wilmington District. This plate also indicates the precipitation stations that include river stages in observer reports. Plate 4-5 shows the location of the stream gaging network used in the operation of Corps reservoir projects and for long-term planning and studies. (Refer to Chapter VI for hydrologic forecasts.) A summary of hydrologic stations is shown on tables 4-7, 4-8, and 4-15 (see Chapter IV).

b. Reporting. Reservoir and hydrometeorological data are received by the Reservoir Regulation Section daily by telephone, satellite, and computer. Six-hour precipitation amounts at 10 airport stations or class "A" stations are obtained daily, by telephone, from the National Weather Service office in Wilmington. Precipitation amounts occurring at class "B" stations in the Yadkin River Basin as well as in adjacent basins are reported to the Weather Service Forecast Office in Raleigh by observers. This data is then relayed to the Reservoir Regulation Section by either telephone or computer. River stages at talkamark-equipped gages are obtained by placing a telephone call to the appropriate number and listening to the signal. The talkamark and attendant telephone relay equipment automatically "answers" when the gaging station is called. The gage height is indicated by a simulated voice signal. SAW Form 134a, which is used for recording these calls, is shown on plate 5-1. Telephone numbers for the gages are unlisted and are only for use by authorized persons. Current U.S. Geological Survey rating tables are used in converting stage to discharge. River stations equipped with Data Collection Platforms (DCP's) transmit river stages, reservoir elevations, and/or precipitation to the Geostationary Operational Environmental Satellite (GOES). This data is obtained from the National Environmental Satellite Data and Information Service (NESDIS) by a Hydrology and Hydraulics Branch computer network. DCP locations are shown on plates 4-4 and 4-5.

c. Maintenance. Any maintenance required at observer-operated precipitation stations is performed by the National Weather Service office in Raleigh in accordance with reciprocal agreements and cooperative reporting networks. The collection and transmission equipment for both the headwater gages above Scott Dam and the Yadkin River gages below the dam are operated and maintained by the U.S. Geological Survey. Telephone lines for talkamark gages are maintained by the local area telephone companies. Any hydrometeorological equipment malfunction should be reported to Reservoir Regulation Section personnel for appropriate action.

5-02. Water Quality Monitoring. Water samples are collected on a monthly basis from April through October at two locations in the reservoir. Temperature is recorded at 5-foot intervals from top to bottom, dissolved oxygen at 20-foot intervals, and pH at 10-foot intervals. Additionally, the State of North Carolina's Department of Environment, Health and Natural

Resources (EHNR), Division of Environmental Management (DEM), has included Scott Reservoir in its Ambient Lakes Monitoring program since the inception of that program in 1981. According to DEM's "1988 North Carolina Lakes Monitoring Report" and their "Water Quality Progress in North Carolina: 1988-1989 305(b) Report," their three water quality sampling stations in Scott Reservoir have been tested for turbidity, solids, nutrients, chlorophyll-a, fecal coliform, heavy metals, conductivity, dissolved oxygen, temperature, pH, phytoplankton types and numbers, and macrophyte types and numbers. Sampling and testing are done once every 1-5 years during late summer, when trophic conditions are likely to be at their worst. Data collected are entered into the Environmental Protection Agency (EPA) STORET data base. The State of North Carolina's Division of Environmental Management also monitors ambient stream and river water quality throughout the State, including regular monitoring of 62 stream and river water quality stations in the Yadkin-Pee Dee River Basin, for chemical and/or biological parameters. The nearest of these below Scott Dam is at Wilkesboro, NC, with stations also at Elkin, at Enon, near Clemmons, and at Yadkin College. DEM's Benthic Macroinvertebrate Ambient Network, Phytoplankton Ambient Network, Algal Bloom Studies, Aquatic Weed Program, and Special Monitoring Studies provide additional water quality information. Data from these monitoring programs is also entered into the EPA STORET data base. The U.S. Geological Survey publishes water quality data for its Yadkin River at Yadkin College, NC stream gage in its annual "Water Resources Data -- North Carolina" report.

5-03. Sediment Stations.

a. Facilities. A network of sedimentation and degradation ranges has been established at W. Kerr Scott Reservoir and was used in the early years of the project to monitor these processes. Eight sedimentation ranges and three degradation ranges were established and surveyed in 1962 prior to the initial filling of the reservoir. Another 12 sedimentation ranges were added in 1972. This network is shown on plate 2-16. Many of the original range markers and bench marks are gone or are unlocatable, which creates some question as to the accuracy and validity of the initial cross section surveys.

b. Reporting Results of Resurveys. Two sedimentation resurveys were done by Charleston District resulting in resurvey reports dated November 1972 and March 1980.

5-04. Recording Hydrologic Data. Hydrologic data are both manually and electronically recorded in the Reservoir Regulation Section. Precipitation is manually recorded on SAW Form 38 shown on plate 5-2. The average daily precipitation above and below the dam is computed electronically as shown on plate 5-3. Project personnel prepare a daily report of reservoir data on the H&H Branch computer network as shown on plate 5-4. Headwater elevation data are stored on computer files.

5-05. Communication Network. Telephone facilities available throughout the watershed are used to exchange hydrometeorological data by talkamark equipment and by computer modems, and for communication between District and project personnel. Radio communication from the District office to the Scott Reservoir project is not available. Radio communication is available within a 25-mile radius of the project office.

5-06. Communication with Project.

a. Reservoir Regulation Section with Project Office. The Reservoir Regulation Section, Hydrology and Hydraulics Branch, Engineering Division, Wilmington District is responsible for the regulation of Scott Reservoir. Hydrometeorological and pertinent reservoir data is submitted electronically by project personnel to the Reservoir Regulation Section on a daily basis. Instructions on the regulation of the reservoir are issued directly to the project office by the Reservoir Regulation Section as necessary to comply with the approved plan of operation. Table 5-1 shows organization for Scott Reservoir regulation. Emergency operation is to be in accordance with instructions to the damtender which are provided as exhibit A.

Table 5-1
Organization for Scott Reservoir Regulation

```
                        |Executive Office|
              _______________|________________
             |                                |
 | Engineering Division |      |Construction - Operations Division|
             |                                |
             |          ------|Natural Resources Management Branch|
             |         |                      |
|Hydrology & Hydraulics Branch|  ------|Scott Reservoir Project|
|Max B. Grimes, Chief         | |
             |                  |
|Reservoir Regulation Section       |   | Water Management Branch  |
|Terry M. Brown, Supv. Hydr. Engr   |---| Engineering Directorate  |
|G. Allen Piner, Hydr. Engr.        |   | South Atlantic Division  |
|Chris B. Cline, Hydr. Engr.        |
|Jan P. Brodmerkel, Hydr. Engr.     |
|Daniel Emerson, Hydr. Engr.        |
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Note: Channel through which reservoir regulation instructions and information are issued ------

b. Between Project Office and Others. Campers, concessionaires, and visitors to the project are kept informed of any impending hazardous lake rises or drawdowns by project personnel based on forecasts furnished by the Reservoir Regulation Section. Communications with affected persons are by the most direct means available, such as by telephone or in person, as appropriate.

5-07. Project Reporting Instructions. Instructions for flow releases are furnished to project personnel by the Reservoir Regulation Section. (Refer to exhibit A for instructions to damtender during periods when communication lines are out). Any operating machinery failures that affect functional operation of the project should be reported to the Reservoir Regulation Section as soon as possible. Public complaints or inquiries concerning project operation are also to be referred to the Reservoir Regulation Section.

5-08. Warnings. Warnings concerning the flooding of campsites, boat launching areas, roads, and recreation facilities at the project are issued by the Resource Manager. Warnings concerning flood stages at downstream locations are issued by the National Weather Service River Forecast Office in Raleigh. Warning information for dam failure can be found in the Dam Failure Notification Plan prepared by the Emergency Management Office of the Corps of Engineers, Wilmington District.

5-09. Data Collection During Non-Work Hours. A member of the Reservoir Regulation Section is specifically scheduled to collect precipitation and rainfall forecast data from the Wilmington office of the National Weather Service during non-work hours, particularly on weekends and holidays. Project personnel and the Raleigh office of the National Weather Service are to contact personnel of the Wilmington District during non-work hours, if necessary, by using the Reservoir Regulation Call Roster shown in table 5-2. Special reports on precipitation or any conditions that affect water control management of Scott Reservoir are to be phoned to a person in the Reservoir Regulation Call Roster in the order listed. South Atlantic Division will be notified by a member of the Reservoir Regulation Section of any abnormal conditions that affect regulation at Scott Reservoir.

Table 5-2
Reservoir Regulation Call Roster

Wilmington District
Area Code (910)

Name	Organization	Office telephone	Home telephone
Terry Brown	Ch., Res. Reg. Sec.	251-4761	799-5041
Allen Piner	Res. Reg. Section	251-4762	799-6658
Chris Cline	Res. Reg. Section	251-4760	799-6887
Jan Brodmerkel	Res. Reg. Section	251-4414	259-6234
Dan Emerson	Res. Reg. Section	251-4490	452-0907
Max Grimes	Ch., H. & H. Branch	251-4759	799-4049

South Atlantic Division
Area Code (404)

Name	Organization	Office telephone	Home telephone
Bob Watson	Ch., Water Mgmt. Br.	331-6705	404-474-0810
Pat Davis	Ch., H. & H. Division	331-6775	404-923-2944
A.G. (Bert) Holler	Ch., Hydraulics & Coastal Engr. Branch	331-4260	404-458-1920
Vacant	Ch., Engr. Directorate	331-6694	

VI. HYDROLOGIC FORECASTS

6-01. General. The main objective of preparing forecasts is to make an early determination of expected inflow to Scott Reservoir in order that releases may be made in accordance with the approved plan of reservoir regulation.

a. Role of Corps. The Reservoir Regulation Section prepares forecasts of inflow into Scott Reservoir. The Section also determines the proper reservoir releases based on these forecasts and directs the damtender accordingly. Forecasts of actual or expected releases from the reservoir are furnished to the River Forecast Center (RFC), National Weather Service (NWS), Atlanta, Georgia. A forecast of the maximum or minimum reservoir elevation expected to be reached during a flood or drought is prepared by the Reservoir Regulation Section and is made available to project personnel and all other interested parties. However, due to flashiness of the streams in the watershed above Scott Dam, there are times when the reservoir peaks before a forecast can be made.

b. Role of Other Agencies. The NWS has responsibility for supplying the public with official river stage forecasts in the Yadkin River Basin. Also, the NWS prepares weather forecasts which serve as an early indication of potential flood events. These forecasts are described in further detail in paragraph 6-02.

6-02. Weather Forecasts.

a. Quantitative Precipitation Forecasts. The National Meteorological Center of NOAA Weather Service prepares daily Quantitative Precipitation Forecasts (QPF's) for the United States. These forecasts are available from the Wilmington office of the NWS, and electronically from the River Forecast Center in Atlanta, GA. Personnel of the Reservoir Regulation Section obtain both recorded precipitation and QPF's for the Wilmington District each morning and record the information on SAW Form 38 as shown on plate 5-2.

b. Wilmington District Weather Forecasts. General and specific weather forecasts for the Wilmington District are received daily in the Reservoir Regulation Section. These forecasts are available from both a commercial satellite link to the National Weather Service and a computer link with the RFC in Atlanta, GA. Forecasts are received from the satellite link continually as they are updated, and include general, specific, extended, and special forecasts of abnormal or threatening weather conditions such as hurricanes, tornadoes, hail, flash flooding, etc. Forecasts are received from the RFC on a daily or as-needed basis. Forecasts of drought conditions, cumulative precipitation, extended forecasts, etc. are available from the NOAA National Climatic Center computer in Washington, D.C.

6-03. Flood Condition Forecasts.

a. Forecasts Prepared. During flood times, the Reservoir Regulation Section prepares forecasts of 3-hour inflows to Scott Reservoir; the time, date, and height of the reservoir crest elevation; and the time and magnitude of stages at key downstream river stations. This information is used to properly operate the project for flood releases. A primary flood forecast is made for the Wilkesboro gage, with secondary forecasts at Elkin, Enon, and Yadkin College, if needed. River stage and reservoir elevation forecasts are recorded on SAW Form 131, as shown on plate 6-1. River stage forecasts are coordinated with the NWS River Forecast Office in Raleigh and the RFC in Atlanta.

b. Rainfall-Runoff Relationships. The amount of runoff produced during a given rainfall event over a specific area of the watershed is dependent upon such variable conditions as the type of soil, soil-moisture conditions, vegetative covering, geologic conditions, season of year, antecedent rainfall, and rainfall intensity. One method of estimating the rainfall-runoff relationship for various portions of the watershed is by using the graph shown on plate 6-2. These curves were drawn with month of year, initial discharge, antecedent rainfall, and duration of rainfall as parameters, and they represent the runoff to be expected in relation to these parameters within the range of available data. These curves may be used for all or any part of the watershed. The most frequently used method of determining the rainfall-runoff relationship is based on the infiltration concept. Using this concept, the runoff may be estimated by subtracting from rainfall an initial loss and a loss assumed to occur uniformly throughout the period of rainfall. The losses shown in table 6-1 are applicable to both extreme and average conditions, and permit a reasonable approximation of actual losses.

Table 6-1
Average Rainfall Losses -- Yadkin River Basin

General Conditions	Initial Loss (inches)	Uniform Loss (inches per hr.)
Winter - following prolonged rainy period	0.4	0.03
Average	0.8	0.05
Summer - following prolonged dry period	2.0	0.07

The estimate of initial loss and runoff rates can usually be verified early in a storm by comparing hydrograph ordinates with unit hydrograph ordinates for the stream gage at Patterson on the Yadkin River and Elkville on Elk Creek. Rainfall occurring before the river stages begin to rise may be considered as the initial loss. The relationships developed and employed in approximating the runoff during the early stages of a storm are also used to approximate the reservoir rise by applying the estimated runoff to the Scott Reservoir inflow hydrograph, shown on plate 6-3. Accurately determining the rainfall-runoff relationship for a given storm is the key factor to properly analyzing the reservoir performance. The reservoir performance is the basis for making the decision for discharges from the reservoir that would be in compliance with the approved plan of reservoir regulation. Currently, computer programs are used to compute the inflow hydrograph and reservoir performance of Scott Reservoir.

c. Unit Hydrographs. The natural unit hydrographs were computed from selected flood events for all gaged stations where adequate discharge records were available. Selection of flood events was limited to well-defined moderate flood events which were fairly free from the effects of antecedent or subsequent runoff, and to flood volumes greater than 1 inch. Generally, the formation of a long reservoir in river basins materially alters the order of runoff by speeding the runoff originating above the head of the reservoir. Because of this, the inflow unit hydrograph for Scott Reservoir was developed to reflect a full reservoir condition. The three-hour inflow unit hydrograph for Scott Reservoir is shown on plate 6-3 and in table 6-2. Below Scott Dam, three-hour unit hydrographs were developed for the local drainage area between Scott Dam and Wilkesboro, the local area between Wilkesboro and Elkin, and the local area between Elkin and Enon. These unit hydrographs are shown on plates 6-4, 6-5, and 6-6, and in table 6-2.

Table 6-2
3-Hour Unit Hydrographs
Yadkin River Basin

Component and Drainage Area (sq. mi.)	Inflow to Scott Reservoir (367)	Yadkin River at Wilkesboro (local) (137)	Yadkin River at Elkin (local) (365)	Yadkin River at Enon (local) (825)
Time, hours	Discharge in c.f.s. per 1 inch runoff in 3 hours			
0	0	0	0	0
3	14,110	2,120	5,030	1,400
6	15,440	6,550	17,210	17,700
9	13,890	9,010	18,620	26,000
12	9,250	7,850	16,105	33,500
15	6,040	3,010	12,480	32,100
18	4,730	930	7,250	28,300
21	3,750	0	1,810	23,400
24	3,220		0	12,200
27	2,550			3,100
30	2,100			0
33	1,600			
36	1,280			
39	730			
42	250			
45	0			

d. Procedure for Determining Runoff. The initial determination of the volume of runoff is based on the relationship shown on plate 6-2. The distribution of runoff to be used in the initial unit hydrograph computation is based on a consideration of the losses as indicated in table 6-1. The initial loss can be estimated quite closely since it is equal to the amount of precipitation that falls before the river stages rise. In the event the rain continues, a uniform loss rate can be applied to subsequent rain, and the rainfall excess determined. The cumulative runoff obtained by this method can be checked against the total runoff determined by using plate 6-2. The amount of runoff determined for any preceding rainfall should not be changed unless the comparison between the computed and actual hydrographs of flow indicates such an adjustment is necessary. As additional river-stage data is obtained, a more accurate determination of runoff can be made.

e. Flood Routing. Flood routing is a technique employed in making forecasts of reservoir rise, river discharges, and stages below the dam which result from a storm system moving through a river basin. The Muskingum method is used for flood routing in the Yadkin River Basin. Computer programs are currently used to perform flood routing computations. Routing coefficients are shown in table 6-3 for locations below Scott Dam down to Enon.

Table 6-3
Flood Routing Coefficients

Reach of River			Time of Travel	Equation: $O_2 = C_0 I_2 + C_1 I_1 + C_2 O_1$ Routing Coefficients (T=3 hr.)		
River	From	To	(hours)	C_0	C_1	C_2
Yadkin	Scott Dam	Wilkesboro	2	0.259	0.852	-0.111
Yadkin	Wilkesboro	Elkin	10	-0.036	0.378	0.658
Yadkin	Elkin	Enon	12	0.037	0.230	0.733

f. Stage Prediction by Correlation. The expected stage at Yadkin College is determined from the expected stage at Enon by use of the stage correlation graph shown on plate 6-7.

6-04. Forecasts for Conservation Purposes. Forecasts for conservation purposes will be updated as often as necessary during critical periods to keep all entities with direct responsibilities informed of changing situations. These forecasts will be based on current hydrologic conditions, commitments to existing contracts, State requirements for water quality and low flows, and any other known commitments. Refer to chapter VII for information concerning the actual operation of the project for water control, and to the Drought Contingency Plan in exhibit B for forecasts and operations during dry periods.

VII. WATER CONTROL PLAN

7-01. General Objectives. The operation of the reservoir will be governed primarily by flow in the lower Yadkin River. The objectives of the regulation plan for W. Kerr Scott involve consideration of the project purposes, which are to provide for flood control, water supply, recreation, and fish and wildlife.

7-02. Overall Plan for Water Control. The plan of operation for W. Kerr Scott Dam and Reservoir provides for maintaining a normal pool elevation of 1030 feet above mean sea level (feet, m.s.l.). Normally, outflow will be maintained equal to inflow at this pool elevation. Flood control storage space is reserved between elevations 1030 and 1075 feet, m.s.l. and surcharge storage space is provided in the reservoir above the free-overflow spillway crest elevation of 1075 feet, m.s.l. Flood control releases will be determined primarily by the stage at Wilkesboro, located about 6 miles downstream of the dam. Generally, discharges will be released in such a way as to not contribute to peak stages (due to runoff from uncontrolled drainage areas) at Wilkesboro, Elkin, Enon, and Yadkin College, except that low flow releases will continue to be made. For water conservation purposes, storage space between elevations 1000 and 1030 feet, m.s.l. is reserved for water supply and low flow. A minimum instantaneous flow of 125 c.f.s. will be maintained immediately below the dam. Operation for fish propagation involving water level fluctuations will be undertaken as needed.

7-03. Flood Control. The primary objective of the project is the control of floods on the Yadkin River. A storage of 112,000 acre-feet between elevations 1030 and 1075 feet, m.s.l. is reserved exclusively for the detention storage of floodwaters. An additional 153,000 acre-feet of surcharge storage exists above the free-overflow spillway crest between elevations 1075 and 1102.5 feet, m.s.l. The plan of operation provides for maintaining the normal pool elevation at Scott Reservoir of 1030 feet, m.s.l. by releasing up to nondamage stage flows in the downstream reaches of the river. The flood control objective is to store water in the flood control space in W. Kerr Scott whenever the Wilkesboro river gage exceeds bankfull (damage) stage of 12 feet. Discharges through the conduit at W. Kerr Scott (except for 125 c.f.s.) will not normally be made when the river at Wilkesboro exceeds damage stage. Because of the distance from the dam to Wilkesboro and the amount of uncontrolled drainage area above Wilkesboro, releases from W. Kerr Scott will sometimes be terminated at the beginning of a storm to prevent discharges from contributing substantially to the uncontrolled floodwaters at Wilkesboro.

Therefore, discharges from the conduit will be halted (except for a minimum release of 125 c.f.s.) whenever the reservoir level is below elevation 1075 and it is forecasted that runoff from a storm may cause damaging flows in the lower Yadkin River Basin. Afterwards, the flood control space in the reservoir will be evacuated at a rate that will cause a nondamage stage of below 12 feet on the Wilkesboro gage. The channel capacity below W. Kerr Scott is 5,400 c.f.s. During flood emergencies, the Wilkesboro gage will be monitored as necessary to allow the maximum release from the reservoir without causing damaging stages downstream. Operational criteria for various flood situations are outlined below.

a. Reservoir Near Normal Pool Elevation 1030 feet, m.s.l. Reservoir releases will be equal to inflow up to limits described in paragraph b, below.

b. Reservoir Elevation Between 1030 and 1075. During typical flood conditions, if the stage at Wilkesboro is or is forecasted to be equal to or greater than 12 feet, the reservoir outflow will be 125 c.f.s. (minimum release). If the stage is or is forecasted to be less than 12 feet, the maximum outflow will be equal to approximately 5,400 c.f.s., or the difference between the flow from the uncontrolled drainage area above Wilkesboro, and 9,700 c.f.s., whichever is least. The discharge for a stage of 12 feet at Wilkesboro with releases from W. Kerr Scott is approximately 9,700 c.f.s.

c. Reservoir Above Spillway Crest Elevation 1075. The release will be the full capacity of the outlet works.

d. Rate of Release Change. Increases in discharge rates should not exceed 500 c.f.s. in the first hour of flood release and 1,000 c.f.s. per hour thereafter. Conversely, the transition from high flow releases should be made by reducing discharges from the dam in 500 to 1,000 c.f.s. increments for each 0.5 foot decrease below elevation 1033 feet, m.s.l.

e. Flood Emergency. Whenever W. Kerr Scott Reservoir is in a flood situation and communication with the Reservoir Regulation Section is not possible, the required release from the reservoir will be made by the damtender in accordance with instructions found in the "Standing Operating Instructions to Damtender", exhibit A.

7-04. Low Flow Regulation. The operational plan for maintaining releases from Scott Reservoir which is shown in table 7-1 has been adopted for use during low flow and drought conditions.

7-05. Water Supply. The 33,000 acre-feet of storage space in Scott reservoir between elevations 1000 and 1030 feet, m.s.l. is allocated to water supply. A water supply contract was entered into on 29 June 1960 (Contract No. DA-38-081-CIVENG-60-17) between the Federal Government and the County of Wilkes, NC and the City of Winston-Salem, NC. The contract allows for withdrawals from this storage space, as deemed necessary, provided that such releases, when combined with normal runoff below the dam, will not cause damaging floods. Normally there is no special reservoir operation required for water supply.

Table 7-1
Low Flow Operation Plan

Scott Pool Elevation (ft., m.s.l.)	Minimum Flow and Stage at Wilkesboro, NC Flow (c.f.s.)	Stage* (ft.)
1029.00 and above	400	2.11
1028.00 - 1028.99	350	2.01
1027.00 - 1027.99	300	1.90
1026.00 - 1026.99	250	1.78
1024.00 - 1025.99	200	1.66
1023.00 - 1023.99	150	1.53
1000.00 - 1022.99	**	**

Note: Minimum discharge from Scott should not be less than 125 c.f.s. at any time, except during inspection and maintenance periods.
* These stage readings are from Rating Table 21 for the Yadkin River at Wilkesboro, N.C., and are subject to change.
** In this range, outflow from the reservoir should be set at 125 c.f.s.

7-06. Recreation. The reservoir will be operated in the best interest of recreation to the maximum extent possible. The reservoir water level will be maintained near elevation 1030 feet, m.s.l. under normal conditions, thereby affording ideal recreation conditions. Only during abnormal periods will the reservoir rise or fall appreciably above or below elevation 1030 feet, m.s.l. during the prime recreation season.

7-07. Deviation from Normal Regulation.

a. General. The District is occasionally requested to deviate from normal regulation of W. Kerr Scott. Prior approval for a deviation should be obtained from the South Atlantic Division Office (SAD), except as noted in the emergencies and minor deviations discussed in the following paragraphs.

b. Emergencies. Some emergencies that can be expected are drownings and other accidents, failure of operation facilities, and flushing of pollution during fish kills. Necessary action under emergency conditions should be taken immediately unless such action would create equal or worse conditions. The water control manager for the District will make the decision to deviate, if time permits.

c. Minor Deviations. There are instances that create a temporary need for minor deviations from the normal regulation of the lake, although they are not considered emergencies. Construction downstream of the dam accounts for the major portion of incidents and includes utility stream crossing, bridge work, and major construction contracts. Changes in releases are sometimes necessary for maintenance and inspection. Requests for changes of release rates are generally for a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, condition of Scott Reservoir, and possible alternative measures. In the interest of maintaining good public relations, the requests should be complied with, providing there are no adverse effects on the overall regulation of the project for the authorized purposes. The Water Control Manager will approve these deviations as needed. South Atlantic Division will be notified of the deviation as appropriate.

d. Drought Contingency Plan. Existing project operating procedures may be altered during critical drought situations to provide water to both upstream and downstream towns and municipalities and to farmers. The Drought Contingency Plan for the Scott project and the Yadkin River is described in exhibit B.

7-08. Operating Instructions to Damtender. A summary of the reservoir regulation procedures including the responsibilities of the damtender, specific instructions for data collection, and normal and emergency operation procedures is located in exhibit A, "Standing Operating Instructions to Damtender."

VIII. EFFECT OF WATER CONTROL PLAN

8-01. General. The most substantive benefit of the Scott Dam and Reservoir project is the reduction of peak flood stages downstream of the dam, thereby preventing or reducing flood damages in downstream reaches. The water supply storage of the reservoir is used by the County of Wilkes, NC, and the City of Winston-Salem, NC, for low flow releases to ensure adequate downstream flow to properly dilute municipal and industrial wastewater effluents and to maintain habitat for fishes and other riverine wildlife. Recreation is another prime benefit of the project, which attracts many of its visitors from the North Carolina cities of North Wilkesboro, Wilkesboro, Boone, Hickory, Statesville, and Winston-Salem. Other benefits include the increase in lacustrine environment and the concomitant increase in the population of sport fishes.

8-02. Flood Control. The forecasting procedures and rules of operation for this project have been applied to two hypothetical floods, namely, the spillway design flood and the standard project flood. The results of the simulated project operations for these floods described in the following paragraphs are illustrated on plates 8-1 through 8-3, and summarized in table 8-1. Actual project operations during three flood events in the 1970's are also described, although estimated downstream flows and stages may not be entirely consistent due to different rating curves in use at the times these estimates were made. Plates 8-4 through 8-6 illustrate actual project operation during these floods. Results are included in summary tables 8-1 and 8-2. These three events resulted in the first, second, and sixth highest pool elevations at Scott Reservoir since project operations began in 1963. Paragraph f is a short summary of the actual flood operation of Scott Dam in terms of flood damage prevention. Natural and regulated flood profiles of the Yadkin River have been computed and are shown on plate 4-3 and in summary table 8-3.

a. Spillway Design Flood. The spillway design flood represents a worst case flood scenario and was initially used to design the height of the dam and the length of the spillway crest. As calculation procedures for this hypothetical flood have varied over the years, re-calculations have been performed to verify the adequacy of the initial dam design and operating procedures. The spillway design flood used for design is described in paragraph 1, below is shown on plate 8-1 and is included in summary table 8-1. The most recent spillway design flood calculation is described in paragraph 2, shown on plate 8-2 and included in summary table 8-1.

(1) Pre-Construction Calculations. The spillway design flood hydrograph at Scott Reservoir was based on the runoff from the Probable Maximum Precipitation (PMP) storm. The PMP was taken from Hydrometeorological Report No. 33 prepared by the U. S. Weather Bureau, now known as the National Weather Service (NWS). The rainfall depth-duration

curve for Scott Reservoir was based on 348 square miles of drainage area (the total drainage area above the dam as it was reckoned at the time), and the maximum probable rainfall was reduced by 10 percent to allow for the maximum probable storm isohyets not conforming exactly with the shape of the project drainage basin. The resulting total 2-day PMP was calculated to be a basin average of 25.6 inches. An initial loss of 0.5 inches and an infiltration index of 0.10 inches per hour were adopted as representative of conditions likely to prevail during the spillway design storm. For the purpose of unit hydrograph development, the drainage basin was divided into 8 sub-areas. A Snyder unit hydrograph was developed for each of these sub-areas. Values of the Snyder coefficients 640 C_p and C_t used in the computations were 350 and 0.94, respectively, which were derived from the Reddies River, a gaged tributary to the Yadkin River at North Wilkesboro having similar drainage basin characteristics in terms of size, shape, cover, and topography. These 8 Snyder unit hydrographs were then adjusted to fit the data from the August 1940 flood event. The spillway design flood inflow to the reservoir was determined by applying the rainfall excess of the PMP storm to these 8 adjusted sub-area unit hydrographs. Then the ordinates of the 8 resulting flood hydrographs were added together with the 7 tributary hydro-graphs lagged 15 hours behind the reservoir sub-area hydrograph, and with a constant base flow of 500 c.f.s. added in. This reservoir inflow hydrograph was then routed through the reservoir with an initial pool elevation of 1075 feet, m.s.l. and both service gates fully open. The results of this routing are shown on plate 8-1 and in summary table 8-1. The total storm runoff volume for the spillway design flood amounted to about 400,000 acre-feet, or 21.5 inches of runoff over a basin area of 348 square miles. Reservoir peak inflow was 318,000 c.f.s. The resulting peak outflow was 183,300 c.f.s., with 6,800 c.f.s. of this outflow passing through the conduit and the remaining 176,500 c.f.s. flowing over the spillway. The maximum reservoir pool elevation reached was 1102.5 feet, m.s.l. The area-capacity curves in use at the time show a total reservoir volume of 290,000 acre-feet at elevation 1102.5 feet, m.s.l., and a total reservoir volume of 153,000 acre-feet at elevation 1075.0 feet, m.s.l., so that the reservoir surcharge storage used between these elevations was 137,000 acre-feet.

(2) <u>July 1992 Spillway Design Flood Calculations</u>. The spillway design flood was last recalculated in July 1992. The results are shown on plate 8-2 and in summary table 8-1. The spillway design flood hydrograph at Scott Reservoir was based on the runoff from the PMP storm. The PMP storm was calculated using the methodologies of Hydrometeorological Report No. 52 (HMR 52) prepared by the NWS. The calculations were carried out with the HMR52 computer program from the Corps of Engineers Hydrologic Engineering Center (HEC). The value entered for the preferred PMP storm orientation was 215 degrees, as determined from the HMR 52 publication, and the storm center location was designated to be the centroid of the drainage basin area. The computer program determined the optimum storm area to be 450 square miles and the optimum storm orientation to be 244 degrees. The total 3-day PMP was calculated to be a basin average of 31.3 inches. An initial loss of 0.5 inches and an infiltration rate of 0.10 inches per hour were adopted as representative of conditions likely to prevail during the spillway design storm. For the purpose of unit hydrograph development,

the drainage basin was divided into 9 sub-areas. Snyder unit hydrographs were developed for 7 of these sub-areas. A triangular unit hydrograph was used for the area adjacent to the reservoir. A flat unit hydrograph was used for the area of the reservoir itself. The Snyder unit hydrographs were developed using used Snyder coefficients 640 C_p and C_t of 315 and 1.33, respectively, which were derived from the November 1977 flood event, described in paragraph e. This produced the highest reservoir pool elevation since Scott Reservoir began operation in 1963. The spillway design flood inflow to the reservoir was determined by applying the rainfall excess of the PMP storm to these 9 sub-area unit hydrographs with no infiltration losses ascribed to the reservoir sub-area. Then the ordinates of the 9 resulting flood hydrographs were added together with a constant base flow of 367 c.f.s. (1 c.f.s. per square mile of drainage basin area) added in. This reservoir inflow hydrograph was then routed through the reservoir using the HEC-1 computer program assuming a starting reservoir pool elevation of 1075 feet, m.s.l., and both service gates fully open. The results of this routing are shown on plate 8-2 and in summary table 8-1. The total storm runoff volume for the spillway design flood amounted to about 487,000 acre-feet, or 24.9 inches of runoff over a basin area of 367 square miles. Reservoir peak inflow was 328,000 c.f.s. The resulting peak outflow was 206,250 c.f.s., with about 6,900 c.f.s. of this outflow passing through the conduit and the remaining 199,350 c.f.s. flowing over the spillway. The maximum reservoir pool elevation reached was 1105.2 feet, m.s.l., with a total reservoir volume of 328,300 acre-feet. The total reservoir surcharge storage used (above 1075 feet, m.s.l.) was therefore 175,300 acre-feet.

b. Standard Project Flood. The standard project flood (SPF) represents the largest flood which could reasonably be expected to occur at the damsite. The SPF analysis was performed during the design phase of the Scott Reservoir project. For this analysis, the SPF was estimated as 50 percent of the PMP flood discharges under natural conditions. This percentage was chosen because previous detailed studies had shown the SPF to range from 40 to 60 percent of the PMP flood, and the 50 percent value was thought to be most likely representative of average conditions. This estimation was considered adequate, since the SPF was not used as the basis for making design decisions. The peak of the estimated inflow hydrograph for the SPF was 140,000 c.f.s., and the total runoff amounted to about 200,000 acre-feet, or 10.7 inches of runoff over a basin area of 348 square miles. This inflow was routed through the reservoir starting at the normal pool elevation of 1030 feet, m.s.l. The resulting maximum pool elevation was 1083 feet, m.s.l. with a maximum spillway discharge of 29,000 c.f.s. The SPF inflow hydrograph was apparently recalculated sometime prior to May 1964 when the previous W. Kerr Scott water control manual was last revised. The peak of the inflow hydrograph was increased to 193,100 c.f.s. However, the volume of runoff was not substantially changed, and the outcome of the routing in terms of peak pool elevation reached and maximum spillway outflow remained the same as in the earlier routing. This later SPF routing is summarized on plate 8-3 and in summary table 8-1.

Table 8-1

Effects of Scott Dam Operation During Floods

Flood Event	Rainfall Excess (inches)	Storm Runoff Volume (acre-feet)	Peak Inflow (c.f.s.)	Peak Outflow (c.f.s.)	Starting Pool Elevation (ft., m.s.l.)	Peak Pool Elevation (ft., m.s.l.)	Flood Storage Used: Total Volume (acre-feet)	Flood Storage Used: Surcharge Volume (acre-feet)
Spillway Design Flood*	21.5	400,000	318,000	183,300	1075.0	1102.5	137,000	137,000
Spillway Design Flood**	24.9	487,000	328,000	206,250	1075.0	1105.2	175,300	175,300
Standard Project Flood	10.7	200,000	193,100	29,000	1030.0	1083.0	149,000	37,000
August 1940 Flood	6.4	125,000	122,000	6,800	1030.0	1076.4	118,900	6,900
August 1970 Flood	3.0	55,000	47,300	5,400	1028.7	1060.2	64,000	0
June 1972 Flood	1.4	27,000	18,500	5,400	1033.0	1047.7	27,000	0
November 1977 Flood	2.3	42,000	33,000	5,400	1029.9	1061.2	66,000	0

* used for design

** by current methodologies

Table 8-2

Downstream Effects of Scott Dam Operation During Floods

Flood Event	Peak Reservoir Outflow (c.f.s.)	WILKESBORO: Peak Flow Without Dam (c.f.s.)	WILKESBORO: Peak Flow With Dam (c.f.s.)	ELKIN: Peak Flow Without Dam (c.f.s.)	ELKIN: Peak Flow With Dam (c.f.s.)	ENON: Peak Flow Without Dam (c.f.s.)	ENON: Peak Flow With Dam (c.f.s.)	YADKIN COLLEGE: Peak Flow Without Dam (c.f.s.)	YADKIN COLLEGE: Peak Flow With Dam (c.f.s.)
Aug. 1940 Flood	6,800	160,000	35,000					80,200	35,700
Aug. 1970 Flood	5,400	45,000	12,700	54,000	24,700	87,000	63,500	77,000	57,000
Jun. 1972 Flood	5,400	26,400	9,100	37,400	23,400	69,800	64,600	86,700	75,250
Nov. 1977 Flood	5,400	41,900	11,800	45,300	21,900	47,600	27,100	40,800	23,500

Table 8-3

Downstream Effects of Scott Dam Operation

	WILKESBORO		ELKIN		ENON		YADKIN COLLEGE	
	Datum=942.35 ft., m.s.l.		Datum=866.03 ft., m.s.l.		Datum=701.71 ft., m.s.l.		Datum=638.45 ft., m.s.l.	
	Stage (ft.)	Discharge (c.f.s.)	Stage (ft.)	Discharge (c.f.s.)	Stage (ft.)	Discharge (c.f.s.)	Stage (ft.)	Discharge (c.f.s.)
Bankful Stage	11	9,000	17	16,000	18	23,000	17	22,000
Non-Crop Damage Begins	12	10,000	19	19,000	18	23,000	17	22,000
Nat'l Weather Service Flood Stage	14	12,000	16	14,000	18	23,000	18	24,000
Natural Conditions (Without Scott Dam):								
2-Year Flood	17.8	15,500	22.0	23,500	23.4	38,200	22.5	34,600
10-Year Flood	26.0	33,500	34.8	48,500	31.3	76,000	30.8	65,500
50-Year Flood	33.3	69,200	54.1	97,900	41.2	146,000	41.3	126,000
100-Year Flood	35.6	93,000	64.5	130,000	46.5	191,000	46.6	162,000
Modified Conditions (With Scott Dam):								
2-Year Flood	9.8	7,550	15.8	14,100	21.6	32,300	20.9	30,000
10-Year Flood	13.2	10,900	25.6	29,900	28.7	61,000	29.4	59,000
50-Year Flood	18.2	16,100	39.6	59,000	37.5	116,000	39.0	111,000
100-Year Flood	20.6	20,500	47.3	79,000	42.5	155,000	44.4	147,000

c. August 1940 Flood. This storm developed as a hurricane in the Atlantic Ocean about 8 August and struck the coast at Savannah, Georgia during the afternoon of 11 August. As it proceeded inland, the hurricane abated rapidly in severity. The center of heaviest precipitation of this storm crossed the coastline on 11 August at Beaufort, South Carolina, and, following a roughly semicircular path, it moved inland up the Savannah River Basin across the Appalachian Mountains and adjoining areas in North Carolina, and then down the Roanoke River Basin, passing out to sea south of Norfolk, Virginia, about 16 August. Precipitation greater than 15 inches for the entire storm and 8 inches during a single day was measured at numerous points. The intensities of hourly precipitation recorded during this storm were not especially unusual, but the evidence of excessive runoff from small mountainous areas suggests intensities greater than those that were recorded. The period preceding the storm had been unusually dry in North Carolina, so that stream flow at the beginning of the storm was generally low. This flood was most severe on the headwaters of the Catawba and Yadkin Rivers on the eastern slopes of the Blue Ridge. The peak discharge exceeded 100 second-feet per square mile. The very steep slopes of the mountains undoubtedly were contributing factors to the high rates of runoff in the areas where they occurred. The highest rates occurred in the vicinity of Grandfather Mountain and Blowing Rock. The flood was characterized by large masses of floating debris brought down from the mountain areas. The upper Yadkin River Basin received some of the greatest highway damage. Railroads lost many embankments and were buried by landslides at numerous points. Agricultural damage was quite extensive in many valleys, not only because of destroyed crops, but also because of topsoil washed away from some fields and deposition of sterile sand and gravel on others. Many gaging stations were seriously damaged or lost completely, owing to changes in the stream channels or battering by heavy drift. On the headwaters of Yadkin River above Donnaha, North Carolina, the August flood exceeded by a wide margin all previously known floods. All bridges over Yadkin River above North Wilkesboro, North Carolina, were swept away.

A simulated reservoir performance analysis for W. Kerr Scott during this event was accomplished using criteria outlined in Chapter 7. Performance of W. Kerr Scott project during this event is summarized on plate 8-0 and in table 8-1, and the resulting downstream reductions in peak flow are shown in table 8-2. Actual discharge record for the Yadkin River at Wilkesboro, Reddies River at North Wilkesboro, and Yadkin River at Yadkin College was obtained from U.S. Geological Survey Water Supply Paper number 1066 titled "Flood of August 1940 in the Southeastern States." Rainfall at North Wilkesboro varied from 8.2 to 9.5 inches for the period of 10 through 19 August. The peak of the estimated inflow hydrograph was 122,000 c.f.s., and the total estimated volume of storm runoff amounted to about 125,000 acre-feet, or 6.4 inches of runoff over a basin area of 367 square miles. This analysis used a starting pool elevation of 1030 feet m.s.l., and resulted in a maximum pool elevation of 1076.4 feet, m.s.l., on 15 August with a maximum spillway discharge of 1,800 c.f.s. Releases were begun very shortly after the flow at the Wilkesboro gage had peaked. This operation resulted in a reduction of the peak flow at Wilkesboro from 160,000 c.f.s. to an estimated 35,000 c.f.s. and the peak stage from 37.6 feet to 26.5 feet. At Yadkin College, the peak flood flow was reduced from 80,200 c.f.s. to 35,700 c.f.s., and the peak stage from 33.75 feet to 22.9 feet. If W. Kerr Scott project had been in place during this event, much of the damage that occurred in the Wilkesboro area could have been prevented.

d. August 1970 Flood. This flood caused the second-highest reservoir pool elevation since Scott Dam began operation in 1963. It would have been the third-highest flood of record at Wilkesboro, with a computed peak flow of 45,000 c.f.s. at the Wilkesboro stream gage, if Scott Dam had not been built. Scott Dam operations during this flood are summarized on plate 8-4 and in table 8-1, and the resulting downstream peak flow reductions can be seen in table 8-2. The flood-producing rainfall consisted of an average of 10.9 inches of rainfall over the drainage basin above Scott Dam from 8 August through 11 August . This rainfall resulted from an east-west frontal system south of the basin which moved slowly northward as a warm front. Waves in the frontal system moved eastward, triggering rain to the north and northeast of them, especially over high terrain. Support from low centers aloft acted to prevent the surface centers from dissipating, accounting for the sixty-hour period of rainfall. Winds moving upslope from the southeast over the central and northern Piedmont and mountains of North Carolina produced orographic uplift which intensified the rainfall. On the evening of 9 August, winds were blowing upslope at 35 miles per hour. At the start of the rainfall, the reservoir pool was drawn down to elevation 1028.7 feet, m.s.l. due to releases made since 22 July to augment low flows downstream. The volume of direct runoff from the storm was approximately 55,000 acre-feet, or about 3 inches over the drainage basin. Reservoir inflow peaked early on 10 August at 47,300 c.f.s. The flood event filled 64,000 acre-feet of reservoir storage, equal to 3.4 inches of runoff over a basin area of 348 square miles (now 367 square miles), producing a peak reservoir pool elevation of 1060.2 feet, m.s.l. on 12 August. Releases from Scott Reservoir were not made until 2 days after the flood peaked at Wilkesboro in order to avoid contributing to the flood peak at and below Yadkin College. Reservoir operations during this flood are shown on plate 8-4 and in summary table 8-1. Downstream effects of Scott Dam operations are shown in summary table 8-2. Scott Dam operations reduced the peak flow at Wilkesboro from an estimated 45,000 c.f.s. to 12,700 c.f.s., and the peak stage from 26.6 feet (29.3 feet above gage datum by the current rating curve) to 15.7 feet. At Elkin, the peak flood flow was reduced from an estimated 54,000 c.f.s. to 24,700 c.f.s., and the peak stage from 28.0 feet to 23.5 feet. At Enon, the peak flood flow was reduced from an estimated 87,000 c.f.s. to 63,500 c.f.s., and the peak stage from 30.2 feet to 27.7 feet. At Yadkin College, the peak flood flow was reduced from an estimated 77,000 c.f.s. to 57,000 c.f.s., and the peak stage from 33.2 feet to 28.9 feet. These reductions prevented 4.4 million dollars in flood damages (1970 price level), primarily in Wilkesboro and Elkin-Jonesville urban areas.

e. June 1972 Flood. This flood caused the sixth-highest reservoir pool elevation since Scott Dam began operation. It would have been among the 20 highest floods of record at Wilkesboro, with a peak flow of about 26,400 c.f.s. at the Wilkesboro gage, if Scott Dam had not been built. Scott Dam operations during this flood are summarized on plate 8-5 and in table 8-1, with the resulting downstream peak flow reductions shown in table 8-2.

The flood-producing rainfall consisted of an average 7.4 inches over the drainage basin above Scott Dam from 17 June through 22 June 1972. This rainfall resulted from Hurricane Agnes. Agnes began as a tropical depression over Yucatan on 14 June reaching hurricane force over the Gulf of Mexico early on 18 June. Hurricane Agnes made landfall on 19 June on the Florida panhandle and proceeded as a tropical depression northeast across Georgia and South Carolina, reaching North Carolina early on the 21st. Agnes intensified over North Carolina as it neared the Atlantic Ocean. Tropical Storm Agnes then crossed southeastern Virginia and the mouth of Chesapeake Bay, and headed into the Atlantic Ocean. On the 22nd, the tropical storm's path turned more to the north and Agnes made landfall at New York City. Becoming extratropical, it arced through southern New York, entering north central Pennsylvania early on the 23rd. This was an unusual storm system, as evidenced on the 22nd by surface barometric pressures below 1,000 mb over an area from upstate New York to the North Carolina Capes, due in part to a quasi-stationary trough in the Ohio Valley. Prior to 17 June, the drainage basin above Scott Dam was dry. The reservoir pool elevation was 1033.0 feet, m.s.l., which was the temporary normal pool level in effect since September 1971. On 17 June, while Agnes was still a tropical storm in the Yucatan Channel between Yucatan and Cuba, a basin average of about an inch of rain fell above Scott Dam, followed by about another half inch on the 18th. On the evening of the 19th, as Agnes was starting northeast across Georgia, rain began to fall in earnest above the Scott Dam. Roughly 0.4 inches fell on the 19th, followed by 4 inches on the 20th, and another 1.5 inches on the 21st, for a total of 7.4 inches for 17-21 June. The volume of direct runoff from the storm was approximately 26,800 acre-feet, or 1.4 inches over the Scott Dam drainage basin. Reservoir inflow peaked early on 21 June at 18,500 c.f.s. The flood event produced a peak reservoir elevation of 1047.7 feet, m.s.l. on 23 June. Releases from Scott Reservoir on 20 June were reduced to zero at the end of the day so as not to contribute to flooding at Wilkesboro. Releases were not resumed until 23 June, two days after the flood peaked at Wilkesboro, so as not to contribute to the flood peak at Yadkin College. Reservoir operations during this flood are shown on plate 8-5 and in summary table 8-1. Downstream effects of Scott Dam operations are shown in summary table 8-2. Scott Dam operations reduced the peak flood flow at Wilkesboro from an estimated 26,400 c.f.s. to 9,100 c.f.s., and the peak stage from 22.2 feet to 12.3 feet. At Elkin, the peak flood flow was reduced from an estimated 37,400 c.f.s. to 23,400 c.f.s., and the peak stage from 28.0 feet to 22.6 feet. At Enon, the peak flood flow was reduced from an estimated 69,800 c.f.s. to 64,600 c.f.s., and the peak stage from 28.5 feet to 27.8 feet. At Yadkin College, the peak flood flow was reduced from an estimated 86,700 c.f.s. to 75,250 c.f.s., and the peak stage from 34.9 feet to 32.8 feet. These reductions prevented 3.8 million dollars in flood damages (1972 price level), primarily in Wilkesboro and Elkin-Jonesville urban areas.

f. November 1977 Flood. This flood caused the highest reservoir pool elevation since Scott Dam began operation. It would have been the fourth-highest flood of record at Wilkesboro, with a peak flow of 42,000 c.f.s. at the Wilkesboro gage, if Scott Dam had not been built. Scott Dam operations during this flood are summarized on plate 8-6 and in table 8-1, and the resulting downstream peak flow reductions can be seen in table 8-2. The flood-producing rainfall consisted of 9.25 inches over the Scott Dam drainage basin from 1 November through 8 November 1977. This event resulted from a moisture-laden low pressure system centered over extreme southwestern Alabama which provided a southerly to southeasterly flow of moist air over the western mountains of North Carolina, resulting in orographic precipitation on the eastern and southern slopes. Prior to this event, stream flows and basin moisture conditions were normal, and the reservoir pool elevation was at 1029.95 feet, m.s.l., just slightly below the normal pool of 1030 feet, m.s.l. Light intermittent rains began on 1 November, and by 4 November, the reservoir elevation began to rise. Rainfall intensity increased on the evening of the 5th, and by the morning of the 6th, the 24-hour precipitation at Scott Dam was 3.80 inches. The next 24 hours brought another 2.05 inches of rain. A final 0.09 inches of rain fell by the morning of the 8th, bringing the storm precipitation total at Scott Dam to 7.25 inches. The drainage basin above Scott Dam received an average of 8.50 inches of rainfall during this storm event. The volume of direct runoff was 42,000 acre-feet, or 2.3 inches over a basin area of 367 square miles. Reservoir inflow peaked near noon on 6 November at about 32,700 c.f.s. By this time, releases from the dam had been reduced to zero. The flood event filled 65,800 acre-feet of reservoir storage, equal to about 3.5 inches of runoff over a basin area of 348 square miles, producing a peak reservoir pool elevation of 1061.2 feet, m.s.l. Releases from the reservoir recommenced on the afternoon of 7 November, a day after the peak at Wilkesboro and a half day after the peak at Elkin. Reservoir operations during this flood are shown on plate 8-6 and in summary table 8-1. Downstream effects of Scott Dam operations are shown in summary table 8-2. Scott Dam operations reduced the peak flood flow at Wilkesboro from an estimated 41,850 c.f.s. to 11,830 c.f.s., and the peak stage from 27.3 feet to 15.5 feet. At Elkin, the peak flood flow was reduced from an estimated 45,270 c.f.s. to 21,940 c.f.s., and the peak stage from 31.2 feet to 21.1 feet. At Enon, the peak flood flow was reduced from an estimated 47,630 c.f.s. to 27,050 c.f.s., and the peak stage from 24.9 feet to 19.8 feet. At Yadkin College, the peak flood flow was reduced from an estimated 40,750 c.f.s. to 23,540 c.f.s., and the peak stage from 24.6 feet to 18.1 feet. These reductions prevented 11.7 million dollars in flood damages (1977 price level), including 8.5 million dollars of urban damages in Wilkesboro and North Wilkesboro, and 2.9 million dollars in the Elkin-Jonesville area.

g. Flood Operation Experience. Scott Dam operation during floods occurring from October 1964 through September 1992 prevented an estimated 89.4 million dollars of flood damages along the Yadkin River, sometimes 8 million dollars or more in a single event (1991 price level). Average annual flood damage prevention by Scott Dam has been about 3.2 million dollars per year.

8-03. Recreation. Nearly a million people live within 50 miles of Scott project lands and the cities of Charlotte, Asheville, Winston-Salem, High Point, and Greensboro are all within 80 miles. Visitation to Scott Reservoir in Fiscal Year 1992 (Oct. 1991 through Sep. 1992) was 2.2 million people, and has been increasing by an average of 4.5 percent per year over the past 10 years. Steep slopes, quality vegetation, clear water, and the Blue Ridge Mountains in the background highlight the Scott project's dramatic visual quality. The lack of development on project lands and adjacent private lands enhances this visual impact. Picturesque views of the lake and the surrounding mountains can be seen from nearly any location on project lands. Recreation opportunities at Scott Reservoir include boating, fishing, swimming, hunting, camping, hiking, picnicking, and sightseeing. Facilities are provided to accommodate these and other activities. All of the project lands at Scott Reservoir are operated by the Corps of Engineers, Wilmington District, except for Wilkes County Park, operated by the County of Wilkes, and Wilkes Skyline Marina, operated by a private concessionaire.

8-04. Water Quality. W. Kerr Scott Reservoir is a mesotrophic lake, with the low nutrient and chlorophyll-a values reflective of a lake with high water quality. The best-usage classification assigned to Scott Reservoir waters by the North Carolina Department of Environment, Health, and Natural Resources is Class-B Trout Waters, and the lake fully meets the higher water quality standards associated with this classification.

Low flow releases are made from Scott Reservoir as outlined in the low flow operation plan table 7-1. These low flow releases maintain the riverine environment just below the dam and augment downstream flows to maintain the assimilative capacity of the river for wastewater discharges. The minimum flow maintained just below the dam is 125 c.f.s., which is the 7-day, 10-year low flow at this point under natural conditions.

The water released from the dam contains less sediment than it would under natural conditions, as reservoirs, in general, tend to act as sediment traps. Sediment is the greatest cause of degraded stream quality in the Yadkin - Pee Dee River Basin. The water released from Scott Dam tends to dilute the point source sediment that degrades the water quality of the Yadkin River at Wilkesboro. Scott Dam controls 73 percent of the watershed area above Wilkesboro.

Scott Reservoir also may assist in either the containment or the flushing of pollutants should a spill or other circumstance occur in the Scott Reservoir drainage basin or in the Yadkin River downstream of the dam.

8-05. <u>Fish and Wildlife</u>. The responsibility for management of the fisheries resources at W. Kerr Scott Reservoir is shared by the North Carolina Wildlife Resources Commission (NCWRC) and the Corps of Engineers, with the NCWRC having the basic responsibility. Thirty-one species of fish are known to inhabit Scott Reservoir, eleven of which were stocked by the NCWRC and two of which (gizzard shad and white perch) were accidentally introduced. One of the most successful of the stocked fishes has been the spotted bass. In 1987, the North Carolina state record for spotted bass was broken twice with fish caught in Scott Reservoir. Trout are present on a limited basis during late fall, winter, and early spring, but the warm water temperatures from June through September will not support them. However, the feeder streams in the watershed are stocked with trout on a regular basis from March through September, and it is likely that some of these fish are the ones which have been found in the reservoir during cooler months. Other fisheries management efforts include establishing artificial spawning areas for game fish using pea gravel on suitable sites, establishing fish shelters using brush and Christmas trees, monitoring water quality, and trying to maintain a constant reservoir pool elevation during game fish spawning seasons. Efforts are being made to establish water tolerant plants along the shoreline of the lake as food and cover for fishes and waterfowl, and as an erosion control measure.

Wildlife management at the Scott Reservoir project is the responsibility of the Corps of Engineers. Game animals receiving intensive management attention include whitetail deer, ruffed grouse, eastern gray squirrels, mourning doves, bobwhite quail, cottontail rabbits, wild turkeys, raccoons, and various water-fowl such as Canadian geese and wood ducks. In terms of time spent hunting, squirrels are the most popular game animal at Scott Reservoir and water-fowl are the second most popular. Non-game animals which are being encouraged through management practices include purple martins and eastern bluebirds. Wildlife management techniques in use at Scott Reservoir include planting wildlife food plots, placing nesting boxes, encouraging habitats favorable to certain species, regulating hunting, and encouraging a diversity of vegetative types for the benefit of all game and nongame species.

At the present time, there are no known endangered species of flora or fauna which inhabit project lands at W. Kerr Scott Reservoir. The endangered species which may be seen on rare occasions are the bald eagle, the Arctic peregrine falcon, and the Kirtland's warbler. The bald eagle is considered an occasional visitor. The Arctic peregrine falcon breeds in Greenland and northern Canada, and winters along the Atlantic and Gulf coasts. It can be considered a rare migrant through Scott project lands. Kirtland's warbler occurs in North Carolina only as a migrant. Its spring and fall migration routes differ slightly, so that although it might be seen in the fall, it is more likely to pass through the Scott project area in the spring.

8-06. Water Supply. The County of Wilkes and the City of Winston-Salem, NC, jointly entered into a contract with the United States of America on 29 June 1960 whereby they purchased the right to impound water in Scott Reservoir between elevations 1000 and 1030 feet, m.s.l. (about 33,000 acre-feet) and to order releases from this water supply pool at any time provided that such releases, when combined with normal runoff below the dam, will not cause damaging floods. Excerpts of this water supply contract are shown in exhibit C. Releases have been made from this pool, but no releases have been made to date which were specifically for water supply. A pool elevation of 1030 feet, m.s.l., is desired for recreational use of the reservoir, which benefits Wilkes County.

8-07. Frequencies.

a. Peak Inflow Probability. The natural frequency curve at the Scott damsite increased by 25 percent should be representative of peak inflow to the project (see plate 8-9).

b. Frequency of Reservoir Rise, Drawdown, and Duration. The frequency of W. Kerr Scott Reservoir rise and drawdown is shown on plate 8-7. Scott Reservoir should, on the average, reach an elevation of 1039.6 feet, m.s.l. once per year. After reaching this elevation, drawdown will begin immediately and the level of the reservoir should return to normal in about six days. The degree of drawdown below normal is directly dependent on low flow releases. The frequency of drawdown shown on plate 8-7 is based on actual records since 1963, during which time various low flow release schedules have been in use. An elevation-duration curve is shown on plate 8-8.

c. Key Control Points. Prior to the construction of Scott Dam, the non-crop damage stage at Wilkesboro was reached or exceeded an average of about once in 7 years. The 10-year flood at Wilkesboro under natural conditions, with a peak stage 14 feet above the minimum non-crop damage stage, now has an expected exceedance frequency of once in 250 years. At Elkin, what was previously a 10-year flood now occurs an average of once in 30 years, and what was previously a 100-year flood stage has an expected exceedance frequency of about once in 300 years. The natural and regulated discharge-frequency curves for the Yadkin River at the damsite, Wilkesboro, Elkin, Enon, and Yadkin College are shown on plates 8-9 through 8-13. Discharges and stages for various natural and modified flood frequencies are shown in table 8-3.

8-08. <u>Other Studies</u>. An operational study was done in Fiscal Year 1989 to propose a revised operational plan for making low flow releases from the water supply pool. The purpose of the revision was to reduce drawdowns which adversely affect recreational use of the reservoir, and to ensure ample water supply during prolonged or severe dry periods. The proposed revisions were promptly accepted by the City of Winston-Salem and the County of Wilkes.

IX. WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organization of Corps of Engineers.

a. Wilmington District. The regulation, operation, and maintenance of W. Kerr Scott Dam and Reservoir involves both the Engineering and the Construction-Operations Divisions within the Wilmington District. Responsibilities of the Reservoir Regulation Section, Hydrology and Hydraulics Branch within the Engineering Division are listed below.

(1) Regulate Scott Reservoir as set forth in this water control manual.

(2) Prepare and periodically update and revise this manual which prescribes and documents the regulation of the Scott project for its congressionally authorized purposes of flood control, water supply, recreation, and fish and wildlife.

(3) Submit to the Division Office, as required, reservoir regulation charts consisting of pool elevations, inflows, outflows, precipitation amounts, hydrographs at downstream control points, and other hydrologic data. During floods, forward daily reports containing, in addition to the above, data on predicted peak stages and percentage of flood control storage utilized.

(4) Keep Emergency Operations Manager advised during emergencies.

The Natural Resources Management Branch, within the Construction-Operations Division, is responsible for security, physical operation, and maintenance of the Scott Reservoir project. These duties include staffing the project with qualified personnel, supervision of maintenance activities, and coordination of these activities as required. If disaster-type situations exist at or below the Scott project, the Emergency Operations Manager's Office is responsible for coordinating emergency activities, including downstream notification, flood fighting, rescue work, liaison with local interests, and authorized disaster operations. An organization chart for water control management activities within the Wilmington District is shown in table 9-1.

b. South Atlantic Division (SAD). Table 9-2 shows the organization of SAD for water control management. The Reservoir Regulation Section (Wilmington) contact with SAD on water control management is usually with Water Management Branch.

9-02. Coordination.

a. Press Releases. The Public Affairs Officer within the Wilmington District is responsible for releasing information to the media concerning special events of project operation including emergency flood flows, dam break, etc.

Table 9-1

Organization Chart of the Wilmington District for Water Control Management Responsibilities of the Scott Reservoir Project

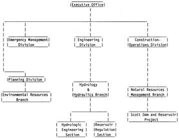
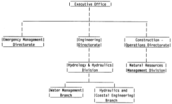


Table 9-2

Organization in SAD for Water Control Management



b. National Weather Service. Cooperative arrangements with the National Weather Service (NWS) provide for an exchange of hydrometeorologic data to avoid duplication of effort in obtaining data and disseminating forecasts. The NWS River Forecast Office at Raleigh is the collection center for the river precipitation-reporting network which is supported by and maintained on a cooperative basis with the Reservoir Regulation Section, Wilmington District, Corps of Engineers. River stage forecasts are issued to the public by the NWS, Raleigh. Usually these forecasts are issued after a discussion with the Reservoir Regulation Section, particularly in connection with those stations which are affected by Scott Reservoir operations.

c. U.S. Geological Survey. The Corps of Engineers and the U.S. Geological Survey (USGS) cooperate in the construction, maintenance, and operation of stream-gaging stations in the Yadkin River Basin. The cooperation of the Corps of Engineers consists of an annual transfer of funds for the operation and maintenance of stations, with actual operation being accomplished by the Geological Survey. During large floods, the Wilmington District may furnish personnel support to supplement the USGS so that a maximum number of streamflow measurements can be obtained.

d. State of North Carolina. Any unusual conditions affecting water releases from the dam will be coordinated with the N.C. Department of Environment, Health, and Natural Resources in Raleigh.

9-03. Water Supply Contract with the City of Winston-Salem, North Carolina and the County of Wilkes, North Carolina. Storage space between elevations 1000 and 1030 feet, m.s.l., approximately 33,000 acre-feet, has been included in the project for water supply. The County of Wilkes, and the City of Winston-Salem, NC, jointly entered into a contract with the United States of America on 29 June 1960 for the right to impound water. This contract obligates all of the allocated water supply storage space within Scott Reservoir. The contract is to continue in force and effect for 50 years after the first releases were made from the water supply pool on 22 July 1970. The contract is then renewable for successive periods of 25 years each for the physical life of the project. Payment for use of the water supply storage space is based on the project construction cost and the annual operation and maintenance costs. Excerpts from the water supply contract are shown in exhibit C. In accordance with the water supply contract, the City of Winston-Salem and the County of Wilkes have agreed to a low flow release schedule to be followed during times of reservoir drawdown or low inflows to the reservoir. The current low flow release schedule is shown in table 7-1.

9-04. Reports.

a. Daily. Daily reports are prepared by project personnel and the Reservoir Regulation Section. Daily Report, SAW Form No. 512, is shown on plate 5-4. The Reservoir Regulation Section is in daily communication with the Scott Reservoir project and the NWS office in Raleigh to exchange data. The daily reports include rainfall, reservoir elevations, outflow, inflow, gate openings, and river stages at Wilkesboro, Elkin, Enon, and Yadkin College stream gages.

b. Monthly Regulation Charts. A graphical chart for Scott Reservoir is prepared by the Reservoir Regulation Section and is submitted monthly to SAD, in compliance with EM 1110-2-3600. The chart is a representation of data pertaining to the operation of the reservoir including rainfall, average inflow, average outflow, and reservoir pool elevations during the month.

c. Flood Situation. Flood situation reports are prepared as needed to comply with procedures outlined in ER 500-1-1. These reports basically consist of meterological data describing the flood event, forecasts of additional precipitation, current and forecast river stages, reservoir pool elevations, damages incurred, and actions taken.

Reports prepared in the Reservoir Regulation Section are made available to the Emergency Operations Manager and other personnel as required. Also, in accordance with paragraph 72.73 of ER 500-1-1, "Emergency Employment of Army Resources -- Natural Disaster Activities," the District Office submits a post-flood report to the Division Office within 3 months after a major flood event. This report contains a complete summary of flood characteristics, reservoir operations, damages incurred, and damages prevented by flood control operations. The post-flood report is prepared for the Emergency Operations Manager by the Engineering/Planning Divisions and is reviewed by Reservoir Regulation Section.

d. Annual Activities Report. Shortly after each fiscal year, the Reservoir Regulation Section prepares a District report on annual reservoir regulation activities for each project. This report presents a general and specific overview of the operation of Scott Dam and Reservoir project during the preceding fiscal year.

EXHIBIT A

W. KERR SCOTT DAM AND RESERVOIR

STANDING OPERATING INSTRUCTIONS TO DAMTENDER

1. Responsibility of Engineering Division. The Reservoir Regulation Section, Hydrology & Hydraulics Branch of the Engineering Division, is responsible for all functions of reservoir regulation pertinent to the operation of W. Kerr Scott Dam and Reservoir. The following duties are performed in carrying out this responsibility:

a. Obtain and analyze weather forecasts and current precipitation and streamflow data.

b. Prepare forecasts of streamflow and reservoir elevations. Keep Construction-Operations Division informed of project operations.

c. Issue instructions for water releases.

2. Responsibility of Construction-Operation Division. The Natural Resources Management Branch of the Construction-Operations Division is responsible for the physical operation of W. Kerr Scott Dam and Reservoir. The responsibility for the operation of the dam is delegated to the Resource Manager. The following duties are performed in carrying out this responsibility:

a. Maintain all equipment required for operation and communication in good operating condition. Plan necessary maintenance of outlet works with the Reservoir Regulation Section. In the event of a failure of equipment, notify the Reservoir Regulation Section.

b. Operate outlet gates as specified by the Reservoir Regulation Section, and when communication with the District fails, release outflows from the reservoir during flood periods in accordance with instructions for emergency operation.

c. Operate climatological substation and obtain and transmit data to the Reservoir Regulation Section.

3. Responsibility of Planning Division. The Environmental Resources Branch is responsible for water quality concerns related to the W. Kerr Scott Dam and Reservoir. The following duties are performed in carrying out this responsibility:

a. Require water quality monitoring of the reservoir, tributaries, and/or releases from the dam if water quality problems are observed or anticipated.

b. Coordinate water quality information with NC Division of Environmental Management and other appropriate agencies.

4. Comments on reservoir regulation made by the public. Any complaints or other comments on reservoir regulation, including newspaper clippings, are referred to the District.

5. Data collection. Data to be collected by the project personnel includes the following: precipitation, reservoir water temperature in the spring, reservoir elevation, releases from the reservoir, and water quality data when needed. Readings shall be made daily about 8 a.m.

6. Special reports on precipitation. The W. Kerr Scott precipitation gage is part of a network of reporting precipitation stations set up for use in operating W. Kerr Scott Reservoir. Special reports on precipitation shall be made to Reservoir Regulation Section personnel as follows:

a. Whenever 0.5 inch or more of rainfall is measured at the 8 a.m. reading on a non-work day.

b. Whenever rainfall measured at any 8 a.m. reading is less than 0.5 inch, but continued rain produces a total of 0.5 inch or more by about 1 p.m.

c. After the first special report, continue reporting at each observation time (about 8 a.m. and 1 p.m.) as long as any additional rain occurs since the previous report.

d. As requested by Reservoir Regulation Section.

7. Daily report. A daily report summarizing rainfall and streamflow conditions is prepared for each day. Data on this report is transmitted to the Reservoir Regulation Section. During periods of normal flow, the report for non-work days is prepared on the next normal work day.

8. Low flow regulation. Whenever the reservoir is in a low flow or drought condition, the damtender will maintain releases from Scott according to the following operational plan:

Elevation (ft., m.s.l.)	Minimum Flow and Stage at Wilkesboro, NC Flow (cfs)	Stage* (ft)
1,029.00 and above	400	2.11
1,028.00 - 1,028.99	350	2.01
1,027.00 - 1,027.99	300	1.90
1,026.00 - 1,026.99	250	1.78
1,024.00 - 1,025.99	200	1.66
1,023.00 - 1,023.99	150	1.53
1,000.00 - 1,022.99	**	**

Note: Minimum discharge from Scott should not be less than 125 c.f.s. at any time, except during inspection and maintenance periods.

* Stages are from rating table no. 21 for Yadkin River at Wilkesboro, N.C.
** Minimum release from W. Kerr Scott, i.e., 125 c.f.s. release.

9. Flood forecasts. Forecasts of river stage and discharge will be prepared by the Reservoir Regulation Section for District use. The National Weather Service (NWS) in Raleigh is responsible for issuing official forecasts to the public. The District cooperates with the NWS in preparing these forecasts for points downstream from the dam. Forecasts of headwater elevation will be furnished to the damtender so that he may take such steps as necessary to protect Government property in the reservoir area and issue warnings to other interested parties.

10. Emergency flood control operation. Whenever the reservoir is in a flood situation and communication with the Reservoir Regulation Section is not possible, the damtender will monitor the Wilkesboro telemark at least hourly and make flow releases from the lake in accordance with the following instructions:

a. Wilkesboro talkamark operative. No water except minimum flow will be released through the sluices during the time the stage at Wilkesboro is rising due to rainfall or when the river stage at Wilkesboro is above bankful stage of 12 feet. The release for Scott will be determined by the stage at Wilkesboro and the resevoir elevation as follows:

(1) When the reservoir elevation is between 1030 and 1075 feet., m.s.l. and the stage at Wilkesboro has fallen below 12 feet, the maximum release from Scott will be approximately 5,400 c.f.s. or 9,700 c.f.s. less the flow from the uncontrolled drainage area above Wilkesboro, whichever is the least. Increases in discharge rates should not exceed 500 c.f.s. in the first hour of flood releases and 1,000 c.f.s. per hour thereafter.

(2) When the reservoir elevation is above spillway crest elevation 1075 feet., m.s.l., the releases will be the full capacity of the outlet works.

b. Wilkesboro talkamark inoperative. If the Wilkesboro talkamark is inoperative, no release from Scott will be made until 24 hours after the rainfall has ended. The damtender will obtain the best available rainfall data and if possible will contact the local NWS office to establish rainfall conditions above the dam. Increases in discharge rates will be the same as in 10.a.(1).

11. Special instructions.

a. Both service gates should not be closed at the same time without the consent of the Reservoir Regulation Section.

b. Except in an emergency, the emergency gate should not be used to regulate flows other than by being either fully open or closed completely.

EXHIBIT B

W. Kerr Scott Dam and Reservoir
Yadkin River Basin, NC
DROUGHT CONTINGENCY PLAN
August 1991

INTRODUCTION

The purpose of this report is to (1) provide a platform from which to make decisions on implementation of water conservation measures during future droughts, (2) review the operational flexibility of the W. Kerr Scott Water Control Plan in a drought, and (3) address the potential problems associated with an extreme drought. A severe drought in the Yadkin River basin develops over a long period of time and has a duration of 6-12 months. Adequate time will be available to plan specific details of a drought operation. This plan is an outline of water management measures and coordination actions to be considered when a severe drought occurs. Details of particular water management measures and the timing of their application will be determined as the drought progresses.

BACKGROUND

General. The demand for water is the greatest when the natural supply is the least. Scott Reservoir has been drawn below elevation 1023 ft., m.s.l. on seven separate occasions since completion of permanent impoundment on January 19, 1963. The potential for a serious drought did exist in each of these seven years due to the time of year and the minimum elevation that occurred. Table 1 shows the minimum lake elevation for each calendar year since inception of the project. These elevations would indicate that Scott

TABLE 1
W. Kerr Scott Reservoir
Minimum Annual Elevation Since Permanent Impoundment

Calendar Year	Date	Elevation (ft., m.s.l.)	Calendar Year	Date	Elevation (ft.m.s.l.)
1963	23 Feb	1029.80	1977	6 Sep	1021.10
1964	20 May	1026.90	1978	26 Nov	1019.90
1965	10 Apr	1026.20	1979	1 Jan	1023.50
1966	28 Jun	1029.60	1980	31 Dec	1024.50
1967	25 Feb	1029.70	1981	21 Aug	1019.95
1968	29 Jun	1029.80	1982	23 Oct	1020.10
1969	20 May	1029.40	1983	10 Oct	1025.90
1970	20 Oct	1026.00	1984	31 Dec	1027.15
1971	10 Sep	1021.30	1985	22 Jul	1023.69
1972	6 Nov	1025.80	1986	17 Aug	1022.98
1973	20 Nov	1029.30	1987	5 Sep	1025.64
1974	3 Dec	1029.75	1988	28 Aug	1022.75
1975	9 Jun	1029.10	1989	5 Jun	1029.35
1976	28 Sep	1023.30	1990	12 Jul	1029.18

Reservoir was in a normal dry period from the mid-1970's to mid-1980's. Operational experience gained during these dry periods resulted in a revision to the low-flow operation plan for W. Kerr Scott in 1978, 1982, and 1989.

The resulting low-flow operation plan as shown in table 2 provides for a stepped-down release schedule as the pool elevation decreases. This plan would not produce any failures of the available conservation storage during a repeat of the most critical drought on record. Table 2 should serve as an action guide to follow during a drought event.

TABLE 2

LOW-FLOW OPERATION PLAN FOR W. KERR SCOTT DAM AND RESERVOIR

Scott Pool Elevation Range (ft. m.s.l.)	Minimum at Wilkesboro, NC Flow (cfs)	Stage* (ft)
1,029.00 and above	400	2.11
1,028.00 - 1,028.99	350	2.01
1,027.00 - 1,027.99	300	1.90
1,026.00 - 1,026.99	250	1.78
1,024.00 - 1,025.99	200	1.66
1,023.00 - 1,023.99	150	1.53
1,000.00 - 1,022.99	**	**

Note: Minimum discharge from Scott should not be less than 125 c.f.s. at any time except during inspection and maintenance periods.
*These stage readings are from USGS rating table #21 for Yadkin River at Wilkesboro, NC
**Minimum release from W. Kerr Scott plus intervening flow between the dam and Wilkesboro, NC.

Water Supply Users. All storage within the conservation pool has been contracted for water supply by the County of Wilkes and City of Winston-Salem, North Carolina. Water supply use by municipalities and industries downstream of Scott dam from surface waters as tabulated by U.S. Geological Survey is provided in table 3. This table illustrates that the current volume of water required for water supply (35 MGD) is significant as compared to the minimum release of 125 c.f.s. (81 MGD).

TABLE 3

Yadkin River Water Supply Users Below W. Kerr Scott Dam

Municipality	Source of Supply	Amount of Withdrawal MGD (1987)	Population Served
Wilkesboro	Yadkin River	3.80	2,500
North Wilkesboro	Reddies River	1.90	3,500
Town of Elkin	Big Elkin Creek	1.00	3,000
Town of Jonesville	Yadkin River	0.23	1,800
King District WA	Yadkin River	1.12	15,000
Winston-Salem	Yadkin River	15.00	182,000
Davidson Water, Inc.	Yadkin River	6.32	88,300
Town of Denton	Yadkin River	0.60	1,080
	TOTAL	29.97	297,180

Industry	Source of Supply	Amount of Withdrawal MGD	Location (nearest town)
Abitibi Price Corp.	Yadkin River	1.00	Roaring River, NC
Chatham MFG	Big Elkin Creek	3.50	Elkin, NC
Cunningham Brick Co.	Yadkin River	0.01	Welcome, NC
	TOTAL	4.51	

Impacts to Recreational Use of W. Kerr Scott Reservoir. Operational experience has shown that recreational use of the lake begins to suffer once the elevation falls below 1025 ft., m.s.l. Numerous complaints were received at both the Resource Manager's Office and Wilkes Sky-Line Marina during low elevation periods primarily regarding shoals and navigational hazards within the lake. Problems with the dock system begin to occur near elevation 1025 ft., m.s.l. and concerns over a sewer line were expressed near elevation 1023 ft., m.s.l. Also, a large number of private docks are not designed to accommodate extreme fluctuations and are not available for use during extended periods of drawdown. Lake access availability during periods of low lake levels are illustrated in table 4 which gives the bottom elevation of boat ramps at access areas. Boat ramps generally become unusable at about 2 to 3 feet above the bottom of the ramp elevation.

TABLE 4

W. Kerr Scott Dam and Reservoir
Boat Launching Ramps

LOCATION	LENGTH ft.	BOTTOM ELEVATION (ft. m.s.l.)	LANES
Dam Site Pk.	217.0'	1015.00	1
Marina	164.8'	1015.00	2
Bandits Roost Pk.	170.0'	1015.00	1
Boomer Pk.	130.7'	1016.00	1
Keowee Pk.	162.5'	1015.00	1
Wilkes Co. Pk.	166.7'	1015.00	2
Smitheys Ck. Pk.	160.0'	1015.00	1

SUMMARY OF EXISTING WATER CONTROL PLAN

The authorized purposes of W. Kerr Scott project are flood control, water supply, recreation, and fish and wildlife. The top of the conservation pool is at elevation 1030.0 ft., m.s.l. At that elevation, the mean depth of the lake is approximately 25 feet, and the maximum depth is about 65 feet. Allocated storages for the project are shown in table 5.

TABLE 5

Storage Allocation

	Elevation (ft. m.s.l.)	Area (Ac)	Capacity (Ac-Ft)
Top of Flood control pool	1075	4,000	153,000
Flood control storage	1030-1075	-	112,000
Top of conservation pool	1030	1,475	41,000
Bottom of conservation pool	1000	675	8,000
Conservation pool storage	1000-1030	-	33,000
Sediment storage	965-1000	-	8,000

The plan of operation provides for maintaining a normal pool at elevation 1030 ft., m.s.l. on a year round basis. This is accomplished during periods of normal flow by releasing inflow. During flood periods, releases are based on a combination of downstream flow conditions and lake levels such that flood damages downstream are minimized. Normal and low-flow releases are made as outlined on table 2.

Regulation flexibility is very limited under existing authority. When the lake elevation is in the conservation pool, the project will be operated to meet requirements of the operation plan shown on table 2. The only available flexibility from a regulation viewpoint in this situation would be that the County of Wilkes or City of Winston Salem modify its demands for water supply releases.

Storage-use flexibility between the conservation and flood control pools is not a viable option within the guidelines authorizing the project.

ANALYSIS OF DROUGHT OPERATION

Dry periods occur randomly during any time period. There are no major indicators to distinguish "normal" dry periods from severe droughts during the early stages. Conditions may vary slightly depending on the time of year, length of time the reservoir is below elevation 1030 ft., m.s.l. and downstream requirements. The pool elevation at W. Kerr Scott project will be used to initiate action. Once the elevation at Scott falls below 1030 ft., m.s.l., the operation plan shown in table 2 shall be followed. This plan as agreed to by the County of Wilkes and City of Winston-Salem, North Carolina, was designed to maximize the remaining conservation storage at W. Kerr Scott project.

The Drought Management Committee shall consist of the Wilmington District and other Federal agencies as required. Advisors to the committee will be representatives from the State of North Carolina, and local governments. Coordination activities shall include but not be limited to initiation of a water budget, alerting recreation interests within the lake, issuing forecasts of conservation storage remaining, implementing conservation measures, and making public information releases.

The Division of Water Resources with the North Carolina Department of Environment, Health, and Natural Resources will act as the point of contact for the State of North Carolina, and as the responsible party for notifying all related concerned State interests. The resource manager at Scott project will be responsible for notifying all related concerned interests within the reservoir (marina operation, recreation use areas, etc.) of the current status, forecast of drawdown, and performing duties in conjunction with State agencies as described in the "Operational Management Plan" for W. Kerr Scott Reservoir. Personnel within the Reservoir Regulation Section of the Wilmington District shall prepare a water budget of storage remaining and a forecast of time remaining with the current low-flow operation plan as directed by the Water Control Manager or when the elevation drops below 1026 ft., m.s.l. This forecast and water budget may be updated on a weekly basis and furnished to the Resource Manager at Scott, the Director of Water Resources with the State, the County of Wilkes, and the City of Winston-Salem.

Public press releases shall be made on an "as-needed" basis through the Public Affairs Office (PAO) in the Wilmington District. These statements shall provide the public with a full explanation of drought operations and forecasts of expected conditions in an effort to reduce inquiries from recreation and concerned interests.

A drought situation report for Scott shall be prepared as appropriate by the Reservoir Regulation Section of the Wilmington District. This report shall provide detailed information on current and forecast situations for informational purposes of District and South Atlantic Division elements.

DROUGHT MANAGEMENT PLAN

The following plan has been selected as the procedure to follow for coordinating decisions and implementing actions during a drought. This plan will be administered by the Water Control Manager of the Wilmington District Corps of Engineers. Decisions will be based on lake elevations as indicated below.

Scott Elevation 1023.00 - 1030.00 ft., m.s.l. The low-flow operation plan as shown in table 2 shall be adhered to during this range of elevations. All project purposes shall be maintained with no adverse impacts.

Scott elevation 1020.00 - 1022.99 ft., m.s.l. The water supply users shall be notified by the Wilmington District Water Control Manager that implementation of initial water conservation measures should be considered. Generally, on a weekly basis the State of North Carolina shall be updated by the Wilmington District Corps of Engineers, regarding conservation storage remaining. All project purposes shall be maintained with minimal adverse impacts.

Scott elevation 1000.00 - 1019.99 ft., m.s.l. Whenever the elevation at Scott Reservoir is drawn below 1020.0 ft., m.s.l., recreation within the reservoir and access to the reservoir as shown on table 4 will be severely impacted. Required minimum releases and the water supply contract shall be maintained. The Drought Management Committee may convene to discuss a course of action for the continued operation of Scott and possible alternatives. Alternatives available at this time include, but are not limited to the following:

a. Water supply users could implement restrictive water use measures for personal and emergency use only (no water for lawns, gardens, pools, car washes, etc.) to conserve remaining supplies.

b. The State of North Carolina could temporarily relax state standards for water quality requirements in the river below Scott to permit continued operation of industrial and municipal waste treatment facilities, and conserve remaining storage.

Scott elevation below 1000.00 ft., m.s.l. Should the elevation of Scott Reservoir fall below 1000.0 ft., m.s.l., all conservation storage for minimum releases, water supply and recreation is depleted. Alternatives include but are not limited to:

a. Emergency reallocation by the District Engineer in Wilmington of any water that may remain within the sediment storage pool.

b. Declaration by the State of North Carolina of a water emergency as authorized by G.S. 143-354. After a water emergency has been declared by the Environmental Management Commission, the Commission can order emergency diversions to meet the needs of human consumption, necessary sanitation, and public safety. The Division of Water Resources assesses water supply problems and recommends action to the Commission under this statute.

SELECTED FEDERAL EMERGENCY AUTHORITIES PROVIDING DROUGHT ASSISTANCE

The responsibility for providing an adequate supply of water to inhabitants of any area is non-Federal. Corps assistance to provide emergency water supplies will only be considered when non-Federal interests have exhausted reasonable means for securing necessary water supplies, including assistance and support from other Federal agencies.

Assistance may be available from the Corps through PL 84-99 as amended by PL 95-51. Before Corps assistance is considered under PL 95-51, the applicability of other Federal assistance authorities should be evaluated. As a minimum, the Federal agencies which are to be coordinated with for applicability of programs prior to consideration of Corps assistance are as follows:

1. Small Business Administration (SBA).
2. Farmers Home Administration (FmHA).
3. Economic Development Administration (EDA).

If these programs cannot provide the needed assistance, then maximum coordination should be made with appropriate agencies in implementing Corps assistance.

The Corps authority for Drought Assistance is contained in Chapter 6, "Emergency Water Supplies and Drought Assistance" of Engineering Regulation 500-1-1 Natural Disaster Procedures (1983). Under this authority, the Chief of Engineers, acting for the Secretary of the Army, can construct wells and transport water to farmers, ranchers, and political subdivisions within areas he determines to be drought-distressed.

EXHIBIT C

EXTRACTS
FROM
CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
THE COUNTY OF WILKES, NC, AND THE CITY OF WINSTON-SALEM, NC
FOR
WATER STORAGE SPACE IN WILKESBORO RESERVOIR

CONTRACT DA-38-081-CIVENG-60-17
(Negotiated)

First started 22 July 1970

THIS CONTRACT, entered into this 29th day of June, 1960, by and between the United States of America (hereinafter called the Government), represented by the Contracting Officer executing this contract, and the County of Wilkes, N. C., and the City of Winston-Salem, N. C., hereinafter called the Sponsors, witnesseth that:

WHEREAS, construction of the Wilkesboro Reservoir on Yadkin River, North Carolina, (hereinafter called the Project) has been authorized by Section 10 of the Flood Control Act approved 24 July 1946 (Public Law 526, 79th Congress, 2d Session); and

WHEREAS, the County of Wilkes, N. C., and the City of Winston-Salem, N. C., are bodies corporate and politic duly organized under the laws of the State of North Carolina and authorized by statute to enter into contracts or other similar obligations for public purposes, and due to rapid expanding industrial development of the area contiguous to the Yadkin River, it has become necessary for the Sponsors to make provisions for an assured supply of water for domestic, industrial, and other uses; and

WHEREAS, the Government is authorized by the Water Supply Act of 1958 (Title III of the Act approved 3 July 1958, Public Law 85-500, 85 Congress, 2d Session) to include storage capacity in any reservoir project to be constructed by the Corps of Engineers in order to impound water for present or anticipated future demand or need for municipal or industrial water; and

WHEREAS, storage space of approximately thirty-three thousand acre feet capacity has been included in the Project for municipal and industrial water between elevation 1000 ft. and elevation 1030 ft. above mean sea level; and

WHEREAS, the Sponsors desire to utilize the storage space above specified in order to provide additional water for the purposes above referred to; and

WHEREAS, the Sponsors hereby agree to fulfill the local interest requirements of Title III of the Water Supply Act of 1958 as set forth in this contract.

NOW, THEREFORE, the parties do mutually agree as follows:

ARTICLE 1. The Sponsors shall have the right to utilize the storage space in the Project between elevation 1000 and elevation 1030 feet above mean sea level as is deemed necessary by the Sponsors to impound water in the Project and make such diversions, not contrary to the law of the State of North Carolina, to the extent that such storage will provide.

The Sponsors shall have the right to withdraw water from the aforesaid storage space or to order releases therefrom to be made by the Government at any time, so long as sufficient water is available within the aforesaid storage space to permit direct release, provided that such releases when combined with normal runoff below the dam will not cause damaging floods.

The Government shall not be responsible for any diversion of waters released to the river, nor will it become a party to any controversy between users of the aforesaid storage space.

The Sponsors shall have the right to construct installations or facilities for the purpose of diversions or withdrawals from the Project above elevation 1000 feet above mean sea level, subject to the approval of the Contracting Officer as to design and location but not as to capacity. All costs in connection with such installations or facilities, or any modification thereof, shall be borne by the Sponsors.

The Government reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property when floods are determined to be imminent and throughout the duration of a flood emergency.

ARTICLE 5. CONSIDERATION AND PAYMENT- In consideration of the payments provided in this contract to be paid by the Sponsors to the Government, it is agreed that the Government will provide storage space in the Project and will operate such storage space as provided in Article 1 above. In consideration of the Government's providing and operating the aforesaid storage space for the Sponsors, it is agreed that the Sponsors shall pay the following sums to the Government:

(1) 11.63 per cent of the total construction expenditures for project facilities, exclusive of expenditures for public use facilities, together with interest during construction and interest on unpaid balance at the rate of 2.699 per cent per annum. The present estimate of cost for the construction of the Project is as follows:

(a) Present estimate of Project construction expenditure (excluding public use expenditure)---$8,382,548.00

(b) Construction expenditure allocated to water supply (11.63%)----$ 974,949.00

(c) Interest during construction (2.699%)--------------------------$ 24,563.00

(d) Capital investment to be replaced-$ 999,512.00

In the event the actual first costs of the Project exceed the presently estimated first costs, the annual payments as shown in attached Schedule A shall be increased to reflect the actual first cost, including interest during construction, as determined by the Contracting Officer. In the event such first costs of the Project are less than the presently estimated first costs, the aforesaid annual payments shall be decreased to reflect the actual costs, including interest during construction, as determined by the Contracting Officer. In the event the water storage feature of the project is used by the Sponsor prior to 1 January 1973, the attached Schedule A shall be adjusted so that the date of payment shall commence as of the date that use is first commenced. It is further agreed that the Sponsors shall have the right to anticipate the principal amount or any part thereof due under this section at any time without penalty.

(2) 17.93 per cent of the annual experienced cost of operation and maintenance of the Project, exclusive of the operation and maintenance cost for land management and public utilization. The first payment estimated to be $5,380.00

will be due and payable on 1 January 1973. Annual payment will be due and payable in advance on the 1st day of January thereafter and will be equal to 17.93% of the actual experienced cost of operation and maintenance for the preceding Government fiscal year. The second payment shall be increased or decreased in an amount to reflect the difference between the first payment and 17.93% of the actual experienced cost of operation and maintenance for the preceding fiscal year.

In the event water is first used from the said storage space prior to 1 January 1973, the annual estimated payment of $5,380.00 for operation and maintenance shall be due and payable on such date of first use and will be for the period beginning on said date and ending on 31 December following the date water is first used from the said storage space and will be pro-rated for that period on the basis of the estimated annual operation and maintenance charge. Annual payments will be due and payable in advance on the 1st day of January of each year thereafter and will be equal to 17.93% of the actual cost of operation and maintenance for the preceding Government fiscal year, except that payments due before the first complete fiscal year of operation will be based on the estimated annual operation and maintenance cost. The first payment following the first complete fiscal year of operation shall be increased or decreased in an amount to reflect the difference between the prior payments and 17.93% of the actual experienced cost of operation and maintenance for the period from the date water is first used to the ending date of the first complete fiscal year of operation.

The extent of operation and maintenance of the Project shall be determined by the Contracting Officer, and all records and accounting shall be maintained by the Contracting Officer. In the event the Sponsors should require additional operation and/or maintenance for the conservation storage over and above that deemed necessary by the Contracting Officer, the Sponsors shall bear the entire costs of such additional expense.

Records of cost of operation and maintenance of the Project shall be available for inspection and examination by the Sponsors.

(3) In the event of default in the payment of the costs contained in Article 5 (1) and (2) the amount of such payments shall be increased by an amount equal to the interest on such overdue payment at the rate of 2.699% per annum thereon, compounded annually, and such amount equal to interest shall be charged from the date such payments are due until paid.

ARTICLE 6. PERIOD OF CONTRACT -

(a) This contract shall become effective as of the date of approval by the Secretary of the Army, or his authorized representative, and shall continue in force and effect for a period of fifty (50) years after the water stored in the Project is first used by the Sponsors, and may be renewed thereafter for successive periods of twenty-five (25) years each for the physical life of the Project subject to the provisions of paragraph (b) below.

(b) Upon the expiration of the fifty (50) year period described in (a) above, or upon the expiration of any renewal period, the Sponsors shall have a continued right to utilize the storage space in the Project between elevation 1,000 and elevation 1,030 feet above mean sea level as provided in Article 1 hereof; provided that the Sponsors shall have complied with the provisions herein of this contract; and provided further that any payments by the Sponsors during the renewal period shall have been mutually agreed to by the parties hereto. In computing such payments due consideration will be given to the payments which have been made by the Sponsors during the basic period of this contract and any subsequent prior renewal period, and the estimated costs to be incurred by the Government during the renewal period which are properly chargeable to the use of water supply storage space by the Sponsors, in accordance with the provisions of the Water Supply Act of 1958.

ARTICLE 7. DEFAULT - In the event the Sponsors refuse or fail to comply with the provisions of this contract with respect to payments and transfer and assignment, the Government reserves the right to terminate this contract.

REPAYMENT SCHEDULE A - W. KERR SCOTT RESERVOIR

	Total Payment	Applicable to Interest at 2.699% on unpaid bal.	Principal	Balance of Capital Cost Remaining at End of Year
1/1/1973	$36,656	$26,977	$ 9,679	$989,833
" 1974	"	26,716	9,940	979,893
" 1975	"	26,447	10,209	969,684
" 1976	"	26,172	10,484	959,200
" 1977	"	25,889	10,767	948,433
" 1978	"	25,598	11,058	937,375
" 1979	"	25,300	11,356	926,019
" 1980	"	24,993	11,663	914,356
" 1981	"	24,678	11,978	902,378
" 1982	"	24,355	12,301	890,077
" 1983	"	24,023	12,633	877,444
" 1984	"	23,682	12,974	864,470
" 1985	"	23,332	13,324	851,146
" 1986	"	22,972	13,684	837,462
" 1987	"	22,603	14,053	823,409
" 1988	"	22,224	14,432	808,977
" 1989	"	21,834	14,822	794,155
" 1990	"	21,434	15,222	778,933
" 1991	"	21,023	15,633	763,300
" 1992	"	20,601	16,055	747,245
" 1993	"	20,168	16,488	730,757
" 1994	"	19,723	16,933	713,824
" 1995	"	19,266	17,390	696,434
" 1996	"	18,797	17,859	678,575
" 1997	"	18,315	18,341	660,234
" 1998	"	17,820	18,836	641,398
" 1999	"	17,311	19,345	622,053
" 2000	"	16,789	19,867	602,186
" 2001	"	16,253	20,403	581,783
" 2002	"	15,702	20,954	560,829
" 2003	"	15,137	21,519	539,310
" 2004	"	14,556	22,100	517,210
" 2005	"	13,959	22,697	494,513
" 2006	"	13,347	23,309	471,204
" 2007	"	12,718	23,938	447,266
" 2008	"	12,072	24,584	422,682
" 2009	"	11,408	25,248	397,434
" 2010	"	10,727	25,929	371,505
" 2011	"	10,027	26,629	344,876
" 2012	"	9,308	27,348	317,528
" 2013	"	8,570	28,086	289,442
" 2014	"	7,812	28,844	260,598
" 2015	"	7,034	29,622	230,976
" 2016	"	6,234	30,422	200,554
" 2017	"	5,413	31,243	169,311
" 2018	"	4,570	32,086	137,225
" 2019	"	3,704	32,952	104,273
" 2020	"	2,814	33,842	70,431
" 2021	36,656	1,901	34,755	35,676
" 2022	36,639	963	35,676	0

RESOLUTION OF BOARD OF ALDERMEN OF THE CITY OF WINSTON-SALEM AND BOARD OF COMMISSIONERS OF WILKES COUNTY RE CONTRACT BETWEEN LOCAL INTEREST SPONSORS (CITY OF WINSTON-SALEM AND WILKES COUNTY) AND THE UNITED STATES OF AMERICA FOR WATER STORAGE SPACE IN WILKESBORO RESERVOIR.

WHEREAS, the Board of Aldermen of the City of Winston-Salem and the Board of Commissioners of Wilkes County, in joint session assembled on December 21, 1959, adopted a resolution authorizing execution of an agreement between the City of Winston-Salem and Wilkes County as Local Interest Sponsors on the one part and the United States of America on the other part for the construction of water storage space in the Wilkesboro reservoir to be constructed by the United States of America on the Yadkin River, which resolution provided in part that the form of the contract between the Local Interest Sponsors and the United States of America should be substantially as set forth in the draft attached to the resolution; and

WHEREAS, the Local Interest Sponsors have been advised that the form of contract attached to the aforesaid resolution was not approved by the Secretary of the Army, and the United States of America has now proposed that the percentages and amounts set forth in Article 5 of the contract and in Repayment Schedule A thereof be revised to conform with the Government's most recent engineering and cost data with respect to the Project, and that Article 6, relating to the period of the contract be amended to read as set forth in the form of contract attached to this resolution, marked "Exhibit A"; and

WHEREAS, the form of contract attached to this resolution is acceptable to the Local Interest Sponsors;

NOW, THEREFORE, BE IT RESOLVED by the Board of Aldermen of the City of Winston-Salem, North Carolina, and the Board of Commissioners of Wilkes County, North Carolina, in joint session duly assembled, that the form of contract attached to this resolution, marked "Exhibit A", entitled "Contract Between the United States of America and the County of Wilkes, N. C., and the City of Winston-Salem, N. C. for Water Storage Space in Wilkesboro Reservoir" be and the same is hereby approved, and the Mayor and Secretary of the City of Winston-Salem are hereby authorized to execute said contract in the name and on behalf of the City of Winston-Salem, and the members of the Board of Commissioners of Wilkes County and the Secretary to said Board are hereby authorized to execute said contract in the name and on behalf of the County of Wilkes.