39. Residential locations, by city and county, of full-time WCGS employees.

~~NO THE~~
~~NO DATA~~ DH 4/20/07

- Residential locations, by city and county, of full-time WCGS employees.
- Approximate on-site land area used by major structures and facilities, in square feet.
- Information on plant noise and what can be heard at the site boundaries.
- Records of public water usage by WCGS (e.g., water bills from City of Burlington).
- Federal lands and Native American lands in the area.
- Information regarding the source of the water Public Wholesale District 12 and the City of Burlington distribute as potable water.

Hooper Diane M

From: Dale Julie A
Sent: Monday, March 19, 2007 3:14 PM
To: Hooper Diane M
Subject: City/County

Diane - Attached is the info you requested. Thanks, Julie

County1.xls

City	#
Americus	1
Auburn	1
Burlingame	1
Centerville	1
Eskridge	1
Fort Scott	1
Lane	1
Moran	1
Neosho	1
Neosho Falls	1
North Bethesda	1
Overbrook	1
Paola	1
Quenemo	1
Shawnee	1
Wakarusa	1
Welda	1
Wellsville	1
Berryton	2
Chanute	2
Kincaid	2
Lawrence	2
Richmond	2
Parker	3
Princeton	3
Wichita	3
Williamsburg	3
Carbondale	4
Scranton	4
Colony	5
Madison	5
Neosho Rapids	5
Vassar	5
Iola	6
Olpe	7
Pomona	7
Reading	7
Olathe	8
Osage City	10
Overland Park	10
Hartford	12
Lyndon	14
Melvern	14
Yates Center	14
Westphalia	16
Gridley	19
Topeka	22
Le Roy	34
Garnett	38
Ottawa	50
Lebo	56

County	#
Neosho	1
Wabaunsee	1
Bourbon	1
Erie	1
Bethesda, MD	1
Douglas	2
Miami	2
Sedgwick	3
Linn	4
Greenwood	5
Allen	8
Woodson	15
Johnson	19
Shawnee	26
Osage	54
Anderson	61
Franklin	66
Lyon	162
Coffey	519

New Strawn	61
Waverly	75
Emporia	130
Burlington	273

41. Information on plant noise and what can be heard at the site boundaries.

NOTAB
NO DATA

- Residential locations, by city and county, of full-time WCGS employees.
- Approximate on-site land area used by major structures and facilities, in square feet.
- Information on plant noise and what can be heard at the site boundaries.
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- Federal lands and Native American lands in the area.
- Information regarding the source of the water Public Wholesale District 12 and the City of Burlington distribute as potable water.

ON-SITE LAND AREA

WCGS occupies 9,818 acres. The acreage beyond the site property is leased as farmland and rangeland. The site buildings and adjacent areas comprise 135 acres, and the WCGS cooling pond (Coffey County Lake) occupies 5,090 acres plus 60 acres for the dam and dikes. The site also includes a 31-acre pond originally constructed primarily to receive lime sludge. Buildings on the property include the reactor containment building, turbine building, auxiliary building, control building, fuel handling facility, switchyard, radioactive waste building, training center, visitor's center (includes Emergency Operations Facility and the simulator), outdoor firing range, and other supporting buildings.

The surrounding area is mostly flat to gently rolling landscape with occasional sedimentary rock outcroppings. Maximum topographic relief is 100 feet or less from the uplands to the valley floors. The land is primarily used for rangeland and farmland, with occasional woodland in river and creek bottoms. The rangeland is mostly native and tame (introduced) grass, brush, and managed pastures.

The Wolf Creek Environmental Education Area is an approximately 500-acre nature area accessible from 17th Road near the north end of the site property. It consists of five trails that guide the visitor through a variety of natural Kansas habitats, including native tall grass, woodlands, and wetlands. Added to the natural areas are shelterbelts, planted trees, restored native grasses, developed wetlands, and planted winter food plots for wildlife. The area is the result of a partnership between private citizens, civic organizations, local, state, and federal governments, and the WCGS owners.

ON-SITE STRUCTURES

Given the flat nature of the viewscape, the WCGS containment building is a prominent feature of the area. The structure is approximately two hundred and thirty four foot high. Interconnecting structures include the fuel building, control building, auxiliary building, diesel generator building, and the turbine building.

The turbine building is a horizontal structure with a lower profile than the reactor building. Its steel structure has metal siding and is approximately one hundred and fifty foot high.

The radwaste building is located nearby, facing the fuel building. Also included among the power block structures are the condensate storage tank, refueling water storage tank, reactor makeup water storage tank, dematerialized water tank, emergency fuel oil storage tanks, and several transformers vaults.

Railroad sidings are installed to serve the fuel and turbine buildings. The main access railroad leads into the site from the north and branches into several spurs, which provide access to the outlying structures and encircle the principal building complex.

The major non-power block structures include the administrative building, general office building, Technical Support Center, switchyard, shop building, security building, sewage treatment plant, warehouse, circulating water pumphouse, circulating water discharge structure, meteorological tower, and the essential service water pumphouse. Also located around the site complex are several storage tanks and small buildings for storage of acid, compressed gasses, water and fuel oil.

The Emergency Operations Facility, Simulator, Visitors Center complex is located about 2 and 3/4 miles northwest of the station.

The upper part of the station is visible from U.S. Highway 75, which is 2-¾ miles west. The station is also visible from a number of local roads, some of which pass within 1-½ miles. Most other structures are low-visibility structures that do not appreciably change the skyline of the station.

PLANT NOISE

Noise measurements are not available for the WCGS site. However, noise generated by WCGS operations is mitigated at the nearest receptor because the plant is buffered by undeveloped rangeland and the cooling lake. Most equipment is located within the plant buildings further reducing off-site noise levels.

Higher noise levels are created when testing on-site alarms and off-site warning sirens.

42. Records of public water usage by WCGS (e.g., water bills from City of Burlington).

- Residential locations, by city and county, of full-time WCGS employees.
- Approximate on-site land area used by major structures and facilities, in square feet.
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WCNOC Water Consumption Report Feb.06 - Jan.07

	Actual Consumption (gal.)	Daily Average (gal.)
Feb-06	470000	14687.5
Mar-06	626000	22357.1
Apr-06	714000	21636.4
May-06	780000	26000
Jun-06	910000	29354.8
Jul-06	720000	24000
Aug-06	591000	11820
Sep-06	794500	26483.3
Oct-06	765000	25500
Nov-06	1582000	51032.3
Dec-06	190000	6333.3
Jan-07	533000	17193.5
	8675500	276398.2

Water meters are read by the 20th of each month.
This report only shows information for meter 120 which is the main line running into Wolf Creek.
Wolf Creek does have 6 other water meters that service the:
EOF, Learning Center, Nature Trail, Lake Access and the North and South residents.
A water leak was identified in Mar-06 and repaired in Oct-06 with an estimated leak rate of 10 gpm.

Coffey County Rural Water District #3,
New Strawn

43. Federal lands and Native American lands in the area.

- Residential locations, by city and county, of full-time WCGS employees.
- Approximate on-site land area used by major structures and facilities, in square feet.
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- Records of public water usage by WCGS (e.g., water bills from City of Burlington).
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nationalatlas.gov™ Where We Are

KANSAS

FEDERAL LANDS AND INDIAN RESERVATIONS

- Bureau of Indian Affairs
- Bureau of Reclamation
- Department of Defense (includes Army Corps of Engineers lakes)
- Fish and Wildlife Service / Wilderness
- Forest Service / Wilderness
- National Park Service / Wilderness

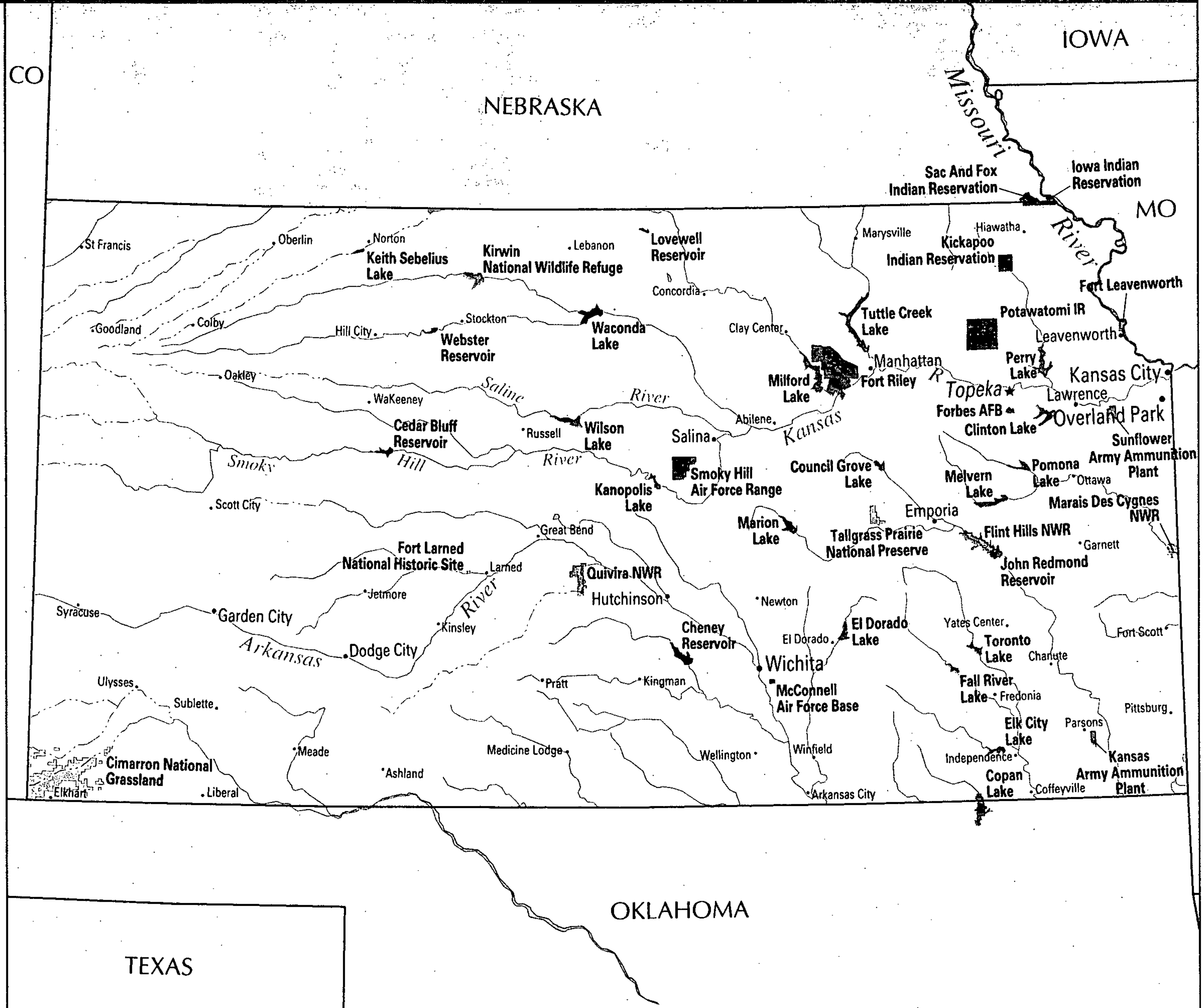
Some small sites are not shown, especially in urban areas.

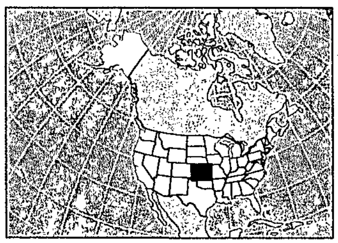
MILES
0 20 40 60 80

Albers equal area projection

Abbreviations

AFB	Air Force Base
IR	Indian Reservation
NWR	National Wildlife Refuge





U.S. Department of the Interior
U.S. Geological Survey

The National Atlas of the United States of America®

pagefed_ks6.pdf INTERIOR-GEOLOGICAL SURVEY, RESTON, VIRGINIA-2003

44. Information regarding the source of the water Public Wholesale District 12 and the City of Burlington distribute as potable water.

- Residential locations, by city and county, of full-time WCGS employees.
- Approximate on-site land area used by major structures and facilities, in square feet.
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Public Wholesale Water Supply District Status

Public Wholesale Water Supply District	Date Formed	Water Source	Status
PWWSD #1 Edgerton Gardner Spring Hill Johnson Co. RWDs 1, 2, 3, 5, 6, 6-A, 7	8/15/77	None	Dissolved – 1983
PWWSD #2 Melvern Waverly (AN Co. RWD 4 & OS Co. RWD 4)	5/1/78	None	Dissolved – Mid 1980s Revived in 1989 as PWWSD #12 with expanded membership.
PWWSD #3 Garnett Anderson Co. RWDs 2, 4, 6	9/1/78	None	Inactive – Garnett built lake and sells to AN Co. RWDs 4 & 6
PWWSD #4 Altamont Bartlett Cherryvale Edna Mound Valley Parsons Labette Co. RWDs 2, 3, 5, 7, 8 Montgomery Co. RWDs 2, 4, 6, 12 Neosho-Labette Co. RWD 4	9/30/80	Big Hill Lake—KWO Water Marketing Contract	Active – Water production for members since 1985
PWWSD #5 Colony La Harpe Moran Walnut Allen Co. RWDs 4, 6, 8, 16 Anderson Co. RWD 5 Bourbon Co. RWD 2C Neosho-Allen Co. RWD 2	9/16/80	Neosho River—Cottonwood/Neosho Assurance District	Active – Water production for members since 1985 with a water treatment plant near the Neosho River
PWWSD #6 Tonganoxie Leavenworth Co. RWDs 6 & 9	5/21/82	Bonner Springs	Active – Supplies water to members through a water purchase contract with Bonner Springs
PWWSD #7 Sedgwick Co. Sedgwick Fire District #1	12/22/82	Unknown	Unknown
PWWSD #8 Butler Co. RWD 3 State Park at El Dorado Lake	7/26/82	City of El Dorado	Active – Supplies water to members through a water purchase contract with El Dorado
PWWSD #9 Gridley Hamilton Virgil Greenwood Co. RWD 3	7/1/85	None	Inactive – Gridley and Hamilton purchase from Burlington and Madison, respectively and Virgil connected to Wilson RWD 9
PWWSD #10 Abilene, McPherson BelAire, Moundridge Chapman, Newton Halstead, Park City Hesston, Salina Hutchinson, Sedgwick Lindsborg, Valley Center Wichita	10/7/88	None	Inactive – District originally considered Milford Lake as a possible source of water supply with a pipeline for members to connect to along a route from Milford to Wichita. Members have since pursued other options to address water supply needs.

Public Wholesale Water Supply District	Date Formed	Water Source	Status
PWWSD #11 Arcadia Arma Cherokee Chicopee Columbus Girard Mulberry Weir West Mineral Cherokee RWD 6 (not a voting member) Crawford Co. RWD 2 & 6	4/10/89	Bone Creek MPSL	Active – Water production for members since March 2000 with a water treatment plant near Bone Creek Lake
PWWSD #12 Lebo Lyndon Melvern Pomona Quenemo Waverly Williamsburg Anderson Co. RWD 4 Coffey Co. RWD 3 Osage Co. RWD 4	9/11/89	Melvern Lake – KWO Marketing Contract	Active – Water production for members since 1995 with a treatment plant near Melvern Lake. Possible addition of Franklin Co. RWD #4, Anderson Co. RWD #3 and City of Richmond contingent upon funding from USDA Rural Development.
PWWSD #13 Amoret, MO Blue Mound Fulton Greeley Hume, MO Mound City Parker Anderson Co. RWD 1C (2&6) Bourbon Co. RWD 2C Linn Co. RWD 1, 2 & 3	1/4/94	Critzer Dam MPSL (Little Sugar Creek)	Under Construction – District secured funding for construction of MPSL through the State Conservation Commission and funding from USDA Rural Development for the treatment plant and distribution system. Construction started in the Summer 2005 with an estimated completion of Fall/Winter 2006.
PWWSD #14 Kechi Valley Center Butler Co. RWD 7 Sedgwick Co. RWDs 1 & 2	2/1/94	Unknown	Unknown
PWWSD #15 Hays Russell	2/22/96	Unknown	Under Development – District is identifying and evaluating potential sources of water. The treatment and distribution system will be determined based upon the source selected.
PWWSD #16 Douglas Co. RWDs 4 & 5	2/13/97	Clinton Lake	Inactive – District formed to explore the feasibility of building a water treatment plant at Clinton Lake to meet the growing demands on their systems due to rapid growth in rural Douglas County. RWDs opted for other alternatives.
PWWSD #17 Halstead Newton North Newton Sedgwick	2/4/97	Wells	Active – Water production for members since February 2001 from 4 wells in Harvey Co.
PWWSD #18 Holton Jackson Co. RWD 3	9/15/97	Banner Creek MPSL	Active – Construction of MPSL and treatment plant completed. Water Production for members since 2003.

Public Wholesale Water Supply District	Date Formed	Water Source	Status
PWWSD #19 Baxter Springs Columbus Galena Riverton (CK Co. RWD 9) Scammon Cherokee Co. RWDs 1, 2, 3, 7	2/16/98	Spring River	Under Development – District is exploring options for funding.
PWWSD #20 Cedar Vale Chautauqua Grenola Peru Sedan Chautauqua Co. RWDs 1, 2, 3, 4 Montgomery Co. RWD 5	7/24/98	Quivera Boy Scout Lake	Active – Phase I completed, water service commenced February 2006 to Sedan, Chautauqua, Chautauqua RWDs #1 & #3 and Peru. Phase II funded by USDA Rural Development with construction scheduled to begin Spring/Summer 2006.
PWWSD #21 Holton Horton Marysville McLouth Nortonville Oskaloosa Sabetha Seneca Valley Falls Winchester Atchison Co RWD 4 Jackson Co RWDs 1, 3 Jefferson Co. RWDs 1, 3, 9, 12 Nemaha Co. RWDs 3, 4 Pottawatomie Co. RWD 2 Shawnee Co. RWD 4	7/5/00	Unknown	Under Development – District cooperated with the Kickapoo Tribe, the Kansas Water Office and the U.S. Army Corps of Engineers on a Northeast Kansas regional public water supply study. Sources of water considered include the Missouri River, Perry Lake, Tuttle Creek Lake and a proposed MPSL on the Kickapoo Reservation. The district continues to explore options for regional cooperation. Some members are pursuing alternatives separately.
PWWSD #22 Derby Mulvane Sedgwick Co. RWD 3	8/1/00	Unknown	Inactive – District was formed to explore water supply options. Members are pursuing alternatives separately.
PWWSD #23 Altoona Buffalo Fredonia Neodesha Thayer Montgomery Co. RWDs 9, 12 Neosho-Labette Co. RWD 4 Neosho Co. RWDs 6, 7, 9, 12 Wilson Co. RWDs 1, 2, 5, 7, 10, 11, 13 Woodson Co. RWD 1	10/12/00	~~Big Hill Lake – KWO Water Marketing Contract~~ Fall River via Fredonia Intake & water rights (additional water right must be secured).	Under Development – District received funding for design and construction from USDA Rural Development. District is working with engineer to develop final plans and specs for upgrade of Fredonia treatment plant and the distribution system.
PWWSD #24 Elk City Howard Longton Moline Severy Elk Co. RWD #2	11/10/2003	Unknown	Under Development—District received funding under KDHE's PWS Regional Supply Grant Program to conduct a preliminary engineering study. The study indicated the best alternative was a connection/consolidation with PWWSD #20. An agreement has not been finalized between PWWSD #24 & 20.

CITY OF BURLINGTON, KANSAS

CAPITAL IMPROVEMENT PROJECTS/UTILITIES

LANDFILL: - COFFEY COUNTY LANDFILL

Location: 1498 12th Lane SE; Burlington, Kansas
Mailing Address:
Coffey County Engineer
110 S. 6th Street; Room 5
Burlington, KS 66839
Phone: (620)364-2048 or 800-232-9423 / FAX 620-364-5192
Hours: Monday - Friday 8:30 a.m. to 4:30 p.m.
1st & 3rd Saturday of Month: 8:30 a.m. - 4:30 p.m.

THE COFFEY COUNTY SANITARY LANDFILL, owned and operated by Coffey County, is approximately one mile northeast of Burlington. All solid waste is brought to the existing landfill from six incorporated communities by commercial haulers and from rural areas by individual residents. As of 1996, permitted area occupies approximately 40 acres, and receives approximately 15,000 cubic yards of waste per year.

In December 2001, Coffey County the new Coffey County Landfill was officially opened with a ribbon cutting ceremony. The first six cells of the new Landfill were completed at an estimated cost of $1,000,000 and has a life expectancy of more than forty years. Although this phase of the project is completed, this is an on-going project.

Ordinance 606 approves a special use to establish the following: limestone mining, crushing, stockpiling; temporary production of asphalt concrete; facilities for noxious weeds, household hazardous waste, recycling collection, waste tire monofill reduction and shredding, composting site; a solid waste management office, truck scales, scale house, groundwater monitoring wells, methane monitoring wells, lechate collection and treatment, storage of specialized Highway Department equipment and materials, and other used accessory to solid waste management operations in the I-2 Heavy Industrial District.

NOTE: Household Hazardous waste should be taken to the Coffey County Noxious Weed Department which is located next to the Coffey County Recycling Center. Tires: In 2004, Coffey County Landfill began charging a fee for tire disposal.

COFFEY COUNTY SANITARY LANDFILL RATES
K.D.H.E. Permit No. 297

Effective January 1, 2005

[Call 620-2048 for further information.]

All loads must be tarped or properly secured and all household waste, paper, and burned material must be bagged.	
PASSENGER CAR	$ 2.50 per load
Solid Waste (In County)	$15.00 per ton ($5.00 minimum)
Solid Waste (Out of County)	$23.00 per ton ($7.50 minimum)
TIRES	
Passenger Car Tires	$ 1.00 each
Passenger Car Tires on Rim	$ 2.00 each
Truck Tires	$ 5.00 each
Truck Tires on Rim	$10.00 each
Rear Tractor Tires	$15.00 each
Off-road Tires	$30.00 each
PERMITTED SPECIAL WASTE	[KDHE Permit Required]
55 Gallon Barrel	$15.00 each
5 Gallon Barrel	$ 6.25 each
IN County	$15.00 per ton [$5 minimum]
OUT of County	$23.00 per ton [$7.50 minimum]
CONSTRUCTION/DEMOLITION WASTE	Call: 620-364-2048
IN County	$12.50 per ton [$5 minimum]
OUT of County	$20.50 per ton [$7.50 minimum]

RECYCLING CENTERS:

COFFEY COUNTY RECYCLING CENTER	
Telephone: (620)364-8409	
Hours:	
Monday, Tuesday, Thursday and Friday	7:30 a.m. to 4:00 p.m.
Wednesdays	7:30 a.m. to 8:00 p.m.
Saturdays (1st & 3rd Sat. of month)	8:00 a.m. to noon
Location: 1432 12th Lane SE - Go east on Neosho Street out of Burlington; follow the signs. The Recycling Center is about a quarter of a mile west of the Coffey County Landfill. For more information on the Recycling Center and on disposal of household hazardous waste, contact the Coffey County Noxious Weed Department.	
CURBSIDE RECYCLING	
CALL THE RECYCLING CENTER FOR INFORMATION	

RECYCLING TRANSFER CENTER **Metals and Metal Appliances**	

Telephone	620-364-2151 [Hosford's]
Hours	Monday - Friday 9:00 a.m. to 3:00 p.m.
Location	East of Burlington - CALL FOR PICKUP

STREET DEPARTMENT:

Doug Mast, Street Superintendent
P.O. Box 207; 901 South 10th
Burlington, KS 66839

Phone: (620)364-2703/FAX: (620)364-2996
Email: burlstreets@mchsi.com

Burlington has a total of 515.5 blocks of streets totaling 42.95 miles. This does not include a new housing development, development of Commerce Park, or the three industrial parks. There are no natural streets, 57 rock streets, 312 chip & seal (cold mix) streets, 75 hot mix streets, and 16 concrete streets in the City. (See also: "City Departments/Services")

WATER/WASTEWATER DEPARTMENT

Dennis Smith, Water/Wastewater Superintendent
P.O. Box 207; 101 E. Miami St.; Burlington, KS 66839

Phone: (620)364-8332/FAX: (620)364-2996
Email: h2oburlington@mchsi.com

See also: "City Departments/Services", and
"Transportation/Industry/Economic Development", "Utilities"

WATER:

The City of Burlington not only supplies water to residents and business within the city limits, but also to Industrial Parks #1, #2, #3, and #4 just south of the city on U.S. Highway 75. The city also supplies water to Rural Water District No. 2, Rural Water District No. 3, the City of Gridley, the City of LeRoy, and the City of New Strawn.

Water Statistics	
Supplier	City of Burlington
Source	Neosho River
Capacity of Water Plant:	1,500 gal per minute. 2.1 MGD
Average Consumption	600,000 gal/day
Peak Demand:	1,200,000 gal/day 1.2 MGD
Storage Capacity	450,000 gal

http://skyways.lib.ks.us/kansas/towns/Burlington/capital.html

WASTEWATER/SEWER:

The sewage collection system for the City of Burlington has developed along with the expanding population to serve the residential and business activities. The system consists largely of 8" gravity lines, however, there are a few 10" and 12" mains in the critical areas. The main lift station, located near Second Street and St. Lawrence Street, pumps directly to the sewage treatment plant. There are seven smaller lift stations located throughout the City, one of which also pumps directly to the sewage treatment plant.

Sewer Lagoons - The City of Burlington has recently built new sewer lagoons on approximately 59.74 acres south of Burlington and east of Highway 75.

Email: *sburlington@mchsi.com*

46. Examples of the implementation of these policies and procedures during past ground surface disturbing activities.

• WCNOC policies and procedures concerning the identification and documentation of cultural resources in advance of ground surface disturbing activities.

• Examples of the implementation of these policies and procedures during past ground surface disturbing activities.

46

WOLF CREEK
NUCLEAR OPERATING CORPORATION

AI 07-002

EPP PLANT DESIGN OR OPERATIONAL CHANGE EVALUATION

Responsible Manager

Manager Regulatory Affairs

Revision Number	3
Use Category	Reference
Administrative Controls Procedure	No
Management Oversight Evolution	No
Program Number	07

DC38 8/4/2006

TABLE OF CONTENTS

1.0 PURPOSE

1.1 This document provides methods to determine and document whether plant design or operational changes constitute an unreviewed environmental question according to criteria in the Environmental Protection Plan (EPP).

2.0 SCOPE

2.1 Anticipated plant design or operational changes with potential environmental impact identified in accordance with AI 26A-003, REGULATORY EVALUATIONS (OTHER THAN 10 CFR 50.59) shall be evaluated in accordance with this procedure.

2.2 Unanticipated operational events may be evaluated in accordance with this procedure.

3.0 REFERENCES AND COMMITMENTS

3.1 References

3.1.1 Title 10 Code of Federal Regulations Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions

3.1.2 U.S. Nuclear Regulatory Commission NRR Office Instruction LIC-203, "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues", June 21, 2001.

3.1.3 Updated Safety Analysis Report (USAR)

3.1.4 Appendix B to Facility Operating License No. NPF-42, Environmental Protection Plan (Nonradiological)(EPP)

3.1.5 NUREG-0878, Final Environmental Statement related to the operation of Wolf Creek Generating Station, Unit No. 1 (FES-OLS)

3.1.6 NUREG-75/096, Final Environmental Statement related to the construction of Wolf Creek Generating Station, Unit 1 (FES-CP)

3.1.7 Wolf Creek Generating Station Environmental Report - Operating License Stage (ER-OLS)

3.1.8 Wolf Creek Generating Station Environmental Report - Construction Permit Stage (ER-CP)

3.1.9 AP 15A-003, RECORDS

3.1.10 AP 07-002, ENVIRONMENTAL PROTECTION PROGRAM

3.1.11 AP 26A-004, COMMUNICATIONS WITH THE NUCLEAR REGULATORY COMMISSION (NRC)

3.1.12 AP 26B-001, REVISIONS TO THE OPERATING LICENSE AND/OR TECHNICAL SPECIFICATIONS

3.1.13 AI 26A-003, REGULATORY EVALUATIONS (OTHER THAN 10 CFR 50.59)

3.2 Commitments

3.2.1 None

4.0 DEFINITIONS

4.1 Cultural Resources

4.1.1 Means areas, sites, buildings, structures, and objects significant in American history, architecture, archeology, engineering and culture.

4.2 On-site Area

4.2.1 For the purposes of EPP evaluation, an on-site area is that property within the Owner Controlled Area.

4.3 Owner Controlled Area

4.3.1 Property contiguous to the reactor site and acquired by fee title or easement for Wolf Creek Generating Station. This includes the 9,818 acres occupied by the site. (Reference 3.1.3 section 2.1.1.2)

4.4 Site Preparation

4.4.1 Any on-site area ground-disturbing activity including but are not limited to, clearing and grubbing, plowing, excavating, digging and trenching, post driving or pole erection.

4.5 Unreviewed Environmental Question

4.5.1 A proposed change, test or experiment which may result in one or more of the following:

1. a significant increase in an adverse environmental impact previously evaluated by the NRC,

2. a significant change in effluents or power level,

3. a matter not previously reviewed and evaluated by the NRC which may have significant adverse environmental impact,

4. The following **exceptions** apply to this definition.

   a. a change, test, or experiment with measurable nonradiological environmental effects confined to an on-site area previously disturbed during site preparation for plant construction,

   b. a change required by other Federal, State, and local environmental regulations.

5.0 RESPONSIBILITIES

5.1 Supervisor Regulatory Support

5.1.1 Ensures preparation of design and operational change evaluations for design packages received from other WCNOC personnel.

5.1.2 Ensures participation of appropriate organizational disciplines in preparation of evaluations.

5.1.3 Ensures resolution of comments generated as part of the evaluation review process.

5.1.4 Obtains concurrence from the Manager Regulatory Affairs when an evaluation indicates that a change involves an unreviewed environmental question, reduces the effectiveness of the EPP, or an EPP change is required.

5.2 Environmental Management

5.2.1 Prepares evaluations as directed by the supervisor.

6.0 PROCEDURE

6.1 Design or operational changes that require evaluation for a potential unreviewed environmental question may be initiated from any source, but will typically be initiated by AI 26A-003, REGULATORY EVALUATIONS (OTHER THAN 10 CFR 50.59).

6.2 Upon receipt of a design or operational change determined to possibly involve an unreviewed environmental question, Form AIF 07-002-01, EPP PLANT DESIGN OR OPERATIONAL CHANGE EVALUATION shall be completed by Environmental Management. The evaluator shall:

6.2.1 Log the sequential EPP evaluation number and enter the number on the evaluation form,

6.2.2 Identify applicable change package references,

6.2.3 Provide a summary of the change,

6.2.4 Provide a justification for each yes or no answer for documentation purposes,

6.2.5 Include source documents including section, subsection and topics which define the level of environmental impact previously evaluated by the NRC pertinent to the change (i.e., References ER-CP, FES-CP, ER-OLS and FES-OLS).

6.3 IF an evaluation is required, THEN Form AIF 07-002-01 should be attached to a completed Form AIF 26A-003-01.

NOTE

Question 2.B on Form AIF 07-002-01 should be interpreted to mean only changes mandated by a regulatory authority. Changes made by design or operational choice will not be considered as necessary to achieve compliance with other environmental regulations, and therefore will require an unreviewed environmental question determination.

6.4 IF either questions 2.A OR 2.B on Form AIF 07-002-01 are answered yes, THEN an unreviewed environmental question determination is not required. Section 3 on Form AIF 007-002-01 can be skipped.

6.5 IF the change involves an unreviewed environmental question, THEN prior NRC approval is required and shall be acquired in accordance with EPP Section 3.1 and AP 26A-004, COMMUNICATIONS WITH THE NUCLEAR REGULATORY COMMISSION (NRC).

6.5.1 IF any of questions 3.A, 3.B, or 3.C on Form AIF 07-002-01 are answered yes, THEN an unreviewed environmental question exists.

6.5.2 IF review by Environmental Management indicates that an unreviewed environmental question may exist, THEN concurrence from the Manager Regulatory Affairs is required.

6.6 IF the change decreases the effectiveness of OR requires a change to the EPP, THEN an EPP change request shall be submitted to the NRC in accordance with EPP Section 5.3, AP 26A-004, COMMUNICATIONS WITH THE NUCLEAR REGULATORY COMMISSION (NRC) and AP 26B-001, REVISIONS TO THE OPERATING LICENSE AND/OR TECHNICAL SPECIFICATIONS.

6.6.1 IF questions 4.A, or 5.A on Form AIF 07-002-01 are answered yes, a decrease in the EPP effectiveness OR a change to the EPP exists.

6.6.2 IF review by Environmental Management indicates that the change reduces the effectiveness of the EPP, OR requires an EPP change, THEN concurrence from the Manager Regulatory Affairs is required.

NOTE

The NRC staff concluded in NUREG-0878 that operation of the station will not result in any significant impact on cultural resources in the on-site area as there are none presently known. (Reference 3.1.5 section 5.7).

6.7 IF question 6.A on Form AIF 07-002-01 is answered yes, THEN the change involves site preparation activities that have the potential to discover cultural resources.

6.7.1 IF cultural resources are discovered during site preparation, THEN all activity within a 50-foot radius of the discovery will cease AND Environmental Management will be immediately notified.

1. IF cultural resources are confirmed, THEN Environmental Management will notify the Manager Regulatory Affairs.

    a. The NRC will be notified in accordance with AP 07-002, ENVIRONMENTAL PROTECTION PROGRAM.

    b. The State Historic Preservation Officer (SHPO) at the Kansas State Historical Society will be notified by Environmental Management to evaluate the newly discovered cultural resources.

2. Confirmed cultural resources shall not be disturbed without prior concurrence from the SHPO.

7.0 RECORDS

7.1 The following QA records are generated by this procedure:

7.1.1 Completed EPP Plant Design Or Operational Change Evaluation Forms (AIF 07-002-01).

8.0 FORMS

8.1 AIF 07-002-01, EPP Plant Design Or Operational Change Evaluation

- END -

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EPP PLANT DESIGN OR OPERATIONAL CHANGE EVALUATION

No.__________

1. GENERAL SUMMARY:

Document Number ______________________________ Rev ____________

Summary of Design or Operational Change:

2. EXCLUSIONS:

IF either questions 2.A OR 2.B listed below are answered yes, THEN an unreviewed environmental question determination is not required. Section 3 on this form can be skipped. Provide explanations complete with applicable source document references.

2.A. Are all measurable nonradiological environmental effects confined to the on-site areas previously disturbed during site preparation and plant construction?

Answer: Yes ☐ or No ☐

Explanation:

2.B. Is this design or operational change required to achieve compliance with other Federal, State, and local environmental regulations (EPP section 3.3)?

Answer: Yes ☐ or No ☐

Explanation:

EPP PLANT DESIGN OR OPERATIONAL CHANGE EVALUATION

3. UNREVIEWED ENVIRONMENTAL QUESTION DETERMINATION:

An environmental question must meet one or more of the following criteria to be classified as unreviewed. Provide explanations complete with applicable source document references.

3.A. Does this change constitute a matter, which results in a significant increase in any adverse environmental impact previously evaluated by NRC?

Answer: Yes ☐ or No ☐

Explanation:

3.B. Will this change constitute a significant change in effluents or power level?

Answer: Yes ☐ or No ☐

Explanation:

3.C. Will this change constitute a matter not previously reviewed and evaluated in licensing documents, which results in a significant adverse environmental impact?

Answer: Yes ☐ or No ☐

Explanation:

EPP PLANT DESIGN OR OPERATIONAL CHANGE EVALUATION

4. EPP EFFECTIVENESS:

4.A Does this design or operational change constitute a decrease in the effectiveness of the EPP in meeting its objectives?

Answer: Yes ☐ or No ☐

Explanation:

5. EPP CHANGE:

5.A Does this design or operational change necessitate an EPP change?

Answer: Yes ☐ or No ☐

Explanation:

6. CULTURAL RESOURCES IMPACT DETERMINATION:

6.A Does this change have the potential to discover cultural resources not previously reviewed and evaluated in licensing documents?

Answer: Yes ☐ or No ☐

NOTE: Previous evaluation indicates that impacts to cultural resources should not be expected (reference NUREG 0878, FES-OLS Section 5.7). If question 2.A. is answered yes, then it should be identified in applicable planning and work authorization documents that if any cultural resources are discovered during site preparation, work shall be stopped and Environmental Management contacted.

Explanation:

EPP PLANT DESIGN OR OPERATIONAL CHANGE EVALUATION

If this design or operational change has been determined to be unreviewed with significant environmental impact, reducing the effectiveness of the EPP, or constitute an EPP change, a written evaluation must be submitted to the NRC and approval received PRIOR to initiation of the change. Submittals shall be in accordance with AP 26A-004 and AP 26B-001.

Evaluation prepared by: ______________________________ / __________
Prepared by: Date

Supervisory approval: ______________________________ / __________
Supervisor Date

Manager approval: ______________________________ / __________
Manager Date

(Manager approval required only if the design or operational change involves an unreviewed environmental question, reduces the effectiveness of the EPP, or requires an EPP change.)

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WOLF CREEK
NUCLEAR OPERATING CORPORATION

Kevin J. Moles
Manager Regulatory Affairs

FEB 27 2004

RA 04-0026

Kansas Department of Health and Environment
Attention: Mr. Alan Brooks
Bureau of Water – Industrial Programs Section
1000 SW Jackson St., Suite 420
Topeka, Kansas 66612-1367

Subject: Notice of Intent for the Wolf Creek Generating Station Sediment Storage Site Project

Dear Mr. Brooks:

Please find enclosed with this letter a Notice of Intent (NOI) and a check for sixty dollars ($60.00) for a construction project that will start on June 1, 2004, at Wolf Creek Generating Station. Attachment 1.0 to this letter contains the Sediment Storage Site Project description. Also included on the attachment is the additional information required by the NOI for this construction project.

A stormwater pollution prevention (SWP2) plan has been developed for this construction project. Please contact Mr. Ralph Logsdon at (620) 364-8831, extension 4730, if you have any questions regarding this submittal.

Sincerely,

Kevin J. Moles

Kevin J. Moles

KJM/rll

Attachment

Enclosures

cc: Mr. Joe Mester, KDHE

See Attached Sheet for Instructions

NOTICE OF INTENT (NOI)
For Stormwater Runoff from Construction Activities
Authorized by a Kansas Water Pollution Control General Permit
Under the National Pollutant Discharge Elimination System

Submission of this Notice of Intent constitutes notice that the party identified in Section I of this form requests authorization for coverage under the Kansas Water Pollution Control general permit, or KDHE authorized successors, issued for stormwater runoff from construction activities in the State of Kansas. Becoming a permittee obligates the discharger to comply with the terms and conditions of the general permit. **Completion of this NOI does not provide automatic coverage under the general permit. Coverage is provided and discharge permitted when the Kansas Department of Health and Environment (KDHE) authorizes the NOI. A signed and dated copy of the authorized NOI will be provided to the owner or operator.** Upon authorization of the NOI, a Kansas permit number and a Federal permit number will be assigned to the construction project. ONLY COMPLETE APPLICATIONS ACCOMPANIED BY THE $60 ANNUAL PERMIT FEE WILL BE PROCESSED. KDHE WILL NOTIFY APPLICANTS WHOSE APPLICATIONS ARE INCOMPLETE, DEFICIENT, OR DENIED. **Please Print or Type**.

I. OWNER OR OPERATOR ADDRESS & RECORD LOCATION INFORMATION

Owner or Operator's Name: Wolf Creek Nuclear Operating Corporation
Company Name: WCNOC
Owner or Operator's Phone: (620) 364-8831
Mailing Address: P.O. Box 411
City: Burlington State: KS Zip Code: 66839

Owner's Contact Name: Kevin J. Moles
Company Name: KGE, KCPL, KEPCO
Contact Phone: (620) 364-8831
Mailing Address: P.O. Box 411
City: Burlington State: KS Zip Code: 66839

Will permit records be located on site? ☒ Y; ☐ N If not, provide an address where records will be kept:

Company Name: ______
Street Address: ______
City: ______ State: ___ Zip Code: ______

Mailing Address: ______
City: ______ State: ___ Zip Code: ______

II. SITE INFORMATION

A. LOCATION

Project Name: Sediment Storage Site
Street Address: 1550 Oxen Lane
City: Burlington State: KS Zip Code: 66839

On-Site Contact Name: Ron Traudt
Company Name: WCNOC
Contact Phone: (620) 364-8831
Mailing Address: P.O. Box 411
City: Burlington State: KS Zip Code: 66839

Physical Location: Wolf Creek Generating Station

___ QTR ___ QTR ___ QTR 5, 8 & 17 Section 21 Township South, 16 Range ☒ E; ☐ W; County: Coffey

For Official Use Only:

Received	Paid Date: Initials: Check No:	Authorized ☐ Y; ☐ N Reviewer
Secretary, Kansas Department of Health and Environment		Date
KS Permit No. S - _ _ _ _ - _ _ _ _ _	Federal Permit No. KS	

To receive a hard copy of the general permit information packet check yes: ☐ Y; ☐ N

B. EXISTING CONDITIONS/USES

Is any part of the project located on Indian lands? ☐ Y; ☒ N

If yes, contact EPA regarding discharging stormwater runoff from construction activities on Indian lands.

If site runoff goes into a Municipal Separate Storm Sewer System; Owner/Operator's Name: N/A

Name of the first receiving water; stream; or lake: Coffey County Lake River Basin: Neosho

Are there any known soil contamination areas which will be disturbed by the construction activity? ☐ Y; ☒ N

Are contaminated soils or hazardous wastes present on the site: ☐ Y; ☒ N

Are there any surface water intakes for public drinking water supplies located within ½ mile of the site discharge points? ☐ Y; ☒ N

Are there any known historical or archeological sites present within the site boundary? ☐ Y; ☒ N

Are any threatened or endangered species known to be present within the site boundary or in the receiving water body? ☐ Y; ☒ N

If yes, list species and describe habitat location in relation to project location:

Are any Critical Water Quality Management Areas, Special Aquatic Life Use Waters, or Outstanding National Resource Waters located within ½ mile of the site boundary? ☐ Y; ☒ N

C. PROJECT DESCRIPTION

Project Description: See Attachment 1.0

Anticipated Start Date: 6-1-04 and Completion Date: 12-31-08

Estimated area to be disturbed: 20 Acres Total area of the site: 500 Acres

Do you plan to disturb ten or more acres that are within a common drainage area? ☐ Y; ☒ N

If yes, will a sedimentation basin be installed in that drainage area? ☐ Y; ☒ N

If not, on a separate sheet, explain what similarly effective erosion and sediment control measures that will be implemented in lieu of a sedimentation basin.

D. EROSION CONTROL PLAN AND BEST MANAGEMENT PRACTICES

Attach a site plan showing the erosion control measures and the locations of stormwater management or pollution control features including BMPs. Incorporate details and notes as necessary to describe the erosion control plans and BMPs.

Attach a description of the best management practices which will be utilized to control erosion, sedimentation and other pollutants in stormwater runoff during construction. Include a description of applicable local erosion and sediment control requirements.

Describe the BMPs which will be permanent stormwater management or pollution control features. Include a description of applicable local stormwater pollution control requirements for permanent stormwater management features.

Summarize the sequence of major soil disturbing activities and the corresponding erosion control measures or BMPs.

E. AREA MAP

Attach a topographic map showing the project location and significant features in the surrounding area.

III. ANNUAL FEE

Enclose a check for the first year of the annual permit fee specified in K.A.R. 28-16-56 et seq. as amended. Make the check payable to "KDHE". Per K.A.R. 28-16-56, as amended, the current annual permit fee for this general permit is $60. An annual bill will be sent to the contact person requesting a permit fee until such time as the permit holder submits a Notice of Termination (NOT).

IV. APPLICANT CERTIFICATIONS

I, the undersigned, certify that a Stormwater Pollution Prevention Plan will be or has been developed for the construction site listed in Section II of this NOI. I further certify that the plan will be implemented at the time construction begins, and, as required by the NPDES general permit for Stormwater Runoff from Construction Activity, will revise the SWP2 plan if necessary.

I understand that continued coverage under the NPDES general permit for Stormwater Runoff from Construction Activities is contingent upon maintaining eligibility as provided for in the requirements and conditions of the general permit, and paying the annual fee.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility ~~of fine~~ and imprisonment for knowing violations.

Kevin J. Moles
Signature

02-27-2004
Date

Kevin J. Moles Manager Regulatory Affairs
Name and Official Title (Please Print)

Attachment 1.0

Wolf Creek Sediment Storage Site Project Description

Construct eight sediment storage sites for sediment that will be removed by dredging from Coffey County Lake ultimate heat sink (UHS). The purpose for dredging is to return the UHS to design specifications, which will ensure that, sufficient cooling water from the UHS can reach intake pumps. The UHS is an underwater reservoir within Coffey County Lake. It is required to provide cooling water for plant components if the main dam should fail. This dredging will remove approximately 125 acre-feet accumulated silt/sediment from the UHS by pumping the silt/sediment to eight sediment-settling sites located on upland areas adjacent to the UHS portion of Coffey County Lake over a four-year period of time. Further explanation is provided below for this construction activity in the next section.

Sediment Storage Sites

The sediment settling sites will be located on upland areas adjacent to the UHS portion of Coffey County Lake (CCL). Native grass areas were purposefully avoided if possible. Water control structure will be installed on each sediment pool. The discharge water velocity will be slowed to control erosion using riprap, or other suitable material. A minimum of two silt control structures (i.e. staked bales, silt curtains) will be installed in the discharge from each pool to prevent residual sediment from returning to CCL. A permanent grass cover will be established on all pool dikes and disturbed soil.

The attached aerial photo and topographic maps indicate sediment storage area locations. A brief description of each sediment site is described below:

Site 1:

This is an upland area previously disturbed by WCGS construction. Existing ground cover consists primarily of domestic grasses including tall fescue and smooth brome. Small osage orange trees are scattered in some portions.

Estimated sediment storage on this site is 21 acre-feet (34,000 cu yd). Maximum dike height will be less than eight feet with top-of-dike volume will be less than 40 acre-feet. There will be little to no surface runoff into this pool. Future use may involve sediment removal and reuse to make room for future dredging, or perennial grasses may be established and managed as wildlife habitat.

Site 2:

Site number 2 is an upland area consisting primarily of idled cropland. Vegetation cover is typical of succession stages of abandoned cropland. Brush includes smooth sumac and rough-leafed dogwood, with osage orange trees scattered throughout.

Estimated sediment storage is approximately 28 acre-feet (45,000 cu yd). Maximum dike height will be approximately eight feet with top-of-dike volume less than 48 acre-feet. Expected storm water runoff into this pool is less than 10 acres. Future use may involve sediment removal and reuse to make room for future dredging, or perennial grasses may be established and managed as wildlife habitat.

Site 3:

This site is an upland area previously used as cropland. Vegetation cover includes annual and perennials common for succession stages of idled cropland. American elm trees and rough-leaf dogwood are scattered within the area.

Estimated sediment storage is approximately 18 acre-feet (29,000 cu yd). Maximum dike height will be approximately eight feet with top-of-dike capacity less than 33 acre-feet. Upstream drainage into this pool is expected to be less than five acres. Future use may involve sediment removal and reuse to make room for future dredging, or perennial grasses may be established and managed as wildlife habitat.

Site 4:

Site 4 is an area a portion of which was previously disturbed by WCGS construction. Domestic grasses are present, but native perennial grasses are common. Eastern red cedar, osage orange, and American elm trees are common.

Estimated sediment storage of this pool is 35 acre-feet (56,000 cu yd). Maximum dike height will be approximately 12 feet with top-of-dike capacity less than 48 acre-feet. Land area upstream is estimated at less than 20 acres. Future use may involve removal and reuse of stored sediment to make room for future dredging, or management as shallow water habitat for wildlife.

Site 5:

This is an upland area previously used as cropland and native hay meadow. Vegetation typical in abandoned cropland is dominant. Small eastern red cedar and osage orange trees are common in the area.

Sediment volume capacity is estimated at 11 acre-feet (18,000 cu yd). Expected dike height will be a maximum of 12 feet with top-of-dike capacity less than 20 acre feet. Runoff area into this pool will be approximately 55 acres, including the area for Site 6. Future use may involve removal and reuse of stored sediment to make room for future dredging, or management as shallow water habitat for wildlife.

Site 6:

This area is currently being used as cropland. A native grass waterway is also included.

Sediment volume capacity is expected to be 20 acre-feet (32,000 cu yd). Maximum dike height will be approximately 12 feet with top-of-dike capacity less than 30 acre-feet. Runoff area into this pool will be approximately 40 acres. Future use may involve removal and reuse of stored sediment to make room for future dredging, or management as shallow water habitat for wildlife.

Site 7:

This is an area previously used as cropland. Current use is as a hay meadow with long reestablished native grass species. Osage orange and American elm trees exist in portions of this site.

Sediment volume capacity is expected to be 35 acre-feet (57,000 cu yd). Maximum dike height will be approximately eight feet with a top-of-dike capacity less than 45 acre feet. Runoff area into this pool will be approximately 100 acres. Future use may involve removal and reuse of stored sediment to make room for future dredging, or management as shallow water habitat for wildlife.

Site 8:

This area is identical to Site 7, which was previously used as cropland. Current use is as a hay meadow with long reestablished native grass species. Osage orange and American elm trees exist in portions of this site.

Sediment volume capacity is expected to be 7 acre-feet (11,000 cu yd). Maximum dike height will be approximately eight feet with top-of-dike capacity less than 16 acre-feet. Runoff area into this pool will be approximately 115 acres, which includes the runoff area of Site 7. Future use may involve removal and reuse of stored sediment to make room for future dredging, or management as shallow water habitat for wildlife.

Erosion Control and Best Management Practices

1. Proposed stormwater pollution control measures:

   A. temporary stabilization of exposed soil stockpiles and dikes with mulch.

   B. temporary stabilization of small drainage ditches with bales of straw.

   C. retention of stormwater using basin as needed.

   D. weekly erosion inspections of dikes, ditches, soil stockpiles and equipment staging areas.

   E. permanent stabilization of disturbed soil by seeding with grass.

   F. permanent stabilization of any borrow area by replacing topsoil and seeding with domestic grass.

2. Local erosion control requirements:

   Neither the Coffey County Health Department nor the Coffey County Engineer requires erosion control for construction projects in Coffey County.

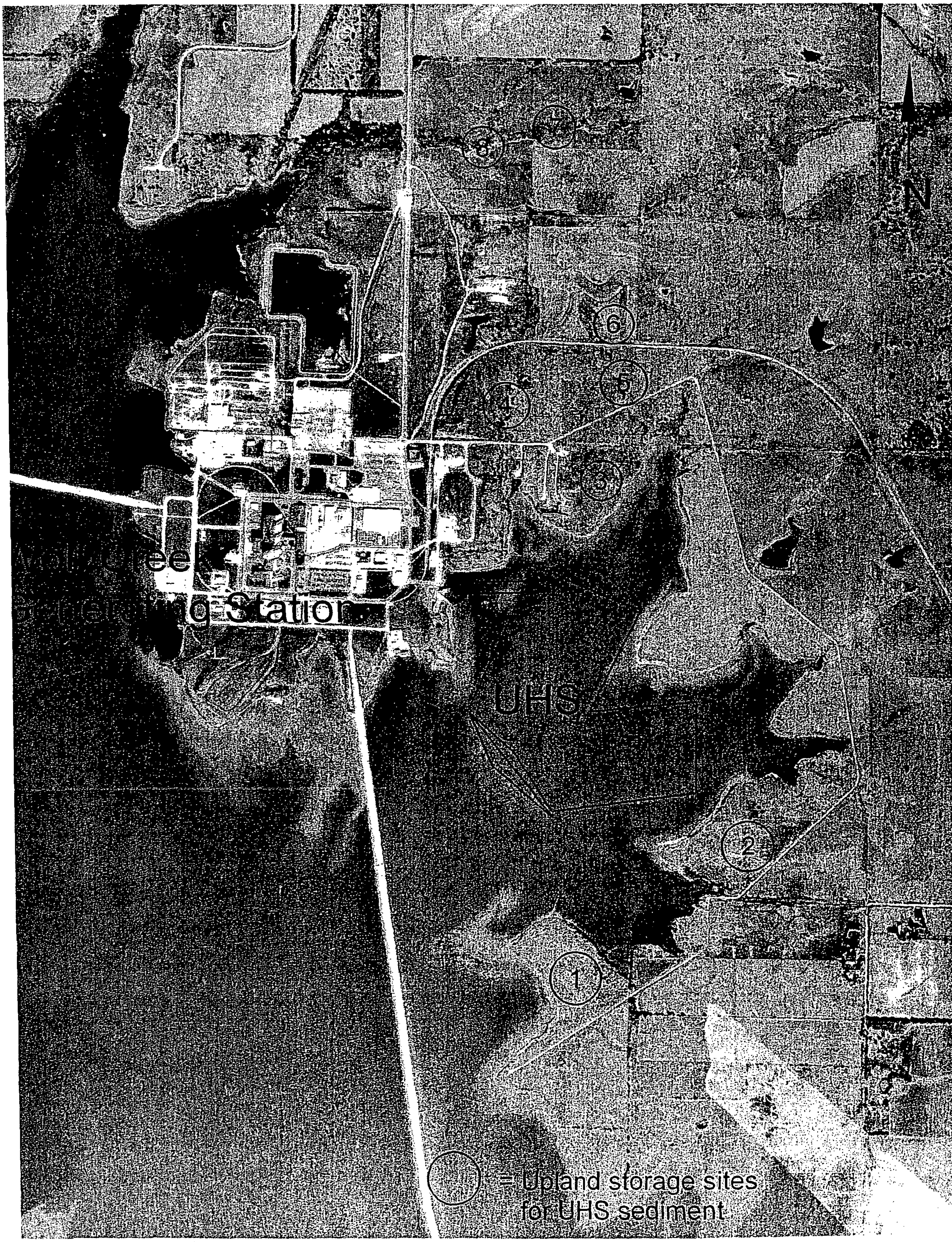
3. Sequence of major soil disturbing activities:

   A. designate and use equipment staging area for the construction operation.

   B. stake hay bales in drainage ditches to prevent down stream erosion and sediment transport.

   C. monitor and maintain pollution control measures to ensure effectiveness.

   D. upon completion of project, disturbed areas including equipment staging areas will be stabilized and re-seeded if necessary.


N
1
2
3
4
5
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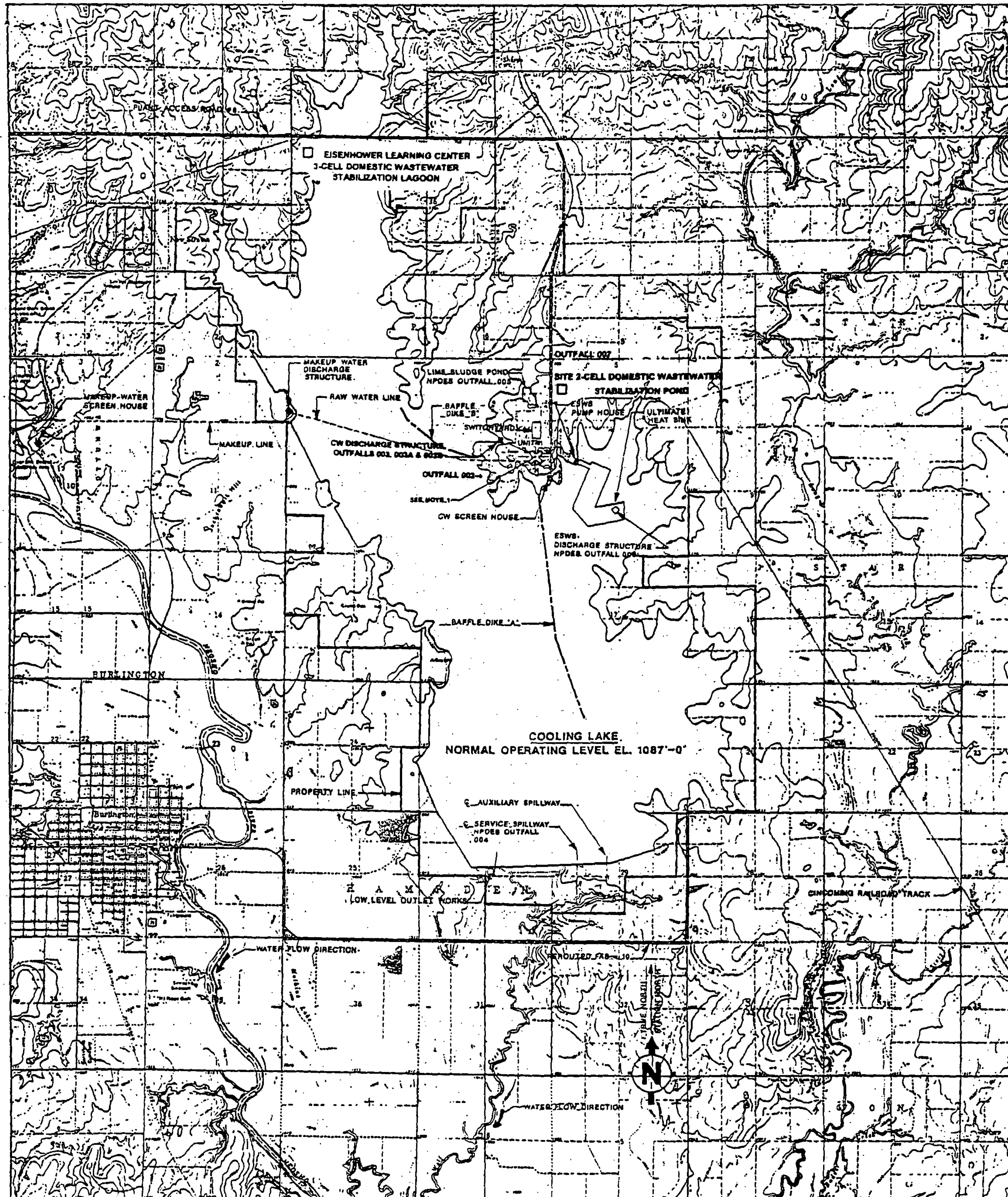
7
8
UHS
Station
= Upland storage sites
for UHS sediment



NOTES:

1. WOLF CREEK GENERATING STATION SITE IS ENHANCED ON "9-100 SITE DRAINAGE" WITH CENTER OF REACTOR LATITUDE 38°14'20" NORTH, LONGITUDE 95°41'20" WEST
2. LAND USE OF WCGS SITE SHOWN ON "9-100 SITE DRAINAGE" IS FOR COMMERCIAL NUCLEAR POWER PRODUCTION. SURROUNDING LAND USE IS AGRICULTURAL.
3. SEE "9-100 SITE DRAINAGE" FOR NPDES OUTFALLS 001, 002 AND 005.
4. SEE "9-100 SITE DRAINAGE" FOR HAZARDOUS WASTE AND MIXED WASTE MANAGEMENT FACILITIES.
5. ALL ELEVATIONS ARE U.S.G.S.

WOLF CREEK

STORMWATER APPLICATION
TOPOGRAPHIC MAP

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WOLF CREEK
NUCLEAR OPERATING CORPORATION

Kevin J. Moles
Manager Regulatory Affairs

JUL 0 8 2003

RA 03-0086

Kansas Department of Health and Environment
Attention: Mr. Alan Brooks
Bureau of Water – Industrial Programs Section
1000 SW Jackson St., Suite 420
Topeka, Kansas 66612-1367

Subject: Notice of Intent for the Wolf Creek Generating Station Main Gate North Plant Access Project

Dear Mr. Brooks:

Please find enclosed with this letter a Notice of Intent (NOI) and a check for sixty dollars ($60.00) for a small construction project that was started on June 2, 2003, at Wolf Creek Generating Station. Attachment 1.0 to this letter contains the Main Gate North Plant Access Project description. Also included on the attachment is the additional information required by the NOI for this construction project.

This letter also serves as a follow-up to a phone call made to Mr. Joe Mester of Kansas Department of Health and Environment (KDHE) on June 26, 2003. The topic of the phone call was to notify KDHE that a small construction project began on our plant site without an authorized NOI. Mr. Mester did not impose a work stoppage on the construction as long as we 1) developed a stormwater pollution prevention (SWP2) plan, 2) we put into place best management practices (BMPs) on the construction site, and 3) submit a NOI to KDHE. The SWP2 and BMPs were implemented on June 27, 2003.

Please contact Mr. Ralph Logsdon at (620) 364-8831, extension 4730, if you have any questions regarding this submittal.

Sincerely,

Kevin J. Moles

Kevin J. Moles

KJM/rll

Attachment

Enclosures

cc: Mr. Joe Mester, KDHE

See Attached Sheet for Instructions

NOTICE OF INTENT (NOI)
For Stormwater Runoff from Construction Activities
Authorized by a Kansas Water Pollution Control General Permit
Under the National Pollutant Discharge Elimination System

Submission of this Notice of Intent constitutes notice that the party identified in Section I of this form requests authorization for coverage under the Kansas Water Pollution Control general permit, or KDHE authorized successors, issued for stormwater runoff from construction activities in the State of Kansas. Becoming a permittee obligates the discharger to comply with the terms and conditions of the general permit. **Completion of this NOI does not provide automatic coverage under the general permit. Coverage is provided and discharge permitted when the Kansas Department of Health and Environment (KDHE) authorizes the NOI. A signed and dated copy of the authorized NOI will be provided to the owner or operator.** Upon authorization of the NOI, a Kansas permit number and a Federal permit number will be assigned to the construction project. ONLY COMPLETE APPLICATIONS ACCOMPANIED BY THE $60 ANNUAL PERMIT FEE WILL BE PROCESSED. KDHE WILL NOTIFY APPLICANTS WHOSE APPLICATIONS ARE INCOMPLETE, DEFICIENT, OR DENIED. **Please Print or Type**.

I. OWNER OR OPERATOR ADDRESS & RECORD LOCATION INFORMATION

Owner or Operator's Name: Wolf Creek Nuclear Operating Corporation (WCNOC)

Company Name: WCNOC

Owner or Operator's Phone: 620-364-8831

Mailing Address: P.O. Box 411

City: Burlington State KS Zip Code: 66839

Owner's Contact Name: Kevin J. Moles

Company Name: KGE, KCPL, KEPCO

Contact Phone: 620-364-8831 ext. 4565

Mailing Address: P.O. Box 411

City: Burlington State: KS Zip Code 66839

Will permit records be located on site? ☒ Y; ☐ N If not, provide an address where records will be kept:

Company Name: ____

Street Address: ____

City: ____ State: ____ Zip Code: ____

Mailing Address: ____

City: ____ State: ____ Zip Code: ____

II. SITE INFORMATION

A. LOCATION

Project Name: Main Gate North Plant Access

Street Address: 1550 Oxen Lane N.E.

City: Burlington State KS Zip Code: 66839

Physical Location: ____

____ QTR ____ QTR ____ QTR, ____ Section, ____ Township South, ____ Range ☐ E; ☐ W;

On-Site Contact Name: Greg Stice

Company Name: WCNOC

Contact Phone: 620-364-8831 ext. 4417

Mailing Address: P.O. Box 411

City: Burlington State: KS Zip Code: 66839

County: ____

For Official Use Only:

Received	Paid	Authorized ☐ Y; ☐ N
	Date:	
	Initials:	
	Check No:	Reviewer
Secretary, Kansas Department of Health and Environment		Date
KS Permit No. S - _ _ _ _ - _ _ _ _	Federal Permit No. KS	

To receive a hard copy of the general permit information packet check yes: ☐ Y; ☐ N

B. EXISTING CONDITIONS/USES

Is any part of the project located on Indian lands? ☐ Y; ☒ N

If yes, contact EPA regarding discharging stormwater runoff from construction activities on Indian lands.

If site runoff goes into a Municipal Separate Storm Sewer System; Owner/Operator's Name: N/A

Name of the first receiving water; stream; or lake: Coffey County Lake River Basin: Neosho

Are there any known soil contamination areas which will be disturbed by the construction activity? ☐ Y; ☒ N

Are contaminated soils or hazardous wastes present on the site: ☐ Y; ☒ N

Are there any surface water intakes for public drinking water supplies located within ½ mile of the site discharge points? ☐ Y; ☒ N

Are there any known historical or archeological sites present within the site boundary? ☐ Y; ☒ N

Are any threatened or endangered species known to be present within the site boundary or in the receiving water body? ☐ Y; ☒ N

If yes, list species and describe habitat location in relation to project location: ____________________

Are any Critical Water Quality Management Areas, Special Aquatic Life Use Waters,

or Outstanding National Resource Waters located within ½ mile of the site boundary? ☐ Y; ☒ N

C. PROJECT DESCRIPTION

Project Description: See Attachment 1.0

Anticipated Start Date: 06-02-03 and Completion Date: 09-01-03

Estimated area to be disturbed: 2.75 Acres Total area of the site: 135 Acres

Do you plan to disturb ten or more acres that are within a common drainage area? ☐ Y; ☒ N

If yes, will a sedimentation basin be installed in that drainage area? ☐ Y; ☐ N

If not, on a separate sheet, explain what similarly effective erosion and sediment control measures that will be implemented in lieu of a sedimentation basin.

D. EROSION CONTROL PLAN AND BEST MANAGEMENT PRACTICES

Attach a site plan showing the erosion control measures and the locations of stormwater management or pollution control features including BMPs. Incorporate details and notes as necessary to describe the erosion control plans and BMPs.

Attach a description of the best management practices which will be utilized to control erosion, sedimentation and other pollutants in stormwater runoff during construction. Include a description of applicable local erosion and sediment control requirements.

Describe the BMPs which will be permanent stormwater management or pollution control features. Include a description of applicable local stormwater pollution control requirements for permanent stormwater management features.

Summarize the sequence of major soil disturbing activities and the corresponding erosion control measures or BMPs.

E. AREA MAP

Attach a topographic map showing the project location and significant features in the surrounding area.

III. ANNUAL FEE

Enclose a check for the first year of the annual permit fee specified in K.A.R. 28-16-56 et seq. as amended. Make the check payable to "KDHE". Per K.A.R. 28-16-56, as amended, the current annual permit fee for this general permit is $60. An annual bill will be sent to the contact person requesting a permit fee until such time as the permit holder submits a Notice of Termination (NOT).

IV. APPLICANT CERTIFICATIONS

I, the undersigned, certify that a Stormwater Pollution Prevention Plan will be or has been developed for the construction site listed in Section II of this NOI. I further certify that the plan will be implemented at the time construction begins, and, as required by the NPDES general permit for Stormwater Runoff from Construction Activity, will revise the SWP2 plan if necessary.

I understand that continued coverage under the NPDES general permit for Stormwater Runoff from Construction Activities is contingent upon maintaining eligibility as provided for in the requirements and conditions of the general permit, and paying the annual fee.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Warren B. Wood 7-2-03

Signature Date

Warren B. Wood General Counsel/Secretary

Name and Official Title (Please Print)

Attachment 1.0

Wolf Creek Main Gate North Plant Access Project Description

A plant access project is being constructed to provide improved control and working environment for plant employees. This will provide better working conditions and ease of access into the plant for employees and visitors especially prior to and during refueling outages.

The scope includes a multi-lane approach to a three point check-in, much like the approach of a turnpike entrance. There is one main checkpoint office structure that will be occupied full time by a Wolf Creek Security Officer. There are two other checkpoint booths that will be utilized for daily early morning traffic and increased outage traffic. One of the points will be designated as a large truck check point and search area that will be located on the west end.

There will also be an additional 45' by 70' vehicle search building constructed just south of the check point to allow vehicle searches to be completed in a better controlled environment in a timely manor.

Erosion Control and Best Management Practices

1. Proposed stormwater pollution control measures:

   A. temporary stabilization of exposed soil stockpiles and dikes with mulch.

   B. temporary stabilization of small drainage ditches with bales of straw.

   C. retention of stormwater using basin as needed.

   D. weekly erosion inspections of dikes, ditches, soil stockpiles and equipment staging areas.

   E. permanent stabilization of disturbed soil by seeding domestic grass.

   F. permanent stabilization of any borrow area by replacing topsoil and seeding with domestic grass.

   G. an underground drainage system is being install to collect stormwater runoff on the construction site. This drainage system connects up to a pre-existing system that drains stormwater from this area of the plant site.

2. Local erosion control requirements:

   Neither the Coffey County Health Department nor the Coffey County Engineer requires erosion control for construction projects in Coffey County.

3. Sequence of major soil disturbing activities:

   A. Designate and use equipment staging area for the construction operation.

   B. stake hay bales in drainage ditches to prevent down stream erosion and sediment transport.

C. monitor and maintain pollution control measures to ensure effectiveness.

D. upon completion of project, disturbed areas including equipment staging areas will be stabilized and re-seeded if necessary.

Ralph Logsdon

TE: 42092

FEB 14 1996

46

96-00284

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
700 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

REPLY TO
ATTENTION OF:

February 9, 1996

Western Project Section
(95-02651)
(Coffey, KS, Wolf Creek Reservoir, NW 26, PDN)

Mr. Warren B. Wood
Wolf Creek Nuclear Operating Corporation
P.O. Box 411
Burlington, Kansas 66839

Dear Mr. Wood:

This is in response to your application dated January 12, 1996, for a Department of the Army (DA) permit concerning construction of a five lane boat ramp, breakwater, and associated excavation and dredge material disposal. The project is located in Section 1, Township 21 south, Range 15 east, Coffey County, Kansas.

Section 404 of the Clean Water Act (33 USC 1344), which is administered under Federal regulations 33 CFR 320-330, provides the Corps of Engineers with regulatory jurisdiction over all waters of the United States. These provisions require prior authorization from the Corps of Engineers for excavation or the discharge of dredged or fill material in waters of the United States, including wetlands.

Based on our review of the information furnished and our coordination with other agencies in response to predischarge notification requirements, we have determined that your proposed project is authorized by nationwide permit (NWP) No. 26, provided you ensure that the conditions listed in the enclosed copy of excerpts from Appendix A.C., are met. In addition to these general conditions, you must also comply with the following project specific conditions.

a. You must coordinate with the U.S. Fish and Wildlife Service and the Kansas Department of Wildlife and Parks to identify important nesting and feeding areas for the federally listed Bald Eagle, *Haliaeetus leucocephalus*. Following identification of these areas, you must protect these areas from disturbance by fisherman by placing marking buoys and signs to prevent water and land access to the areas. The closest disturbance distance around any nest site should be no less than 300 yards.

b. You must develop a plan in association with condition "a" above to monitor Bald Eagle activity during the first fishing season. This plan should address the impact fishing access has on the Bald Eagle. The results of this monitoring must be provided to the Corps of Engineers and the U.S. Fish and Wildlife Service by December 31, following opening of the waterbody to fishing.

We have enclosed a copy of the comment letter provided by the Kansas Department of Health and Environment (KDHE). They have reviewed the project and have provided comments concerning the on-site disposal from the restroom facility proposed with the project. Although this portion of the project is not regulated pursuant to Section 404, we suggest you incorporate these recommendations in the final design of this facility.

The KDHE also provided measures that should be incorporated to ensure water quality violations do not occur as a result of construction and/or operation of the proposed project. We suggest these measures also be incorporated into your project.

This NWP verification is valid until this NWP is modified, reissued, or revoked which is scheduled to be accomplished prior to January 21, 1997. It is your responsibility to remain informed of changes to this NWP. We will issue a public notice announcing the reissuance or changes when they occur. Furthermore, if this NWP is modified or revoked and you commence or are under contract to commence this activity before the date the NWP is modified or revoked, you would have only 12 months from that date to complete the activity under the present terms and conditions of this NWP.

Although an individual DA permit is not required, other Federal, state and/or local permits may be required, and you should satisfy yourself in this regard.

If you have any questions, please feel free to write me or to call Brian A. McNulty at 816-426-5047 (FAX 816-426-2321).

Sincerely,

Richard E. Lenning

Richard E. Lenning
Chief, Western Project Section
Regulatory Branch

Enclosure

Copies Furnished:
(See attached list)

Copies Furnished:

Environmental Protection Agency,
Wetlands Protection Section wo/enclosure

U.S. Fish and Wildlife Service
Manhattan, Kansas Office wo/enclosure

Kansas Department of Health and
Environment wo/enclosure

Kansas State Historical Society
Historic Preservation Department
wo/enclosure

Kansas Department of Wildlife
and Parks wo/enclosure (Mammoliti)

Kansas Department of Wildlife
and Parks wo/enclosures (Yasui/Badders)

Kansas State Board of Agriculture
wo/enclosure

CEMRK-OD-PC

NOVEMBER 22, 1991 FEDERAL REGISTER
EXCERPTS FROM 33 CFR PART 330, APPENDIX A
ACTIVITIES IN WATERS OF THE UNITED STATES

C. NATIONWIDE PERMIT CONDITIONS

GENERAL CONDITIONS: The following general conditions must be followed in order for any authorization by a nationwide permit (NWP) to be valid:

1. Navigation. No activity may cause more than a minimal adverse effect on navigation.

2. Proper maintenance. Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety.

3. Erosion and siltation controls. Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills must be permanently stabilized at the earliest practicable date.

4. Aquatic life movements. No activity may substantially disrupt the movement of those species of aquatic life indigenous to the waterbody, including those species which normally migrate through the area, unless the activity's primary purpose is to impound water.

5. Equipment. Heavy equipment working in wetlands must be placed on mats or other measures must be taken to minimize soil disturbance.

6. Regional and case-by-case conditions. The activity must comply with any regional conditions which may have been added by the Division Engineer (see 33 CFR 330.4(e)) and any case specific conditions added by the Corps.

7. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status. Information on Wild and Scenic Rivers may be obtained from the National Park Service and the U.S. Forest Service.

8. Tribal rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

9. Water quality certification. In certain states, an individual state water quality certification must be obtained or waived (see 33 CFR 330.4(c)).

10. Costal zone management. In certain states, an individual state coastal zone management consistency concurrence must be obtained or waived (see 33 CFR 330.4(d)).

(3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; and any other NWP(s), regional general permit(s) or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity;

(4) Where required by the terms of the NWP, a delineation of affected special aquatic sites, including wetlands; and

(5) A statement that the prospective permittee has contacted:

(i) The USFWS/NMFS regarding the presence of any Federally listed (or proposed for listing) endangered or threatened species or critical habitat in the permit area that may be affected by the proposed project; and any available information provided by those agencies. (The prospective permittee may contact Corps District Offices for USFWS/NMFS agency contacts and lists of critical habitat.)

(ii) The SHPO regarding the presence of any historic properties in the permit area that may be affected by the proposed project; and the available information, if any, provided by that agency.

c. The standard individual permit application form (Form ENG 4345) may be used as the notification but must clearly indicate that it is a PDN and must include all of the information required in (b)(1)-(5) of General Condition 13.

d. In reviewing an activity under the notification procedure, the District Engineer will first determine whether the activity will result in more than minimal individual or cumulative adverse environmental effects or will be contrary to the public interest. The prospective permittee may, at his option, submit a proposed mitigation plan with the predischarge notification to expedite the process and the District Engineer will consider any optional mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects of the proposed work are minimal. The District Engineer will consider any comments from Federal and State agencies concerning the proposed activity's compliance with the terms and conditions of the nationwide permits and the need for mitigation to reduce the project's adverse environmental effects to a minimal level. The District Engineer will upon receipt of a notification provide immediately (e.g. facsimile transmission, overnight mail or other expeditious manner) a copy to the appropriate offices of the Fish and Wildlife Service, State natural resource or water quality agency, EPA, and, if appropriate, the National Marine Fisheries Service. With the exception of NWP 37, these agencies will then have 5 calendar days from the date the material is transmitted to telephone the District Engineer if they intend to provide substantive, site-specific comments. If so contacted by an agency, the District Engineer will wait an additional 10 calendar days before making a decision on the notification. The District Engineer will fully consider agency comments received within the specified time frame, but will provide no response to the resource agency. The District Engineer will indicate in the administrative record associated with each notification that the resource agencies' concerns were considered. Applicants are

SECTION 404 ONLY CONDITIONS: In addition to the General Conditions, the following conditions apply only to activities that involve the discharge of dredged or fill material and must be followed in order for authorization by the nationwide permits to be valid:

1. Water supply intakes. No discharge of dredged or fill material may occur in the proximity of a public water supply intake except where the discharge is for repair of the public water supply intake structures or adjacent bank stabilization.

2. Shellfish production. No discharge of dredged or fill material may occur in areas of concentrated shellfish production, unless the discharge is directly related to a shellfish harvesting activity authorized by nationwide permit 4.

3. Suitable material. No discharge of dredged or fill material may consist of unsuitable material (e.g., trash, debris, car bodies, etc.) and material discharged must be free from toxic pollutants in toxic amounts (see section 307 of the Clean Water Act).

4. Mitigation. Discharges of dredged or fill material into waters of the United States must be minimized or avoided to the maximum extent practicable at the project site (i.e. on-site), unless the DE has approved a compensation mitigation plan for the specific regulated activity.

5. Spawning areas. Discharges in spawning areas during spawning seasons must be avoided to the maximum extent practicable.

6. Obstruction of high flows. To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters).

7. Adverse impacts from impoundments. If the discharge creates an impoundment of water, adverse impacts on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized to the maximum extent practicable.

8. Waterfowl breeding areas. Discharges into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

9. Removal of temporary fills. Any temporary fills must be removed in their entirety and the affected areas returned to their pre-existing elevation.

A6

WOLF CREEK
NUCLEAR OPERATING CORPORATION

AI 07D-001

RESOURCE MANAGEMENT AND ECOLOGICAL MONITORING PROGRAMS

Responsible Manager

Manager Regulatory Affairs

Revision Number	8
Use Category	Reference
Administrative Controls Procedure	No
Management Oversight Evolution	No
Program Number	07D

DC38 8/7/2006

TABLE OF CONTENTS

1.0 PURPOSE

1.1 This procedure defines the intent and format for the Lake and Land Management Programs, and Ecological Monitoring Programs administered by Wolf Creek Nuclear Operating Corporation (WCNOC) personnel. These programs are designed to meet requirements in the Environmental Protection Plan (EPP).

2.0 SCOPE

2.1 This procedure is applicable to Environmental Management personnel responsible for land management activities at WCGS, excluding transmission line right-of-way maintenance.

2.2 This procedure is applicable to Environmental Management personnel responsible for fisheries management activities at WCGS.

2.3 This procedure is applicable to Environmental Management personnel responsible for ecological monitoring including, but not limited to zebra mussel monitoring, waterfowl disease contingency plan, avian protection plan, and water quality monitoring.

3.0 REFERENCES AND COMMITMENTS

3.1 References

3.1.1 APPENDIX B TO FACILITY OPERATING LICENSE NPF-42, ENVIRONMENTAL PROTECTION PLAN (EPP) (NONRADIOLOGICAL)

3.1.2 WOLF CREEK UPDATED SAFETY ANALYSIS REPORT (USAR)

3.1.3 AP 15A-003, RECORDS

3.1.4 AP 26A-003, 10 CFR 50.59 REVIEWS

3.1.5 MEMORANDUM OF UNDERSTANDING (MOU) - OPENING LAKE FOR PUBLIC RECREATION AND FISHING - JUNE 20, 1996

3.1.6 PIR 95-2462, AGRICULTURAL LEASE EXPENSE ACCOUNTING IMPROVEMENT

3.1.7 NRC INFORMATION NOTICE 02-014 EVALUATION

3.1.8 NUREG-0878, FINAL ENVIRONMENTAL STATEMENT RELATED TO THE OPERATION OF WOLF CREEK GENERATING STATION, UNIT NO. 1 (FES-OLS)

3.1.9 WOLF CREEK GENERATING STATION ENVIRONMENTAL REPORT-OPERATING LICENSE STAGE (ER-OLS)

3.1.10 PIR 2002-3053, VAULTING FARM LEASE AGREEMENTS

3.1.11 Letter 05-00616, dated 11-14-05 from United States Department of the Interior regarding WCGS License Renewal

3.2 Commitments

3.2.1 ET 97-0021, R. A. Muench (WCNOC) To U.S. Nuclear Regulatory Commission (NRC), March 7, 1997 (RCMS #1985-092)

3.2.2 ITIP 02047, NRC INFORMATION NOTICE 92-49: RECENT LOSS OR SEVERE DEGRADATION OF SERVICE WATER SYSTEMS

4.0 DEFINITIONS

4.1 Owner Controlled Area

4.1.1 Property contiguous to the reactor site and acquired by fee title or easement for Wolf Creek Generating Station for which public access is limited.

4.2 Ecological Monitoring

4.2.1 Ecological monitoring refers to field research or monitoring activities completed to measure environmental impacts in the vicinity of Wolf Creek Generating Station to support licensing requirements. This definition does not include monitoring required for specific permits such as the Air Operating Permit or NPDES permit.

5.0 RESPONSIBILITIES

5.1 Supervisor Regulatory Support

5.1.1 Directs the revision and implementation of the land management plan, the fishery management plan, the waterfowl disease contingency plan, and ecological monitoring plan(s).

5.1.2 Directs the preparation of lease agreements with tenants to implement the land management plan.

5.1.3 Directs the preparation of necessary reports which summarize land management activities.

5.1.4 Directs the preparation of necessary reports which summarize fisheries management activities.

5.1.5 Administers disposition of income and expenses associated with the land management program.

5.1.6 Directs the preparation of the ecological monitoring plan(s).

5.2 Manager Regulatory Affairs

5.2.1 Reviews and approves the land management plan and reports.

5.2.2 Reviews and approves the fisheries management plan and reports.

5.2.3 Reviews and approves the ecological monitoring plan(s).

6.0 PROCEDURE

6.1 Land Management

6.1.1 Land management activities shall attempt to achieve a balance between production and conservation values through the implementation of conservation and wildlife management techniques.

6.1.2 To facilitate proper management of WCGS property, an annual land management plan will be formulated which may include, but is not limited to wildlife habitat enhancement, land improvements, controlled burning, grazing, haying and crop activities, and other conservation measures projected for the applicable year.

1. This annual plan will be implemented to the maximum extent possible through agreements with tenants farming WCGS lands.
2. The land management plan and associated report will be submitted to the Supervisor Regulatory Support and Manager Regulatory Affairs for approval.
3. A copy of the land management plan shall be sent to Document Services for incorporation into the WCNOC Environmental Permits and Plans Manual.

6.1.3 In accordance with the USAR, all land management activities will prohibit oil or gas exploration, mining and/or drilling on WCGS lands.

6.1.4 In accordance with the EPP, land management activities will maintain a minimum of 500 acres of WCGS lands surrounding the cooling lake in naturally occurring biotic communities.

6.1.5 Tenants and cooperating elevators shall be instructed to transmit income payments to Environmental Management.

6.1.6 Land management income shall be processed and tracked for each tenant and forwarded to the Accounting group by Environmental Management.

6.1.7 Purchase Orders / Agreement will be used for local agricultural vendors to cover the plant's share of expenses as stated in applicable lease agreements if rent is based on a share of the production (refer to Step 3.1.6).

6.1.8 The Supervisor Regulatory Support or designee shall approve all invoices for lease expenses before payments are made. This includes deductions to rents received due to a tenant's improvement of a lease.

6.1.9 Lease expenses will be recorded and verified for each tenant to ensure that expenses are legitimate for the crops planted on WCNOC land if rent\is based on a share of the production.

6.2 Temporary Access

6.2.1 Activities on company lands that are not related to the agricultural lease agreements or are not related to normal work activities will be documented with Form AIF 07D-001-01, TEMPORARY LAND USE PERMIT, and approved by the Supervisor Regulatory Support or designee.

1. The permittee on the Form AIF 07D-001-01 shall be made aware of the emergency planning information provided to the general public at public access facilities or through handouts.

2. A copy of each Form AIF 07D-001-01 should be provided to Security for information purposes.

3. In order to facilitate emergency notification, a pager, tone alert radio, or other suitable means of notification will be provided to the permittee.

6.3 Agricultural Tenants

6.3.1 Agricultural tenants will be informed of emergency plan evacuation expectations while on company lands.

1. Evacuation expectations will follow, to the extent possible, the information provided to the public at the local recreational areas.

2. A pager, tone alert radio, or other suitable means of notification will be provided to the agricultural tenants leasing WCNOC managed lands that are within the Owner Controlled Area.

3. Environmental Management will provide emergency information to the tenants within lease agreements, mailings or other suitable means of notifications.

6.4 Fisheries and Lake Management

6.4.1 Lake management activities shall optimize lake use, enhance fisheries and improve water quality.

6.4.2 To facilitate proper management of Coffey County Lake, an annual fisheries management plan will be formulated which may include, but is not limited to young-of-year gizzard shad changes, adult shad and predator fish population dynamics, angler harvest impacts to the fishery and other similar projects for the applicable year.

1. This annual plan will be implemented to the maximum extent possible through agreements with county, state and federal agencies.

2. The fisheries management plan and associated report will be submitted to the Supervisor Regulatory Support and Manager Regulatory Affairs for approval.

3. A copy of the fisheries management plan shall be sent to Document Services for incorporation into the WCNOC Environmental Permits and Plans Manual.

6.4.3 During late summer of each year the growth of aquatic weeds will be surveyed [Commitment Step 3.2.2]. The survey will target three primary areas as follows:

1. Immediately upstream from the Circulating Water Screenhouse.

2. In the vicinity of the Essential Service Water System Screenhouse.

3. The buoyed Owner Controlled Access Boundary approximately one-half mile south of the Circulating Water Screenhouse.

6.4.4 IF the survey indicates that mechanical removal of the aquatic weeds is not deemed necessary based on weed composition, concentration, or area covered, THEN justification will be documented and transmitted to Operations and Maintenance Support.

6.4.5 IF the survey indicates that removal of the aquatic weeds may be necessary to prevent excessive weed buildup on the rotating screens, THEN Environmental Management will inform Operations and Maintenance Support of the weed buildup potential and removal needs.

6.5 Memorandum of Understanding (MOU)

6.5.1 The MOU for opening the lake to public access will be reviewed periodically. This review may include, but is not limited to fishery management, public access, buoy replacement and any other measures projected for the future (refer to Step 3.1.5) [Commitment Step 3.2.1.].

6.6 Ecological Monitoring

6.6.1 Ecological monitoring or study activities shall attempt to measure impacts from Wolf Creek Generating Station to answer specific environmental questions to support plant operations and licensing (refer to Steps 3.1.1, 3.1.8, and 3.1.9).

1. As environmental questions arise a monitoring plan will be developed to guide field data collection activities to answer the operational or licensing needs.

2. IF the type of monitoring is ongoing, such as zebra mussel presence or absence monitoring, THEN the plan should be updated annually.

3. Reports shall be prepared according to the frequency specified in the applicable monitoring plan.

4. The monitoring plan and associated reports shall be submitted to the Supervisor Regulatory Services and Manager Regulatory Affairs for approval.

5. A copy of the ecological monitoring plan shall be sent to Document Services for incorporation in the WCNOC Environmental Permits and Plans Manual.

6.7 Waterfowl Disease Contingency Plan

6.7.1 The Waterfowl Disease Contingency Plan shall be updated periodically on an "as needed" basis to provide guidance in the event of a waterfowl disease outbreak at the cooling lake.

1. A copy of the Waterfowl Disease Contingency Plan shall be sent to Document Services for incorporation into the WCNOC Environmental Permits and Plans Manual.

6.8 Avian Protection Plan (Reference Step 3.1.11)

6.8.1 The Avian Protection Plan shall be updated periodically on an "as needed" basis to provide guidance in the event of bird electrocutions or collisions events.

1. A copy of the Avian Protection Plan shall be sent to Document Services for incorporation into the WCNOC Environmental Permits and Plans Manual.

7.0 RECORDS

7.1 The following QA records are generated by this procedure and are vaulted via the Permits and Plans Manual

7.1.1 Fisheries Management Report

7.1.2 The Land Management Plan and Report

7.1.3 The Fisheries Management Plan

7.1.4 The Zebra Mussel Monitoring Plan and Report

7.1.5 The Waterfowl Disease Contingency Plan

7.1.6 The Ecological Monitoring Plan and Report

7.1.7 The Avian Protection Plan

7.2 The following Corporate records are generated by this procedure

7.2.1 AIF 07D-001-01, TEMPORARY LAND USE PERMIT

7.2.2 The Farm Lease Agreements

8.0 FORMS

8.1 AIF 07D-001-01, TEMPORARY LAND USE PERMIT

- END -

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DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
700 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

REPLY TO ATTENTION OF:

September 11, 1997

97-01520

Western Project Section
(97-02509)
(Coffey, KS, NWP 27)

Brad S. Loveless
Superintendent, Resource Protection
Wolf Creek Nuclear Operating Corp.
1550 Oxen Lane
P.O. Box 411
Burlington, Kansas 66839

Dear Mr. Loveless:

This letter concerns your application to the Kansas Department of Agriculture, Notice No. 97310, for the proposed creation of two wetland areas within the flood control pool of the Wolf Creek Reservoir. The project is located in Section 24, Township 20 south, Range 15 east, Coffey County, Kansas.

The Corps of Engineers has jurisdiction over all waters of the United States. Excavation or discharges of dredged or fill material in waters of the United States, including wetlands, require prior authorization from the Corps under Section 404 of the Clean Water Act (33 USC 1344). The implementing regulation for this Act is found at 33 CFR 320-330.

We have reviewed the information furnished and have determined that your project is authorized by nationwide permit **(NWP) No. 27**, provided you ensure that the conditions listed in the enclosed copy of excerpts from the December 13, 1996 Federal Register, Final Notice of Issuance, Reissuance, and Modification of Nationwide Permits (61 FR 65874) are met. **General condition 14** requires you to sign and submit the enclosed "Compliance Certification" upon completion of the authorized work and any required mitigation.

This NWP verification is valid for a period of two years from the date of this letter. Should your project plans change or if your activity is not complete within this two year period, you must contact this office for another permit determination.

Although an individual DA permit is not required, other Federal, state and/or local permits may be required. You should verify this yourself. The Kansas Department of Health and Environment has certified that this NWP will not violate existing state water quality standards provided you comply with the conditions included in their attached letter. If you have any questions concerning state water quality standards or associated conditions, please contact the person listed in their letter.

If you have any other questions concerning about this matter, please feel free to contact David R. Hoover, Regulatory Project Manager at 816-983-3653 (FAX 816-426-2321).

Enclosures

Copies Furnished:

Kansas Department of Wildlife
and Parks wo/enclosures

Kansas Department of Agriculture
wo/enclosures

COMPLIANCE CERTIFICATION

General condition 14 of this Nationwide Permit requires that you submit a signed certification regarding the completed work and any required mitigation. This certification page satisfies this condition if it is provided to the Kansas City District at the address shown at the bottom of this page upon completion of the project.

APPLICATION NUMBER: 97-02509

APPLICANT: Wolf Creek Nuclear Operating Corporation
P.O. Box 411
Burlington, KS 66839

PROJECT LOCATION: Within the flood control pool of Wolf Creek Reservoir in Section 24, Township 20 south, Range 15 east, Coffey County, Kansas.

a. I certify that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions.

b. I certify that any required mitigation was completed in accordance with the permit conditions.

c. Your signature below, as permittee, indicates that you have completed the authorized project as certified in paragraphs a and b above.

_______________________________ _______________________________
(PERMITTEE) (DATE)

Return this certification to:

U.S. Army Corps of Engineers
Attn: CENWK-CO-rw (97-02509)
700 Federal Building
Kansas City, MO 64106-2896

Kansas Water Quality Certification
Section 404 Nationwide Permits
Kansas Department of Health and Environment

Drafted February 10, 1997, 1st Revision: April 24, 1997, final revision: July 31, 1997

Authority

This certification is prepared pursuant to Clean Water Act Section 401 and Kansas Administrative Regulation 28-16-28f(c)(1).

Certification

All activities authorized by Corps of Engineers Nationwide Permits published December 13, 1996, are not expected to result in violations of Kansas Water Quality Standards found at Kansas Administrative Regulations 28-16-28b through 28f, provided the person conducting the activity authorized by the nationwide permit adheres to the following certification conditions.

Certification Conditions

1. **Water Quality Protection Plan** Any person wishing to use a Section 404 Nationwide General Permit shall prepare and follow a written water quality protection plan. The water quality protection plan shall identify components of the permitted activity (i.e. solid waste handling, fuel storage and leaks, sediment from construction etc.) which may or will result in the discharge of pollutants to waters of the state. For each component which may discharge pollutants to waters of the state, the plan shall set out the physical, structural and management measures being implemented to prevent or minimize the discharge of pollutants to waters of the state.

2. **Outstanding Natural Resource Waters and Special Aquatic Life Support Use Waters:** In the event the permitted activity occurs in or will impact an Outstanding Natural Resource Water, established pursuant to K.A.R. 28-16-28d(c) or a Special Aquatic Life Support Use Water designated pursuant to K.A.R. 28-16-28d(2)(A), **the person responsible for initiating the activity shall submit a copy of the water quality protection plan to the Nonpoint Source Section - Kansas Department of Health and Environment.** Outstanding Natural Resource Waters subject to this provision are listed in the Corps of Engineers Regional Conditions. A list of **Special Aquatic Life Support Use Waters** is available from Kansas Department of Health and Environment (see last page for contact information).

3. **Solid Waste Disposal** All solid waste materials produced during the execution of the project shall be disposed in accordance with the provisions of Kansas Solid Waste Management Statutes and regulations and applicable local regulations. Direct inquiries to KDHE Bureau of Waste Management (785) 296-1612.

4. **Discharge of Floatable Materials** The person responsible for executing the permitted activity shall assure good house keeping is practiced at the site to minimize the discharge of floatable materials such as personal refuse such as food containers, packing materials, and other liter. Appropriate measures shall be taken to capture and/or recover any floatable materials discharged to waters of the state originating with the permitted project.

5. **Fuel, Chemical and Materials Storage** Fuel, chemical and other materials stored at the project site shall be stored in a manner that minimizes the discharge of product to waters of the state. Spill minimization and recovery measures and procedures shall be documented in the Water Quality Protection Plan.

6. **Spill Reporting** The Kansas Department of Health and Environment shall be notified of all fuel spills or unauthorized discharge of pollutants. Spill reporting numbers are --

   KDHE - daytime (785) 296-1679; after hours (785) 296-0614 or 911 for local response.

7. **Drinking Water Intakes** The person responsible for the permitted activity shall avoid adverse impacts on public water supplies. Whenever permitted activities occur within one mile upstream of a public drinking water supply - surface water intake, the applicant shall contact the official in charge of the public drinking water supply to apprise the drinking water supply official of the permitted activity. The person responsible for the permitted activity shall consider the suggestions and recommendations of the public water supply official when preparing the Water Quality Protection Plan.

8. **Treated Wastewater Effluent Mixing Zones** As a general guideline any Section 404 activity within one-half (½) mile upstream or one-half (½) mile downstream of a permitted wastewater effluent discharge may impact the effluent mixing zone. The person responsible for the permitted activity shall determine if the project will adversely impact the wastewater effluent mixing zones and take appropriate measures to avoid altering or changing the mixing zone. This may include but is not limited to:

   1) The construction or placement of a recreation oriented facility or structure (i.e. boat ramp, walkway) which may require modification of the beneficial use designation to accommodate contact or non-contact recreation, thereby increasing the effluent limitations for the permit.

   2) Any activity which may alter or remove the stream channel geometry or natural oxygenation abilities of the stream such as bridge construction, channelization, stream channel substrate modification etc.

The person responsible for the permitted Section 404 activity shall advise and describe to the waste water discharge permittee and KDHE any potential mixing zone impacts and the measures the person responsible for the Section 404 activity will take to minimize adverse impacts on the mixing zone. Inquiries should be directed to KDHE Bureau of Water (785) 296-5527.

9. **Closure of Project Site** Upon completion of the project, disturbed areas including equipment staging areas shall be expeditiously stabilized with temporary and permanent vegetative or other nonpolluting cover materials. The person responsible for the permitted activity shall monitor and maintain cover materials until such time as the site is stabilized.

10. **Kansas Water Pollution Control General Permit for Stormwater Runoff from Construction Activities.** This certification does not relieve the applicant of the responsibility to determine if the project is subject to the requirements of **General NPDES Permit S-MCSTø-9601-1** to secure such permit as necessary. Questions and inquiries may be directed to:

    Kansas Department of Health and Environment, Bureau of Water - Industrial Program Section, Building 283, Forbes Field, Topeka, Kansas 66620 - Attention -- Dave Freise, Phone (785) 296-5557.

11. Hydrostatic tests for pipeline activities shall be approved prior to discharge of water used for the test. Please contact Om Agrawal at (785) 296-5553 to inquire.

Enforcement and Penalties

This certification does not relieve the applicant of the responsibility for any discharge to waters of the state. The Kansas Department of Health and Environment retains the option of revoking this certification any time an inappropriate discharge may occur. As provided for by K.S.A. 65-171(f), failure to comply with the conditions of this certification may subject the responsible part to fines of $10,000 per violation with each day the violation occurs constituting a separate violation.

Variance

If the applicant believes the conditions of this certification will result in impairment of important social and economic development, the applicant is advised of the variance provisions of K.A.R. 28-16-28f(c)(3).

For Additional Information

For a copy of the Kansas Surface Water Quality Standards, water quality protection plan assistance packet and lists of *Outstanding Natural Resource Waters* and *Special Aquatic Life Use Support Waters*, please contact Kansas Department of Health and Environment Bureau of Water Nonpoint Source Section at (785) 296-4195 or FAX (785) 296-5509. This information can also be obtained by written communication directed to :

Kansas Department of Health and Environment- Bureau of Water - Nonpoint Source Section, Building 283, Forbes Field, Topeka, Kansas 66620. Attention: 40 4 NWP 401 Certification.

CEMRK-CO-R

DECEMBER 13, 1996, FEDERAL REGISTER
[redacted]
ACTIVITIES IN WATERS OF THE UNITED STATES

C. NATIONWIDE PERMIT CONDITIONS

GENERAL CONDITIONS: The following general conditions must be followed in order for any authorization by a nationwide permit (NWP) to be valid:

1. Navigation. No activity may cause more than a minimal adverse effect on navigation.

2. Proper maintenance. Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety.

3. Erosion and siltation controls. Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. Aquatic life movements. No activity may substantially disrupt the movement of those species of aquatic life indigenous to the waterbody, including those species which normally migrate through the area, unless the activity s primary purpose is to impound water.

5. Equipment. Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.

6. Regional and case-by-case conditions. The activity must comply with any regional conditions which may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state or tribe in its Section 401 water quality certification.

7. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status; unless the appropriate Federal agency, with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely effect the Wild and Scenic River designation, or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service.)

8. Tribal rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

9. Water quality certification. In certain states, an individual Section 401 water quality certification must be obtained or waived (see 33 CFR 330.4(c)).

10. Coastal zone management. In certain states, an individual state coastal zone management consistency concurrence must be obtained or waived (see Section 330.4(d)).

b. <u>Contents of Notification</u>: The notification must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), regional general permit(s) or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity; and

(4) For NWPs 14, 18, 21, 26, 29, 34, and 38, the PCN must also include a delineation of affected special aquatic sites, including wetlands (see paragraph 13(f));

(5) For NWP 21 - Surface Coal Mining Activities, the PCN must include an OSM or state approved mitigation plan.

(6) For NWP 29 - Single-Family Housing, the PCN must also include:

(i) Any past use of this NWP by the individual permittee and/or the permitees spouse;

(ii) A statement that the single-family housing activity is for a personal residence of the permittee;

(iii) A description of the entire parcel, including its size, and a delineation of wetlands. For the purpose of this NWP, parcels of land measuring 0.5 acre or less will not require a formal on-site delineation. However, the applicant shall provide an indication of where the wetlands are and the amount of wetlands that exists on the property. For parcels greater than 0.5 acre in size, a formal wetland delineation must be prepared in accordance with the current method required by the Corps. (See paragraph 13(f));

(iv) A written description of all land (including, if available, legal descriptions) owned by the prospective permittee and/or the prospective permittee s spouse, within a one mile radius of the parcel, in any form of ownership (including any land owned as a partner, corporation, joint tenant, co-tenant, or as a tenant-by-the-entirety) and any land on which a purchase and sale agreement or other contract for sale or purchase has been executed;

(7) For NWP 31 - Maintenance of Existing Flood Control Projects, the prospective permittee must either notify the District Engineer with a Pre-Construction Notification (PCN) prior to each maintenance activity or submit a five year (or less) maintenance plan. In addition, the PCN must include all of the following:

(i) Sufficient baseline information so as to identify the approved channel depths and configurations and existing facilities. Minor deviations are authorized, provided that the approved flood control protection or drainage is not increased;

(ii) A delineation of any affected special aquatic sites, including wetlands; and,

(iii) Location of the dredged material disposal site.

(ii) Optional Agency Coordination. For NWPs 5, 7, 12, 13, 17, 18, 27, 31, and 34, where a Regional Administrator of EPA, a Regional Director of USFWS, or a Regional Director of NMFS has formally requested general notification from the District Engineer for the activities covered by any of these NWPs, the Corps will provide the requesting agency with notification on the particular NWPs. However, where the agencies have a record of not generally submitting substantive comments on activities covered by any of these NWPs, the Corps district may discontinue providing notification to those regional agency offices. The District Engineer will coordinate with the resources agencies to identify which activities involving a PCN that the agencies will provide substantive comments to the Corps. The District Engineer may also request comments from the agencies on a case by case basis when the District Engineer determines that such comments would assist the Corps in reaching a decision whether effects are more than minimal either individually or cumulatively.

(iii) Optional Agency Coordination, 401 Denial. For NWP 26 only, where the state has denied its 401 water quality certification for activities with less than 1 acre of wetland impact, the EPA regional administrator may request agency coordination of PCNs between 1/3 and 1 acre. The request may only include acreage limitations within the 1/3 to 1 acre range for which the state has denied water quality certification. In cases where the EPA has requested coordination of projects as described here, the Corps will forward the PCN to EPA only. The PCN will then be forwarded to the Fish and Wildlife Service and the National Marine Fisheries Service by EPA under agreements among those agencies. Any agency receiving the PCN will be bound by the EPA time frames for providing comments to the Corps.

f. <u>Wetland Delineations</u>: Wetland delineations must be prepared in accordance with the current method required by the Corps. For NWP 29 see paragraph (b)(6)(iii) for parcels less than 0.5 acres in size. The permittee may ask the Corps to delineate the special aquatic site. There may be some delay if the Corps does the delineation. Furthermore, the 30-day period (45 days for NWP 26) will not start until the wetland delineation has been completed and submitted to the Corps, where appropriate.

g. <u>Mitigation</u>: Factors that the District Engineer will consider when determining the acceptability of appropriate and practicable mitigation include, but are not limited to:

(i) To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of the overall project purposes;

(ii) To the extent appropriate, permittees should consider mitigation banking and other forms of mitigation including contributions to wetland trust funds, in lieu fees to organizations such as The Nature Conservancy, state or county natural resource management agencies, where such fees contribute to the restoration, creation, replacement, enhancement, or preservation of wetlands. Furthermore, examples of mitigation that may be appropriate and practicable include but are not limited to: reducing the size of the project; establishing wetland or upland buffer zones to protect aquatic resource values; and replacing the loss of aquatic resource values by creating, restoring, and enhancing similar functions and values. In addition, mitigation must address wetland impacts, such as functions and values, and cannot be simply used to offset the acreage of wetland losses that would occur in order to meet the acreage limits of some of the NWPs (e.g., for NWP 26, 5 acres of wetlands cannot be created to change a 6-acre loss of wetlands to a 1 acre loss; however, 2 created acres can be used to reduce the impacts of a 3-acre loss.).

7. **Adverse effects from impoundments**. If the discharge creates an impoundment of water, adverse effects on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized to the maximum extent practicable.

8. **Waterfowl breeding areas**. Discharges into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

9. **Removal of temporary fills**. Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting elevation.

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WOLF CREEK
NUCLEAR OPERATING CORPORATION

AI 26A-003

REGULATORY EVALUATIONS (OTHER THAN 10 CFR 50.59)

Responsible Manager

Manager Regulatory Affairs

Revision Number	6
Use Category	Reference
Administrative Controls Procedure	No
Management Oversight Evolution	No
Program Number	26A

DC38 3/20/2006

TABLE OF CONTENTS

1.0 PURPOSE

1.1 This document provides methods and instructions to determine and document whether changes can be made without prior regulatory approval. This instruction provides guidance for the Regulatory Evaluation process for evaluations other than those performed under 10 CFR 50.59.

2.0 SCOPE

2.1 This instruction establishes guidelines for the preparation of Regulatory Evaluations identified by the Applicability Determination process (Form APF 26A-003-01). This instruction is applicable to personnel performing or approving Regulatory Evaluations (other than 10 CFR 50.59).

3.0 REFERENCES AND COMMITMENTS

3.1 References

3.1.1 Procedure AP 26A-003, "10 CFR 50.59 Reviews"

3.1.2 Procedure AP 05-005, "Design Implementation and Configuration Control of Modifications"

3.1.4 Procedure AP 15C-004, "Preparation, Review, and Approval of Documents"

3.1.5 Procedure AP 07-002, "Environmental Protection Program"

3.1.6 Instruction AI 07A-002, "Environmental Protection Plan"

3.1.7 Instruction AI 26D-001, "Commitment Management System."

3.1.8 10 CFR 50.54, "Conditions of Licenses"

3.1.9 10 CFR 50.59, "Changes, Tests and Experiments"

3.1.10 PIR 96-01699, "10 CFR 50.54(q) Guidance Alignment With 10 CFR 50.47(b)."

3.1.11 Letter WO 97-0137, dated December 19, 1997, LER 97-016-01, "Fire Protection" (RCMS 97-271 - archived).

3.1.12 WCGS Facility Operating License No. NPF-42

3.1.13 USA 50.59 Resource Manual (Desktop Instruction)

3.1.14 NEI 96-07 Revision 1, "Guidelines for 10 CFR 50.59 Implementation."

3.1.15 PIR 2003-1890, Qualifying Activities

3.1.16 NRC Regulatory Issue Summary 2003-18, Supplement No. 1, "Use of Nuclear Energy Institute (NEI) 99-01, Methodology for Development of Emergency Action Levels," Revision 4, dated January 2003"

3.1.17 NRC Regulatory Issue Summary 2005-02, "Clarifying the Process for Making Emergency Plan Changes"

3.2 Commitments

3.2.1 Letter WM 91-0136, dated September 27, 1991, "Response to Violation 482/9116-01 and Exercise Weakness 482/9116-02" (RCMS 91-121)

4.0 DEFINITIONS

4.1 Applicability Determination

4.1.1 A review to determine if a proposed activity is controlled by other more specific regulations and can be excluded from review under 10 CFR 50.59.

4.2 Regulatory Evaluation

4.2.1 An evaluation completed in accordance with regulations or requirements other than 10 CFR 50.59 to determine whether the proposed change can be implemented without prior regulatory approval.

4.3 10 CFR 50.59 Screen

4.3.1 A review conducted to determine the necessity for performing a 10 CFR 50.59 Evaluation.

5.0 RESPONSIBILITIES

5.1 Managers, Superintendents, And Supervisors must ensure:

5.1.1 Regulatory Evaluations are performed and documented prior to implementation of proposed changes to facilities, procedures, tests or experiments for which they are responsible, as specified by this procedure.

5.1.2 Support is provided to other organizations, when needed, to complete a screening or evaluation.

5.2 Preparer

5.2.1 Prepares and develops the Regulatory Evaluation and any supporting documents and forms in accordance with this procedure.

5.2.2 Is cognizant of the technical aspects of the proposed change being reviewed.

5.2.3 Is responsible for the completeness and accuracy of the information provided as justification for the Regulatory Evaluations.

5.2.4 Ensures that the Regulatory Evaluation required by this instruction adequately and appropriately concludes whether NRC review and approval are required prior to implementing the proposed change.

5.3 Approver

5.3.1 Reviews the Regulatory Evaluations and any supporting documents and forms in accordance with this procedure.

5.3.2 Is cognizant of the technical aspects of the proposed change being reviewed.

5.3.3 Is responsible for the completeness and accuracy of the information provided as justification for the Regulatory Evaluation.

5.3.4 Ensures that the Regulatory Evaluations adequately and appropriately conclude whether NRC review and approval are required prior to implementing the proposed change.

5.3.5 Consults others with regard to complex problems that are beyond the approver's scope of expertise.

5.4 Superintendent Emergency Planning

5.4.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document a review under 10 CFR 50.54(q). Also ensures that the 10 CFR 50.54(q) evaluation adequately documents the disposition of all questions answered Yes on Attachment B.

5.4.2 Approves the 50.54(q) evaluation by signing the Form AIF 26A-003-01.

5.5 Manager Security

5.5.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document a Regulatory Evaluation under 10 CFR 50.54(p). Also ensures that the 10 CFR 50.54(p) evaluation adequately documents the disposition of all questions answered Yes on Attachment B.

5.5.2 Approves the 50.54(p) evaluation by signing the Form AIF 26A-003-01.

5.6 Supervisor Regulatory Support

5.6.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document a Regulatory Evaluation for environmental issues in accordance with the WCGS Facility Operation License No. NPF-42.

5.6.2 Approves the Regulatory Evaluation by signing the Form AIF 26A-003-01.

5.7 Manager Support Engineering Or Supervisor Engineer (Programs)

5.7.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document a Regulatory Evaluation for fire protection issues in accordance with the WCGS Facility Operating License NPF-42, Section 2.C.(5)(b).

5.7.2 Approves the Regulatory Evaluation by signing the Form AIF 26A-003-01.

5.8 Manager Quality (10 CFR 50.54(a))

5.8.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document a Regulatory Evaluation for Quality Program issues in accordance with 10 CFR 50.54(a).

5.8.2 Approves the Regulatory Evaluation by signing the Form AIF 26A-003-01

5.9 Manager Training (10 CFR 50.54(i-1)

5.9.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document a Regulatory Evaluation for License Operator Requalification Program issues in accordance with 10 CFR 50.54(i-1).

5.9.2 Approves the Regulatory Evaluation by signing the Form AIF 26A-003-01

5.10 Supervisor Licensing

5.10.1 Ensures the Form AIF 26A-003-01 is properly completed when prepared to document Regulatory Evaluation for a change affecting a commitment in accordance with AI 26D-001, "Commitment Management System."

5.10.2 Approves the Regulatory Evaluation by signing the Form AIF 26A-003-01

5.10.3 Coordinates and prepares submittals to the NRC requesting approval of changes made in accordance with 10 CFR 50.54.

6.0 PROCEDURE

6.1 General Requirements

6.1.1 Preparation of proposed changes to the Wolf Creek Generating Station (WCGS) facility and procedures and development of proposed activities at WCGS are controlled in accordance with various station procedures (e.g., AP 05-005 for design changes and AP 15C-004 for procedure changes). The proposed changes and activities to be reviewed in accordance with this procedure must be completely developed in accordance with applicable procedures prior to performing Regulatory Evaluations.

6.1.2 The Regulatory Evaluation(s), shall contain sufficient detail to allow for independent review. A simple statement of conclusion by itself will not be acceptable.

NOTE

The Regulatory Evaluation is not required for changes or activities made in accordance with regulations or requirements listed in 6.9 of this procedure.

6.1.3 The Regulatory Evaluation(s) shall be used to document the associated review and evaluation of regulatory issues other than 50.59.

6.1.4 Regulatory Evaluations for Computer Software Modifications, Design Change Packages (DCP), Configuration Change Packages (CCP), and General Maintenance Requests should be based on the inservice condition of the proposed modification after installation in accordance with approved design.

6.1.5 Completed Regulatory Evaluations, shall accompany the primary record copy containing the change or modification documentation to the vault (i.e., procedure, USARCR, CCP or DCP). This is the number recorded on the Applicability Determination forms as the document/activity number.

6.1.6 The USA 50.59 Resource Manual is consistent with NEI 96-07 and provides useful guidance on application of rules other than 10 CFR 50.59. The current revision of the USA 50.59 Resource Manual is available on the NEI Website and in Paperless under Regulatory Information.

6.2 Security (APF 26A-003-01, Question II.3)

CAUTION

Exercise appropriate Safeguards Controls.

NOTE

A Regulatory Evaluation is documented only when the activity results in a change to the Security Plan. Changes that result in a decrease to the effectiveness of the Security Plan are submitted to the NRC in accordance with AP 26B-001, "Revisions to the Operating License and/or Technical Specifications."

6.2.1 Could the proposed change potentially result in a violation of provisions of the following documents, or, result in any of these documents being untrue or inaccurate?:

1. The Security Plan,
2. The Safeguards Contingency Plan, or
3. The Security Training and Qualification Plan?

6.2.2 These are all safeguards documents and all documentation relative to this question must be evaluated for potential safeguard controls. If any questions arise relative to this question, the Manager Security or the Manager Design Engineering should be contacted depending upon the nature of the proposed change. If this question is answered "Yes," a security related plan change evaluation must be completed pursuant with 10 CFR 50.54(p) prior to making the change. This evaluation shall be completed in accordance with Attachment B of this instruction and approved by the Superintendent Security or the Manager Design Engineering.

6.3 Operating Quality Program (APF 26A-003-01, Question II.2)

NOTE

A Regulatory Evaluation is documented only when the activity results in a change to the Quality Program as described below. A change cannot be made without prior NRC approval if it reduces a commitment in the Operating Quality Program.

6.3.1 If all answers to the following questions are "No", the change may be accepted without further evaluation. If any answer is "Yes", continue the evaluation in accordance with section 6.3.2.

1. Does the change conflict with 10 CFR Part 50, Appendix B or Regulatory Guide or Standard (ANSI, ANS, etc.) committed to in the Operating Quality Program as described in Chapter 17.2 of the USAR?

2. Does the change eliminate a function, control or activity described in Operating Quality Program described as in Chapter 17.2 of the USAR?

3. Does the change reduce the size of control of the Quality Organization established in the Operating Quality Program as described in Chapter 17.2 of the USAR?

4. Are there any other reasons that the change would reduce a commitment in the Operating Quality Program as described in Chapter 17.2 of the USAR?

NOTE

The bases for review conclusions of 6.3.2.1 through 6.3.2.8 shall be included in the Evaluation of Proposed Change (AIF 26A-03-01).

6.3.2 Changes to the Operating Quality Program as described in Chapter 17.2 of the USAR are Not considered to be a reduction in commitment providing the changes are limited to and do not exceed the following:

1. Administrative improvements and clarifications.

2. Spelling corrections, punctuation, or editorial items.

3. The use of a QA standard approved by the NRC which is more recent than the QA standard in the current Operating Quality Program as described in Chapter 17.2 of the USAR.

4. The use of a quality assurance alternative or exception approved by an NRC safety evaluation, provided that the bases of the NRC approval are applicable to WCGS.

5. The use of generic organizational position titles that clearly denote the position function, supplemented as necessary by descriptive text, rather than specific titles.

6. The use of generic organizational chart to indicate functional relationships, authorities, and responsibilities, or, alternately, the use of descriptive text.

7. The elimination of quality assurance program information that duplicated language in quality assurance regulatory guides and quality assurance standards to which the licensee is committed.

8. Organizational revisions that ensure that persons and organizations performing quality assurance functions continue to have the requisite authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations.

6.3.3 The Manager Quality must evaluate and approve changes processed per this procedure prior to implementation.

6.4 Fire Protection Program (APF 26A-003-01, Question II.7)

NOTE

A Regulatory Evaluation is documented only when the activity results in a change to the Fire Protection Program. The change cannot be made without prior NRC approval if it would adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

6.4.1 Individuals performing an Evaluation of Proposed Change (Other Than 10 CFR 50.59) evaluation for a change to the Fire Protection Program shall be qualified in accordance with ES9280455, "Fire Protection Engineer" (Reference 3.1.15)

6.4.2 Could the proposed change potentially result in a violation of provisions of the Fire Protection Program described in Section 9.5.1, or Appendices, in the USAR, or, result in this document being untrue or inaccurate?

1. If the proposed change modifies the descriptions of the Fire Protection Program in Section 9.5.1, or the Appendices, of the USAR, or makes them inaccurate, an evaluation pursuant to License NPF-42 paragraph 2.C(5) must be approved by the Supervisor Enginner (Programs) or an Engineering Manager responsible for Fire Protection prior to implementing the change. The evaluation shall be completed by a qualified fire protection engineer (Generic Letter 86-10) or an individual fulfilling the requirements of Table 9.5A-1, Section A.1 of the USAR.

6.4.3 The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shut down in the event of a fire.

6.4.4 The Fire Protection Program is that as described in USAR section 9.5.1 and its appendices.

6.4.5 USAR Appendix 9.5B "Fire Hazards Analyses" documents an evaluation of the fire hazards for each plant area and fire protection provision provided to ensure at least one train of post-fire safe shut down equipment is free of fire damage following a fire. Any changes to the Fire Protection Program should be evaluated for its impact on the FHA.

6.4.6 The detail included in the evaluation should be commensurate with the proposed change and the evaluation must provide sufficient evidence that fire safe shutdown is not impacted. As a conclusion, the evaluation should state that the ability to achieve and maintain safe shut down in the event of a fire is maintained.

6.4.7 An evaluation performed in accordance with the license condition should include an assessment of the impact of the change on the existing fire hazards analysis for the area, as is current practice. The assessment should address the effects on combustible loading and distribution and should consider whether circuits or components, including associated circuits, for a train of equipment needed for safe shutdown could be affected, or whether a new element could be introduced into the area. Refer to NEI 96-07, "Guidelines for 10 CFR 50.59 Implementation."

6.4.8 In accordance with the Quality Program (17.2.1.4) changes to the Fire Protection Program are submitted to the Plant Safety Review Committee for approval.

6.5 Emergency Plan (APF 26A-003-01, Question II.4)

NOTE

A Regulatory Evaluation is documented only when the activity results in a change to the Radiological Emergency Response Plan (RERP). The change cannot be made without prior NRC approval if it is a decrease in the effectiveness of the RERP.

6.5.1 Could the change potentially involve a violation of provisions of the Radiological Emergency Response Plan, or, result in this document being untrue or inaccurate? If the answer to this question is "Yes," an evaluation pursuant to 10 CFR 50.54(q) must be approved by the Superintendent Emergency Planning prior to implementing the change.

6.5.2 Attachment A provides guidance to perform an evaluation pursuant to 10 CFR 50.54(q). This evaluation must be approved by the Superintendent Emergency Planning prior to implementing the change. [Reference Commitment 3.2.1]

6.6 Licensed Operator Requalification (APF 26A-003-01, Question VI)

NOTE

A Regulatory Evaluation is documented only when the activity results in a change to the NRC approved program. The change cannot be made without prior NRC approval if it decreases the scope of the NRC approved program.

6.6.1 Could the change potentially result in a violation of provisions of the Licensed Operator Requalification Program as described in USAR Section 13.2.1.2, or, result in this document being untrue or inaccurate?

1. If the proposed change modifies the description of the Licensed Operator Requalification Program in USAR Section 13.2.1.2, or makes it inaccurate, an evaluation must be completed in accordance with 10 CFR 50.54(i-1) and approved by the Manager Training prior to implementing the change.

6.6.2 Evaluation of the proposed change shall be performed in accordance with Attachment C of this instruction.

6.7 Commitment (APF 26A-003-01, Question V.2)

NOTE

The change cannot be made without prior documented NRC agreement if it is a reduction in a commitment in accordance with instruction AI 26D-001.

6.7.1 NRC commitments are identified, tracked and maintained in a computer database. In addition, NRC commitments associated with procedure changes should be specifically cross referenced in procedures. For other proposed changes, the Regulatory Commitment Management System data base may be searched to identify potential affect on NRC commitments. If NRC commitments might be affected, an evaluation must be coordinated by the Supervisor Licensing regarding NRC commitments.

6.7.2 Regulatory Commitments shall be evaluated in accordance with AI 26D-001."

6.8 Appendix B and Environmental (APF 26A-003-01, Question VI)

NOTE

The change cannot be made without prior NRC approval if questions 1 and 2 below are answered Yes. The proposed change could constitute a UEQ and require a license amendment under 10 CFR 50.90. The change cannot be made without prior KDHE approval if questions 3, 4, 8, or 9 below was answered Yes. Therefore, if any of the questions are answered "Yes," an environmental impact determination must be approved by the Supervisor Regulatory Support (using AIF 26A-003-01) prior to implementation of the change.

6.8.1 Appendix B to the OPERATING LICENSE requires certain changes be reviewed and approved prior to implementation. Contact Supervisor Regulatory Support for guidance. Determine if the proposed change involves one or more of the following:

1. An increase in thermal power above the currently licensed level and/or alteration in the amount or temperature of cooling water discharges?

a. Since WCNOC cannot legally increase power above the licensed level, the first part of this question should not be a problem. However, the second part is still valid. We can make changes to equipment or procedures that change the amount or temperature of cooling water discharges. For example, operating with two circulating water pumps instead of three changes the circulating water discharge temperature.

NOTE

For purposes of the following paragraph, the Site Boundary is defined in accordance with USAR 2.1.1.2, as the 9,818 acres occupied by the WCGS site.

2. A physical change in an area outside of the Owner Controlled Area Boundary (OCAB), but within the Site Boundary which was not disturbed by previous construction?

   a. Examples of this item would be the construction of a building, road, or parking lot.

3. A change in the rate, volume, concentration, composition or flow path of nonradiological liquid effluents, including storm water run-off?

   a. This would involve changes to such things as sewage lagoon modifications, waste water treatment discharges, service water and circulating water discharges, ESW discharges, lime sludge pond discharges and all National Pollutant Discharge Elimination System (NPDES) discharges.

   b. This also includes discharges of previously unapproved chemicals, such as biocides and corrosion inhibitors.

4. A change that will result in the modification of an existing air emission source or the installation of a new air emission source?

   a. This could involve changes to such things as the Auxiliary Boiler and various diesel generators fuel consumption, or increases in the potential to emit sulfur dioxide or nitrogen oxides.

b. This could also involve air emission changes that result from open burning such as fire protection training, waste volume reduction or rangeland burning.

c. This could involve the temporary use of boilers, and or internal combustion engines (e.g., diesel generators, pumps or gasoline powered compressors).

5. A change in the volume, concentration or composition of nonradiological solid waste?

   a. This would include changes such as sewage sludge disposal, hazardous waste disposal, and landfill disposal, as well as solids disposed of on company property.

6. A change that will result in the procurement of a non-material code chemical in quantities greater than or equal to 10,000 pounds?

7. A change that will result in procurement, modification, sale or disposal of a radiation producing device (e.g., x-ray machines) regulated by the State of Kansas?

8. The addition of a new storage tank, or physical changes to the piping or capacity of an existing tank, that contains more than 660 gallons of any chemical?

9. A change which involves adding dredge material to or removing dredge material from the cooling lake, Neosho River or facilities such as the circulating water screenhouse, essential service water pumphouse, makeup water screenhouse and makeup water discharge structure?

   a. This would involve the mechanical relocation of silt and sediment. Examples include boat ramp construction, ESW intake canal dredging, and vacuuming the ESW or Circulating water screenhouse intake bays.

6.8.2 The Supervisor Regulatory Support shall ensure the evaluation and approval of a Regulatory Evaluation prior to implementation of this change.

6.8.3 Procedure AP 07-002 and Instruction AI 07A-001 shall be used in performing this evaluation.

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50.54 (Q) GUIDANCE

A.2.4 Does the change affect the Emergency Action Levels (EALs) as stated in the RERP or Regulatory Guide 1.101, including:

1. Changing from one emergency action level scheme to another emergency action level scheme (e.g. a change from an emergency action level scheme based on NUREG-0654 to a scheme based upon NUMARC/NESP-007 or NEI-99-01).

   ☐ Yes ☐ No

2. Have changes to the EALs been submitted to the State and County for their review? (This is not required for NRC approval.)

   ☐ Yes ☐ No

A.2.5 Does the change affect: how the State, County, and WCNOC Emergency Response Organization (ERO) are notified; the content of initial and followup messages to the State, County, Public and ERO; or the means to provide clear instructions to the public in the 10 mile EPZ, as stated in the RERP; and have the State and County concurred if changes to the Immediate and Followup Notification forms have been made?

☐ Yes ☐ No

A.2.6 Does the change affect how prompt communications among principal response organizations to emergency personnel and the public are made, as stated in the RERP?

☐ Yes ☐ No

A.2.7 Does the change affect when the public is furnished information on how they will be notified and what their initial actions should be in an emergency, the principal point(s) of contact with the media for dissemination of information during an emergency and their locations, or the method of coordinating dissemination of information to the public, as stated in the RERP?

☐ Yes ☐ No

A.2.8 Does the change affect the emergency facilities or equipment to support the emergency response, as stated in the RERP, including:

1. Equipment for personnel monitoring?

   ☐ Yes ☐ No

2. Equipment for determining the magnitude of and for continuously assessing the impact of the release of radioactive materials to the environment?

   ☐ Yes ☐ No

3. Facilities and supplies for decontamination of onsite individuals?

   ☐ Yes ☐ No

4. Facilities and supplies for emergency first aid treatment?

   ☐ Yes ☐ No

5. Arrangements for the services of physicians and other medical personnel qualified to handle radiation emergencies on-site?

   ☐ Yes ☐ No

6. Arrangements for transportation of contaminated injured individuals from the site to specifically-identified treatment facilities outside the site boundary?

   ☐ Yes ☐ No

7. Arrangements for treatment of individuals injured in support of licensed activities on the site at treatment facilities outside the site boundary?

   ☐ Yes ☐ No

8. An onsite technical support center and a near-site emergency operations facility from which effective direction can be given and effective control can be exercised during an emergency?

   ☐ Yes ☐ No

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50.54 (Q) GUIDANCE

9. At least one onsite and one offsite communications system, each system having a backup power source?

☐ Yes ☐ No

A.2.9 Does the change affect the methods, systems and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition, including the description for determining the magnitude of and for continually assessing the impact of a release, as stated in the RERP?

☐ Yes ☐ No

A.2.10 Does the change affect protective actions for the 10 mile EPZ for emergency workers and the public, the protective actions guidelines for the 10 mile EPZ and 50 mile EPZ (that are consistent with Federal Guidance) as stated in the RERP?

☐ Yes ☐ No

A.2.11 Does the change affect the means for controlling radiological exposure to emergency workers in an emergency or the exposure guidelines that are consistent with EPA Emergency Worker and Lifesaving Activity Protective Action Guides, as stated in the RERP?

☐ Yes ☐ No

A.2.12 Does the change affect the arrangements made for medical services for contaminated injured individuals as stated in the RERP?

☐ Yes ☐ No

A.2.13 Does the change affect the general plans for recovery and reentry, as stated in the RERP?

☐ Yes ☐ No

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50.54 (Q) GUIDANCE

A.2.14 Does the change affect the requirements for periodic exercises conducted to evaluate major portions of emergency response capabilities or of periodic drills conducted to develop and maintain key skills and correct deficiencies as a result of drills or exercises, as stated in the RERP, including:

1. Testing the adequacy of timing and content of implementing procedures and methods; testing of emergency equipment, communications networks, or the public notification system; and ensuring the emergency organization personnel are familiar with their duties?

   ☐ Yes ☐ No

2. An annual exercise of the onsite emergency plan?

   ☐ Yes ☐ No

3. A biennial exercise with full participation by offsite authorities?

   ☐ Yes ☐ No

4. An ingestion pathway exercise with full participation offsite authorities once every six years?

   ☐ Yes ☐ No

A.2.15 Does the change affect radiological emergency response training for those who may be called in to assist in an emergency, as stated in the RERP, including:

1. Training and exercising, by periodic drills, of employees, ensure that employees are familiar with their specific emergency response duties?

   ☐ Yes ☐ No

2. Training and exercising, by periodic drills, of other persons from whom assistance may be needed in the event of a radiation emergency?

   ☐ Yes ☐ No

3. The description of specialized initial training and periodic retraining for Directors of the emergency organization, accident assessment personnel, radiological monitoring teams, fire brigade, repair and damage control teams, first aid and rescue teams, medical support personnel and security personnel?

   ☐ Yes ☐ No

4. The radiological orientation training program available to local services personnel, including emergency preparedness, local law enforcement, and local news media personnel?

   ☐ Yes ☐ No

5. Provisions for a formal critique in order to identify weak or deficient areas that need correction for all training, including exercises?

   ☐ Yes ☐ No

A.2.16 Does the change affect responsibilities for the development, review, and distribution of the RERP and the training of the planners, as stated in the plan?

☐ Yes ☐ No

A.2.17 Does the change affect the description of the organization for coping with radiological emergencies or the definitions of authorities, responsibilities, and duties of those assigned to the ERO, or the means for notification of those individuals, as stated in the RERP, including:

1. The description of the normal plant operating organization?

   ☐ Yes ☐ No

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2. The description of the onsite ERO, including the detailed descriptions of; the authorities, responsibilities, and duties of the Shift Manager/Site Emergency Manager who will take charge during an emergency; plant staff emergency assignments; or the authorities, responsibilities and duties of the Site Emergency Manager or Off-site Emergency Manager who shall be in charge of the exchange of information with offsite authorities responsible for coordinating and implementing offsite emergency measures?

   ☐ Yes ☐ No

3. Identification, by position and function to be performed, of ERO personnel responsible for making offsite dose projections, and a description of how the results are transmitted to State, County, NRC, and other appropriate governmental agencies?

   ☐ Yes ☐ No

4. Identification, by position and function to be performed, of WCNOC personnel with special qualifications for coping with emergency conditions that may arise or of consultants who may be called upon, and a description of their special qualifications?

   ☐ Yes ☐ No

5. The description of the local offsite services to be provided in support of WCNOC's emergency organization?

   ☐ Yes ☐ No

6. Identification of and assistance expected from appropriate State, County, and Federal agencies with responsibilities for coping with emergencies?

   ☐ Yes ☐ No

7. Identification of the State and County officials responsible for planning, ordering, and controlling appropriate protective actions, including evacuations, when necessary?

   ☐ Yes ☐ No

ATTACHMENT A
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50.54 (Q) GUIDANCE

A.2.18 Does the change affect the description of the activation of the ERO for each emergency classification, as stated in the RERP?

☐ Yes ☐ No

A.2.19 Does the change affect the description of the message authentication scheme used with the State and County for each emergency classification, as stated in the RERP?

☐ Yes ☐ No

A.2.20 Does the change affect the description of: the administrative and physical means of notifying the County, State or Federal agencies; the agreements with County, State, and Federal agencies for the prompt notification of the public and for the implementation of protective actions; or the identification of the appropriate County and State officials, by title and agency, responsible to implement protective actions?

☐ Yes ☐ No

A.2.21 Does this change affect the yearly dissemination of information to the public in the 10 Mile EPZ of basic emergency planning information such as methods and times required for public notification; protective actions planned if an accident occurs; general information on the nature and effects of radiation; or the list of broadcast stations that will disseminate emergency information?

☐ Yes ☐ No

A.2.22 Does the change affect the capability to notify the County and State within 15 minutes after declaring an emergency?

☐ Yes ☐ No

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50.54 (Q) GUIDANCE

A.2.23 Does the change affect communication plans, including titles and alternates for those in charge at both ends of the communication links and the primary and backup means of communication, and:

☐ Yes ☐ No

1. Provisions for communicating with the County and State within the 10 Mile EPZ and for the monthly testing of those provisions?

   ☐ Yes ☐ No

2. Provisions for communicating with Federal emergency response organizations and for the annual testing of those provisions?

   ☐ Yes ☐ No

3. Provisions for communication between the Control Room, Technical Support Center, Operations Support Center, and Emergency Operations Facility, including the County and State Emergency Operations Centers and field assessment teams and the annual testing of those provisions?

   ☐ Yes ☐ No

4. Provisions for communication between the NRC headquarters and Regional Operations Centers and the Control Room, Technical Support Center, Operations Support Center, and Emergency Operations Facility, and for the monthly testing of those provisions?

   ☐ Yes ☐ No

A.2.24 Does the change result in the use of an alternate method for meeting the regulations? Alternate methods for complying with the regulations are the proposed means for meeting the regulation. Regulatory Guide 1.101 states that licensees may propose means other than those specified by the provisions of the Regulatory Position of this guide for meeting applicable regulations.

☐ Yes ☐ No

END -

ATTACHMENT B
(Page 1 of 2)
50.54 (P) GUIDANCE

B.1 Effectiveness Evaluation 10 CFR 50.54(p)

In accordance with 10 CFR 50.54(p), revisions shall be reviewed for changes which might reduce the effectiveness of the Security Plan, the Safeguards Contingency Plan or the Guard Training and Qualification Plan. If effectiveness is reduced, regulatory approval must first be granted before implementation of the change. Reference Generic Letter 95-08, "10 CFR 50.54(p) Process for Changes to Security Plans Without Prior NRC Approval," for further guidance.

B.2 Section Title:

Provide the section and title of where the change is proposed.

B.3 Proposed Commitment:

Specify the relevant existing condition and revised condition. Address any offsetting provisions.

B.4 Impact on Effectiveness of the Physical Security Plan; the Safeguards Contingency Plan or the Security Training and Qualification Plan:

This section asks a series of questions. If the response to each question is "no" and the rationale supports a "no" response, the change may be processed using the provisions of 10 CFR 50.54(p) without NRC prior approval.

NOTE

Rationale for yes and no answers must be explained on Form AIF 26A-003-01.

B.4.1 Does this change delete or contradict any regulatory requirement?

☐ Yes ☐ No

B.4.2 Would the change decrease the overall level of security system performance as described in paragraphs (b) through (h) of 10 CFR 73.55 to protect with the objective of high assurance against the design basis threat of radiological sabotage as stated in 10 CFR 73.1(a)?

☐ Yes ☐ No

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50.54 (P) GUIDANCE

B.4.3 For NRC approved Security Plan commitments that are alternatives to one or more of the requirements of 10 CFR 73.55(b) through (h): Does the change decrease the overall level of security system performance needed to protect, with the objective of high assurance, against the design basis threat of radiological sabotage as stated in 10 CFR 73.1(a)? Explain why the change does not decrease the overall effectiveness of the plan while taking into consideration existing unique site-specific security features. Consider historical reasons why specific commitments were included with security plans. Were there specific counter balancing commitments and has that counter balance been changed negatively.

☐ Yes ☐ No

B.5 Does this proposed revision decrease the effectiveness of the Physical Security Plan; the Safeguards Contingency Plan or the Security Training and Qualifications Plan?

☐ Yes ☐ No

-END-

ATTACHMENT C
(Page 1 of 1)
OPERATOR REQUALIFICATION GUIDANCE

C.1 Does the change cause the requalification program not to run continuously with back-to-back programs?

☐ Yes ☐ No

C.2 Does the change cause the requalification program to exceed 2 year discrete cycles in duration?

☐ Yes ☐ No

C.3 Does the change cause the requalification program to depart from the systems approach to training?

☐ Yes ☐ No

C.4 Does the change reduce the records documenting the participation of each licensed operator and senior operator in the requalification program?

☐ Yes ☐ No

C.5 Does the change cause a reduction in the record retention requirements for the requalification program?

☐ Yes ☐ No

C.6 Does the change cause the requalification program to be administered by people other than Wolf Creek Nuclear Operation Corporation employees?

☐ Yes ☐ No

-END-

47. Site-specific hydrogeological information, including: groundwater depth(s) at site; aquifer(s) present at site; location, elevation, construction, and historical analyses on current and past monitoring wells (including B-12, C-10, C-49, J-1, J-2, G-2, and F-1); details of the current monitoring and analytical program; flow direction information (direction, rate, fate); and comprehensive local production information (locations, construction information, history of analysis, pump rates, use).

• Site-specific hydrogeological information, including: groundwater depth(s) at site; aquifer(s) present at site; location, elevation, construction, and historical analyses on current and past monitoring wells (including B-12, C-10, C-49, J-1, J-2, G-2, and F-1); details of the current monitoring and analytical program; flow direction information (direction, rate, fate); and comprehensive local production information (locations, construction information, history of analysis, pump rates, use).

• Documentation of any environment releases, including any evaluations of the incident with respect to the nature, extent, and impact of the release.

• Locations, volumes, and existing chemical and radiological analytical data on drinking water intakes for Burlington, Neosho Falls, Iola, and any other intakes on the Neosho River between JRR and Iola.

• Correspondence, reports, and any other information related to any past restrictions on water withdrawal, if any have occurred. If none have occurred, a statement that these restrictions have never been implemented.

• More detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells included in the study, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

• A map showing the locations of all groundwater monitoring or production wells in the local area, including their depths, rates of production, and use of water, if known. Section 2.9.1 states that 80% of water use in the basin is from surface sources – describe the source, location, and use of the other 20%.

• More detailed meteorological data, including historic rainfall data, to provide additional information for the evaluation of water use conflicts in Section 2.10 of the ER (WCGS, 1980). Include average rainfall, seasonal variations, and information on extreme conditions. Please provide the average peak and low-flow values for the Neosho River. Also provide information on seasonal variability, if it exists.

• Clarification of the relationship between the WCNOC contract with the Kansas Water Resources Board, versus the "Certificate of Appropriation" discussed in ER Section 4.1. It appears that the contract has controls based on available supply within the reservoir, while certificate has controls based on the flow rate in the river. Please verify if this is correct. Also identify if a different agency implements the controls in either case, or if this is a single agency.

ATTACHMENT A
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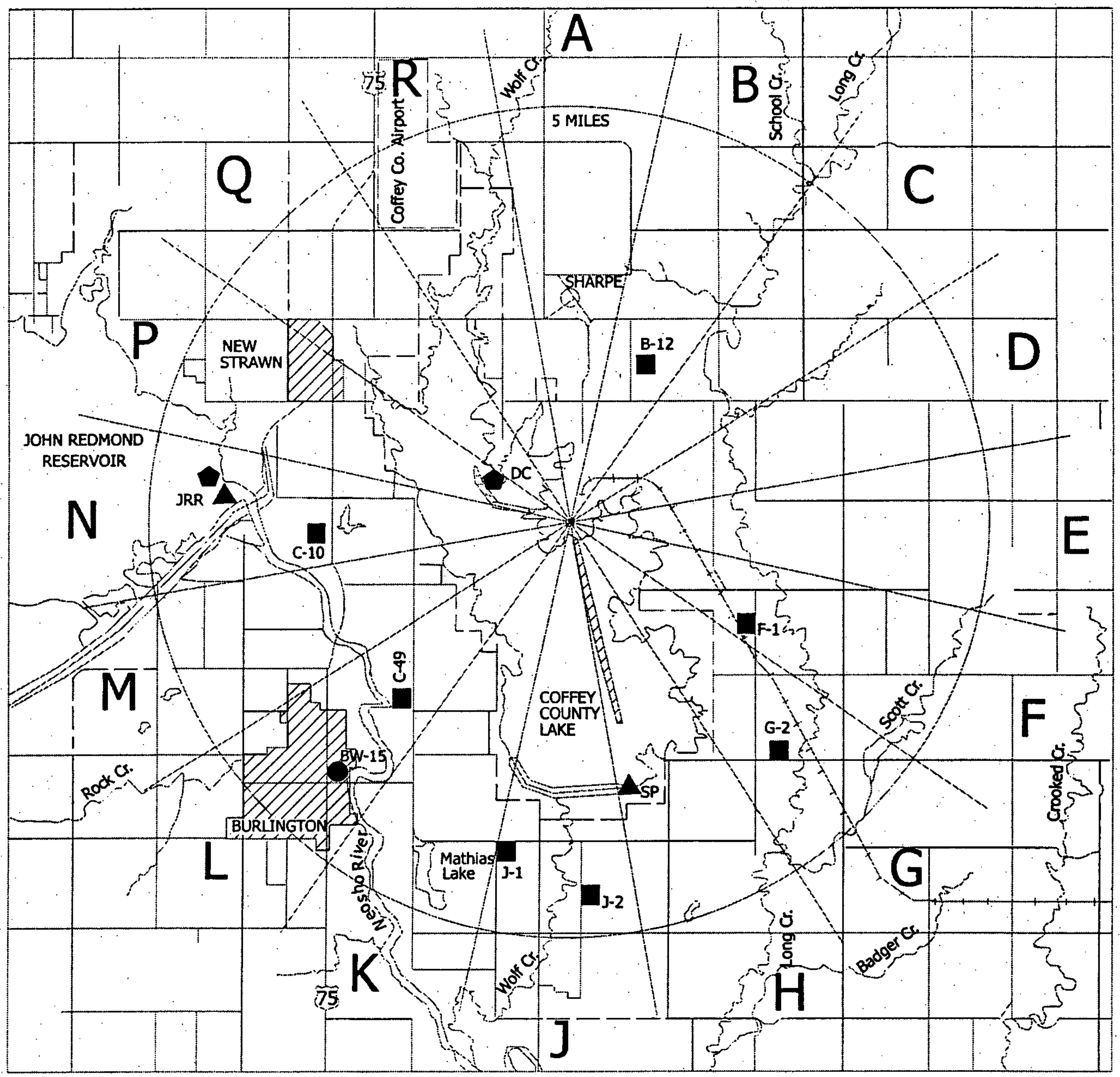
OFFSITE DOSE CALCULATION MANUAL (REMP)

FIGURE 5.3



WATERBORNE PATHWAY SAMPLING LOCATIONS

● = DRINKING WATER ▲ = SURFACE WATER
■ = GROUND WATER ⬟ = SHORELINE SEDIMENT

2.4 HYDROLOGY

The surface-water, ground-water, and water-quality characteristics of the Wolf Creek Generating Station site and vicinity have previously been described in Section 2.5 of the Environmental Report - Construction Permit Stage [ER(CPS)]. Section 2.4 of the ER(OLS) updates some of the information previously presented and also repeats much of the information from the ER (CPS) for continuity.

Section 2.4.1.1 (Hydrosphere) incorporates some new information such as the drainage area of the Neosho River upstream of Burlington, the nearest downstream control structure on the Neosho River, and the average annual snowfall near the site. Portions of the section have been repeated for continuity with some editorial changes for clarity.

Section 2.4.1.2 (Flow Characteristics) includes updated information on estimated Wolf Creek monthly streamflows, and Neosho River water rights downstream of Wolf Creek. Portions of the section have been repeated with some editorial changes.

Section 2.4.1.3 (Wolf Creek Cooling Lake) has been revised to include information and descriptions of the cooling lake, make-up water supply from John Redmond Reservoir, and bathymetry of the circulating water intake and discharge channels.

Section 2.4.2 (Ground-Water) includes updated information on piezometer water-level readings, and supplemental permeability data not available at the time of the ER(CPS). These data are presented in updated tables and figures. The text of Sections 2.4.2.1 through 2.4.2.3 has been repeated for continuity with some editorial changes. Section 2.4.2.4 (Ground-Water Models - Seepage from the Cooling Lake) has been added to present the results of seepage analyses which were not available at the time of the ER(CPS).

Figures which illustrate the locations of piezometers relative to site structures have also been updated to show the revised arrangement of site facilities.

Section 2.4.3 (Water Quality) has been revised to reflect the ongoing water quality monitoring program which has been conducted near the WCGS site since 1973.

2.4.1 SURFACE WATER

The site of the Wolf Creek Generating Station is located in the Wolf Creek watershed. Natural topographical, hydrological and other physical features of the Wolf Creek watershed as well as site facilities are shown on Figure

2.4.2 GROUND-WATER

2.4.2.1 Formational Hydrogeologic Characteristics

Small quantities of ground-water are regionally available from three sources within a 50-mile radius of the site:

1. The alluvial deposits in the river valleys;

2. The shallow soils and weathered bedrock; and

3. The deep bedrock.

2.4.2.1.1 Alluvium

The river alluvium in the region is composed of silt, sand, and gravel. The Neosho River flows southeast through Morris, Chase, Lyon, Coffey, Anderson, Woodson, Allen and Neosho counties, and passes within 3 miles of the site. The width of the alluvium in the valley ranges from about 1 to 10 miles. Other alluvial aquifers are associated with the Marias des Cygnes River in Osage, Franklin, Miami, Anderson, and Linn counties; the Verdigris River in Lyon, Greenwood, Woodson, Elk, and Wilson counties; and the Osage River in Bourbon County adjoining the state of Missouri.

The alluvium along the Neosho River in Coffey, Woodson, and Allen counties is less than 20 feet thick, has a water producing potential of less than 100 gallons per minute (gpm) to wells. The alluvium receives recharge mainly from precipitation and from bedrock discharge in areas where an artesian head is higher than the river surface. The alluvium discharges ground-water to the Neosho River; the ground-water system contributes water to the Neosho, an effluent stream, from John Redmond Reservior to at least as far downstream as Iola, Kansas (the furthest downstream place studied). As there are no large withdrawals of ground-water to create water level declines in the alluvium, water from the Neosho River is not being artifically induced into the alluvium because of a gradient reversal. Other than the supply well of the city of New Strawn, located above the confluence of Wolf Creek and the Neosho River, there are no irrigation, industrial, commercial, or public supply wells tapping the alluvium along the Neosho River as far downstream as Iola, Kansas. Because the alluvium does not yield sufficient quantities of water for irrigation, it is unlikely that significant irrigation withdrawals will be developed in the future. A detailed discussion of ground-water use along the Neosho River is presented in Section 2.1.3.4.

High-water conditions of the Neosho River are not likely to affect ground-water conditions significantly. Normal seasonal increases of the river stage increases bank storage (water absorbed into the banks of the stream channel) in the alluvium. As the stage recedes, the water returns from the banks to the river. The actual horizontal migration distance of river water back into the alluvium under these conditions is on the order of up to 100 to 200 feet. The high volume of runoff during high river stage would dilute any blowdown effluent that might recharge the shallow ground-water during that period. There are probably no domestic or stock wells that would be affected by normal high seasonal stages of the Neosho River at least as far downstream as Iola, Kansas. Therefore, the discharge of any effluents to the Neosho River is not expected to contaminate the shallow ground-water system.

The flood control dams at Council Grove, Marion, Cedar Point and John Redmond Reservoirs help reduce the severity of flooding. The July 1948 flood, selected as an intermediate flood by the U.S. Army Corps of Engineers (1965), would not have flooded Neosho Falls had the flood control dams been constructed. Thus, privately-owned water wells in the community of Neosho Falls would not now (1979) be affected by a flood of the July 1948 magnitude, and there are few residences and wells on the floodplain of the Neosho River. In a small watershed such as the Neosho River Basin, ground-water levels in the floodplain will have already risen and the soil will be saturated in response to precipitation so that, by the time a flood occurs, there will be little available room for additional recharge from the flood waters. Most of the flood waters would retreat by runoff as the stage falls. High dilution of any blowdown effluent would preclude deterioration of ground-water quality by recharge of flood waters.

2.4.2.1.2 Soil and Weathered Bedrock

The soil and weathered bedrock is composed of weathered shales, siltstones, sandstones, and limestones and the soils derived from them. The weathered materials usually retain some of the characteristics of the parent rock.

Wells in the weathered zone yield up to 10 gallons per minute in the region (Bayne and Ward, 1967), and are generally used domestically and for livestock. Recharge to the weathered zone which may extend down to about 20 feet is from local precipitation. Discharge is into the alluvium, streams, and local wells.

Water levels in the wells and shallow piezometers show that the shallow ground-water table closely resembles the topography within a 5-mile radius of the site area, as shown on Figure 2.4-6.

The permeability values presented for the geologic strata in Tables 2.4-6 and 2.4-7 represent estimated horizontal permeabilities. The actual vertical permeabilities are probably several orders of magnitude less than the horizontal permeabilities shown. There are, however, no accurate means to approximate the ratio of the vertical to the horizontal permeability using existing data. The vertical permeability can best be determined from laboratory tests. Laboratory tests of samples will only be reliable if the samples are consolidated and relatively undisturbed.

The methods and techniques utilized in the determination of the in-situ permeabilities are outlined in Section 2.5.4 of the Wolf Creek Generating Station, Unit No. 1 Final Safety Analysis Report (WCGS FSAR).

Permeability of the surficial materials is primarily dependent upon the intensity of weathering of the parent rock. Near and at the surface, the weathered limestones are vuggy and exhibit a much higher permeability than do the weathered shales. The sandy facies of the Jackson Park Shale Member commonly has an appreciably higher permeability than the shaley facies. The depth of the weathered zone on the hill tops and upper hill slopes is less than the depth of weathering in lower, flatter areas where ground-water is closer to the ground surface.

Generally, the surficial weathered zone in the upper 5 to 10 feet is comprised of residual clayey soils (from shale parent rocks) with numerous root holes, insect burrows, and animal burrows. Desiccation and soil creep have opened minute cracks. These openings provide water channels that allow the rapid infiltration of water. As infiltration continues, internal scour produces detached particles that gradually clog the narrowest parts of the water passages, and swelling of the desiccated clay particles further reduces the effective size of the openings. In response to recharge, the coeffcient of permeability decreases to a small fraction of its "dry" or initial value.

Where it is saturated, the weathered bedrock (except limestone) has a greater permeability than the overlying soil zone. Table 2.4-7 provides a summary of the permeabilities of the bedrock as related to depth. The permeability values were broken down according to depth because of the variation with depth. The column labeled 0 to 20 feet provides a tabulation of the permeabilities (essentially horizontal permeabilities) of the weathered bedrock units. The permeabilities of the deeper bedrock (greater than 20 feet) are generally less and are representative of unweathered bedrock.

As indicated on Tables 2.4-6 and 2.4-7, the numerous unweathered shale units in the area retard the vertical movement of water. In the site area, the in-situ permeabilities obtained for the deeper bedrock strata are essentially horizontal permeabilities. During the various in-situ tests, the shales restricted water flow in the vertical direction and the water, taking the path of least resistance, flowed radially and horizontally out from the tested interval.

Briefly, the numerous shale units and residual soils, because of their horizontal bedding structure, have permeabilities in the vertical direction of several orders of magnitude less than in the horizontal direction. The in-situ permeability tests performed were adequate for measuring these values, and the horizontal permeabilities obtained are presented in Tables 2.4-6 and 2.4-7.

2.4.2.1.3 Consolidated Bedrock

The sandstone and limestone bedrock below the weathered zones in the region yield small quantities of water to wells (Merriam, 1963; and Bayne and Ward, 1967). Their stratigraphy and lithology are described in Section 2.5.6.1; a detailed site stratigraphic column is presented on Figure 2.5-9. The strata as determined from borehole data range upwards from the Lansing Group (Missourian stage) of the Pennsylvanian System. The yield of water from wells in these rocks ranges from 1 to 10 gallons per minute (Bayne and Ward, 1967). Practically all recharge is from rainfall and runoff, and occurs where the formations crop out at the surface. In the subsurface, the bedrock is commonly overlain by shales and siltstones which partly confine and retard the vertical movement of water.

Only a few of the deeper bedrock units have any appreciable permeability; four of them are described in the following paragraphs. There are no published reports on aquifiers in Coffey County. A summary of the hydrogeologic characteristics of the bedrock strata is given in Table 2.4-6.

The Plattsmouth Limestone Member of the Oread Formation is a fine-grained, medium-bedded, fossiliferous, slightly fractured limestone with thin shale and silty clay layers. It is from 11 to 14 feet thick. It generally yields less than 1 gallon per minute of water to wells and has vertical fractures near the surface when weathered.

The Plattsmouth Limestone Member, which is semiconfined by the overlying Heumader Shale Member, exhibited a slight seasonal artesian head in piezometers located in the plant site area. The top of the Plattsmouth Limestone at the plant site is at an elevation of about 1,065 feet. The piezometric surface of ground-water in the Plattsmouth Limestone has ranged in elevation from 1,064 to 1,069 feet, fluctuating with variations in rainfall. The undisturbed piezometric level is about 1,068 feet (Figure 2.4-9). The estimated (conservative) permeability of the Plattsmouth Limestone is very low (2.3×10^{-6} cm/sec, Table 2.4-6). At the WCGS site the Plattsmouth Limestone Member is unweathered underneath the Heumader Shale Member. Further to the south, where the Plattsmouth is overlain by only a thin layer of shale or is exposed at the surface, the Plattsmouth may be weathered, and its permeability is slightly greater.

The Toronto Limestone Member of the Oread Formation is 14 to 19 feet thick, and is a fine-grained, thin to thick-bedded limestone with pinpoint vugs, thin shale layers, and fossil fragment beds. Yields to wells are estimated to be less than 2 gallons per minute.

The Toronto Limestone crops out east and south of the plant site. Discharge from this formation occurs in the valley of Wolf Creek. The relatively impermeable nature of the overlying shale units retards vertical water movement except where the depth of weathering has extended downward through the shale. In the vicinity of the site the Toronto Limestone is under semi-artesian conditions, and its potentiometric surface is at about elevation 1,054 (Figure 2.4-10).

The Ireland Member of the Lawrence Formation is a fine-grained, calcareous sandstone with interbedded siltstone and laminated with clayey shale layers. It has some fractured zones and coal seams and is from 40 to 117 feet thick. It yields small quantities of water to wells, estimated to be less than 0.5 gallon per minute. The formation exhibits an artesian head at about elevation 1,049 in the vicinity of the site (Figure 2.4-11). It does not crop out in the valleys of nearby drainage areas. Most recharge into the Ireland occurs where it is exposed to land surface, approximately 6 to 10 miles east of the site.

The Tonganoxie Sandstone Member of the Stranger Formation ranges from 42 to 142 feet thick, is a fine-grained, slightly calcareous, micaceous sandstone interbedded with shale and siltstone, and has some vertical fractures. The Tonganoxie Sandstone yields to wells small to moderate quantities of water estimated at about 3 gallons per minute.

2.4.2.2 <u>Ground-Water Recharge and Discharge</u>

2.4.2.2.1 Recharge and Discharge in Alluvium and Weathered Bedrock

Recharge to the alluvium is from rainfall and the rivers during periods of flooding. Discharge is to the rivers as the ground-water table in the alluvium is normally above the river surface. Within a 20-mile radius, the towns of New Strawn and Hartford obtain water from an alluvial aquifer (Figure 2.4-12).

Recharge to the weathered rock aquifer is from rainfall and vertical percolation through the soils. The rate of infiltration is high, as demonstrated by the high degree of correlation between rainfall and water levels (Figure 2.4-13). During periods of drought, water levels in the weathered rocks drop significantly (Broeker and Fishel, 1961).

A well inventory (Table 2.1-24) shows that there are numerous dug wells within a 5-mile radius. Withdrawal from these wells constitutes an artificial discharge from the weathered bedrock.

2.4.2.2.2 Recharge and Discharge in Consolidated Bedrock Strata

There is some cross-bed leakage and recharge to the bedrock strata as deep as the Toronto at the plant site. In the deeper bedrock strata, recharge is essentially by rainfall and runoff where the formations crop out at the surface east of the site. Pressure tests show that the shale zones about 40 feet below land surface have very low permeability (Table 2.4-7). The semi-artesian heads measured in the Plattsmouth Limestone below the weathered bedrock indicate that the shale beds partly confine and retard the vertical movement of water from and to the limestone beds. The ground water frequently discharges from units lying within 30 to 50 feet below the stream beds in the low-lying areas. During the boring program, none of the formations yielded more than 2 gallons per minute in a 3-inch test hole. The permeability was determined by falling head permeability tests in the piezometers having slotted intervals for the various formations (Table 2.4-7).

2.4.2.3 <u>Ground-Water Hydraulic Gradients</u>

Potentiometric contour maps for the Plattsmouth Limestone, Toronto Limestone, and the Ireland Sandstone are shown on Figures 2.4-9 through 2.4-11, respectively. The locations of the B-series piezometers are shown on Figure 2.4-14. The locations of the P-, HS-, and ESW-series piezometers are shown on Figure 2.4-15. A summary of water levels of each B-series piezometer is given in Table 2.4-8. A summary of the P-, HS-, ESW-, and LK-piezometer water levels is given in Table 2.4-9.

Fluctuations in shallow piezometers (Figure 2.4-16, Tables 2.4-8 and 2.4-9) reflect residual boring and testing effects, seasonal variations and sometimes nearby drilling and testing operations. Water levels in the deeper piezometers fluctuate less than a few feet in response to natural seasonal changes.

The water-table contour map of the ground-water in the weathered rock zone generally reflects the topographic surface. In the site vicinity, the gradients range from 20 to 160 feet per mile. The direction of ground-water flow in the weathered rock zone is perpendicular to the ground-water elevation contour lines (Figure 2.4-6).

The gradient of the potentiometric surface of ground-water in the Plattsmouth and Toronto limestones tends to follow the local and regional structure of those rock layers. The Plattsmouth Limestone is hydraulically connected to the weathered rock zone at the site area. The Heebner Shale retards the vertical movement of water and the transmission of head between the Plattsmouth and the Toronto limestones. The Ireland Sandstone does not crop out in the site area.

2.4.2.4 Ground-Water Models - Seepage from the Cooling Lake

2.4.2.4.1 Introduction

Seepage from the cooling lake was analyzed to assess its ability to degrade ground-water in the downgradient area by increasing the concentration of total dissolved solids (TDS) and radionuclides. The analysis included the effects of both normal and drought conditions.

2.4.2.4.2 Seepage

When the cooling lake area is flooded, the following bedrock units, which are exposed in the Wolf Creek Valley, will be inundated: Stull Shale Member, Clay Creek Limestone Member, Jackson Park Shale Member, Heumader Shale Member, Plattsmouth Limestone Member, Heebner Shale Member, Leavenworth Limestone Member, Snyderville Shale Member, Toronto Limestone Member, and part of the Lawrence Formation. These units are shown in the Detailed Site Stratigraphic Column (Figure 2.5-9) described in Section 2.5.6. A description of the water-bearing characteristics of these units is presented in Section 2.4.13 of the WCGS FSAR and Section 2.4.2.1.3 of this report.

Water from the cooling lake may migrate through either the inundated bedrock units, which dip gently to the southwest, or through the weathered bedrock that serves as the lateral confinement for the lake. The bedrock units may transmit water from their outcrops in the inundated valley to their outcrop on the hill slope opposite the lake. For the analysis, the eastern and western ridges bordering the lake were divided into 10 sectors which have similar geologic and seepage characteristics. The sectors are shown in Figure 2.4-17.

The amount of seepage through bedrock units in each sector can be calculated using the Darcy equation (Ferris and others 1962):

$$q = kia, \qquad [2.4\text{-}1]$$

where:

q = quantity of ground-water seeping through the bedrock in a given sector, taken at an average width, of the sector (cubic feet per second);

k = permeability of the bedrock unit (foot per year);

i = hydraulic gradient of the head difference between the cooling lake surface and the bottom of the bedrock unit outside of the cooling lake divided by the horizontal distance between them;

a = cross-sectional area; or outcrop width multiplied by the bed thickness, the values used are average values for the particular sector (feet^2).

Table 2.4-10 lists the results of the analysis and shows that seepage from the cooling lake will be negligible, about 0.014 cfs (6.1 gpm). That value was obtained using average permeability values obtained from pressure testing (Table 2.4-6). If the maximum known permeabilities are used (Table 2.4-7), the seepage is calculated to be about 0.029 cfs (13.0 gpm). For conservatism, seepage was calculated for the weathered portions of the Jackson Park Shale, Heumader Shale, and other bedrock units cropping out around the cooling lake, but the construction of saddle dams will significantly reduce seepage in those areas. Quarrying of portions of the Plattsmouth and Toronto limestones during construction will not significantly increase the rate of seepage after the filling of the cooling lake.

2.4.2.4.3 Ground-Water Movement

The actual rate of ground-water movement in response to the cooling lake will be very slow. The ground-water velocity can be calculated by modifying the Darcy equation:

$$V = \frac{ki}{n} \qquad [2.4\text{-}2]$$

where:

> v = velocity (feet per year);
>
> k = average permeability (feet per year);
>
> i = hydraulic gradient;
>
> n = effective porosity (estimated to be 5 percent based on examination of core).

For the Plattsmouth Limestone in Sector 3, k = 2.38 feet per year (2.3×10^{-6} cm/sec, Table 2.4-6), i = 0.022, n = 5 percent, and v = 1.04 feet per year. Similarly, for the Jackson Park and Heumader Shale Members, k = 24.8 feet per year (2.4×10^{-5} cm/sec), i = 0.065, n = 20 percent, and v = 8.1 feet per year. The outcrop of the Plattsmouth that is closest to the cooling lake is about 2,500 feet away, and, according to this analysis, the time of travel for ground-water for that distance is about 2,400 years. For ground-water to move 800 feet through the Jackson Park Shale and Heumader Shale, the time of travel would be about 100 years. The time of travel to wells D-42 and C-50 is several thousand years.

2.4.2.4.4 Total Dissolved Solids and Radionuclide Concentrations in Ground Water

Data on existing ground-water quality in the site area are presented in Section 2.4.3. The total dissolved solids (TDS) concentrations and radionuclide concentrations which are expected to occur in the cooling lake due to routine operations are presented in Sections 3.6 and 5.2, respectively. Due to the negligible seepage from the cooling lake, the seepage will not significantly degrade the ground-water in the downgradient area.

TABLE 2.4-8

PIEZOMETER WATER LEVEL READINGS - B BORINGS

Boring/Piezometer	Date	Water Level Depth	Water Level Elevation
B-1, P-1	8-04-73	11.5[a]	1,008.3
	8-04-73	10.1	1,009.7
	8-11-73	11.2	1,008.7
	8-23-73	11.7	1,008.1
Interval: 132-272	8-30-73	11.5	1,008.3
(130-272)	9-06-73	11.3	1,008.5
Tonganoxie	9-13-73	11.4	1,008.4
Sandstone	9-20-73	11.4	1,008.4
	9-27-73	10.9	1,008.9
	10-18-73	10.9	1,008.9
	11-15-73	10.9	1,008.9
	12-14-73	5.4	1,014.4
	1-14-74	10.8	1,009.0
	3-14-74	10.9	1,008.9
	4-19-74	11.0	1,008.8
	5-16-74	10.9	1,008.9
	7-18-74	11.5	1,008.3
	8-15-74	11.5	1,008.3
	9-12-74	11.2	1,008.6
	10-17-74	11.2	1,008.6
	11-14-74	11.0	1,008.8
	12-19-74	11.0	1,008.8
	1-15-75	11.2	1,008.6
	3-13-75	11.0	1,008.8
	4-18-75	10.9	1,008.9
	5-22-75	11.1	1,008.7
	9-15-75	11.6	1,008.2
	12-22-75	11.6	1,008.2
	3-25-76	11.6	1,008.2
	9-10-76	14.8	1,005.0
	12-14-76	14.6	1,005.2

Note: Effective interval given in parenthesis following slotted interval if intervals differ. Interval depths reported are to the nearest foot.

[a]Value obtained following falling head permeameter testing.

Below the coal layer, sandstone content ranges from 10 to 100 percent, although these beds rarely exceed 2 feet in thickness. The sandstone percentage decreases steadily with depth, with a corresponding increase in the percentage of siltstone and shale. The basal contact of the Ireland Member is a gradational facies between the shaley siltstone of the Ireland and the pure shale of the Robbins Member.

2.5.6.2 Ground-water Hydrology

A detailed treatment of the ground-water and surface-water hydrology is presented in Section 2.4 and in Section 2.4 of the WCGS FSAR. This section outlines the geologic framework at the site within which the ground-water occurs.

The regional ground-water sources can be subdivided on the basis of lithology and weathering into three general types: alluvial deposits in river valleys, soil and weathered bedrock, and deep, unweathered bedrock.

Water-bearing strata below elevations penetrated by the deepest borings (below elevation 700) generally contain water of poor to unsuitable quality, and they are separated from the near-surface bedrock at the WCGS site by numerous low permeability shale units. This separation minimizes or eliminates any environmental impact the plant might have on the deeper aquifers.

No bedrock aquifers of significance were found at the site during the boring program. The Tonganoxie Sandstone Member of the Stranger Formation (which in some areas of eastern Kansas is an important aquifer) was found in borings drilled in the site area as a facies of silty shale with thin interbeds of sandstone, and was characterized by very low permeabilities.

The channel-deposited facies of the Tonganoxie Sandstone Member that Lins (1950) describes as the important aquifer was not encountered in any of the borings and is not present at the site.

At the site, the soil and weathered bedrock aquifer ranges from less than 1 foot to about 20 feet thick; the shallow zones develop on the more resistant limestones, and the deeper zones on the shales and sandstones. The river alluvium is predominantly a silty clay with lenses and stringers of fine-grained sand. The silty clay has low permeability while the fine-grained sand lenses provide somewhat higher flow rates.

2.4.12.2 Radiological Dose Assessment

A review of the concentrations of radionuclides in the refueling water storage tank (Table 11.1-6) shows that all nuclides except three are already at concentrations below 10 CFR 20, Appendix B, Table II, Column 2 limits. The exceptions are:

	TANK CONCENTRATION µCi/ml	10 CFR 20 LIMIT µCi/ml
H-3	2.5	$1x10^{-3}$
I-131	$3.87x10^{-6}$	$3x10^{-7}$
I-133	$7.52x10^{-6}$	$1x10^{-6}$

The analysis in Section 2.4.12.1 shows that the tank concentrations would be diluted by a factor of 67,610. This is more than adequate to assure that concentrations at the cooling lake discharge and all downstream water users will be less than 10 CFR 20 limits. See Table 2.4-4 for a listing of water rights in Coffey County and Figure 2.4-8, which shows all water users and municipal users downstream of the site.

2.4.13 GROUND WATER

2.4.13.1 Description and Onsite Use

2.4.13.1.1 Aquifer Systems

This section describes the water-bearing characteristics of the soil and bedrock in the vicinity of the WCGS site. Information about regional aquifers, which includes a 50-mile radius around the site, was obtained from a literature search. Hydrogeologic characteristics of the ground-water system within 5 miles of the site are based on the results of site investigations as described in Section 2.5.4.

2.4.13.1.1.1 Regional Ground-Water Systems

Small quantities of ground water are available regionally from three sources within a 50-mile radius of the site. These sources are the alluvial deposits in the river valleys, the near-surface weathered bedrock including shallow soils, and the deep bedrock.

The major alluvial aquifers within a 50-mile radius are in the Neosho, Marais des Cygnes, Verdigris, and Osage river valleys. Nearest to the site, the Neosho River flows in a southeasterly direction through Morris, Chase, Lyon, Coffey, Anderson, Woodson, Allen, and Neosho counties (Figure 2.4-8). It passes within 3 miles southwest of the plant site. The width of the alluvium in the valley ranges from about 1 to 10 miles.

The alluvial aquifer in the Marais des Cygnes River Valley is found in Osage, Franklin, Miami, Anderson, and Linn counties. The Marais des Cygnes River flows in an easterly and south-easterly direction and passes about 17 miles north of the site. The alluvial aquifer in the Verdigris River Valley is in Lyon, Greenwood, Woodson, Elk, and Wilson counties. Its closest point is 22 miles southwest of the site. The Osage River Valley alluvial aquifer is in Bourbon County adjoining the state of Missouri about 27 miles southeast of the site at the nearest point.

The alluvial aquifers in the site region are composed of silt, sand, and gravel. Yields from wells in the alluvial aquifers are much greater than yields from the other regional sources, and commonly range as high as 100 gallons per minute (Reference 3).

Recharge to the alluvial aquifers is derived from precipitation and from ground water in the weathered rock zone where the zone is hydraulically connected to the alluvium. Periods of high river stage may also contribute some short-term recharge. Ground-water discharge occurs where the ground-water table is above and adjacent to surface drainage, and where wells are being pumped. Within a 20-mile radius of the site, the towns of New Strawn, 3 miles west-northwest, and Hartford, 15 miles west-northwest of the plant site, obtain water from alluvial aquifers.

The weathered bedrock is composed of weathered shales, silt-stones, sandstones, and limestones, and the soils derived from them. The process of chemical and physical weathering alters the near-surface bedrock and produces additional porosity in the bedrock materials. The weathered bedrock, which is as deep as 40 feet in places, is sufficiently permeable to yield water to wells. Yields from wells in the weathered bedrock range up to 10 gallons per minute (Reference 3). This zone is developed mainly for domestic and livestock purposes. Recharge to the weathered bedrock is from local precipitation, and discharge occurs into alluvial deposits, streams, and wells.

In the site region, the bedrock units below the weathered zone are composed of sandstones, siltstones, shales, and limestones with typically low water yields (Reference 37). Unweathered bedrock units range in age from Permian to Pennsylvanian and dip gently westward from 10 to 30 feet per mile. Recharge from precipitation occurs primarily at formational outcrops. These bedrock units supply water for domestic and livestock purposes and yield from 1 to 10 gallons per minute to wells (Reference 3).

2.4.13.1.1.2 Local Ground-Water Systems

The local ground-water systems have characteristics similar to the regional systems. Water levels in local wells indicate that the shallow ground-water table closely parallels the topographic surface within at least a 5-mile radial area of the plant site (Figure 2.4-50). Wells in this area tap either or both the alluvium and weathered bedrock. Where these units are contiguous they are hydraulically connected.

Vertical recharge is derived from precipitation. During periods of drought, the water levels drop significantly, especially in the weathered bedrock (Reference 4).

There are no published reports on the aquifer hydraulic characteristics in Coffey County. Listed below is a summary of hydrogeologic characteristics of local water-bearing units (Table 2.4-28 and Figure 2.4-51) based on the results of site as described in Section 2.5.4 and accompanying tables:

a. The Spring Branch Limestone Member of the Lecompton Formation is a light gray, thin-bedded, fossiliferous limestone interbedded with thinly laminated shale. The Spring Branch Member is absent at the plant site due to erosion but crops out to the north and west of the plant site with a thickness ranging up to 10 feet. It yields less than 1 gallon per minute to local wells;

b. The Stull Shale Member of the Kanwaka Shale Formation is a dark gray, laminated, fossiliferous shale interbedded with light gray, calcareous sandstone and shaley siltstone. It crops out north and west of the site. Its thickness in Boring B-20 is 51 feet. The Stull Shale Member is absent at the plant site, having been removed by erosion. It yields less than 1 gallon per minute to local wells;

c. The Clay Creek Limestone Member of the Kanwaka Shale Formation is a fine-grained, fossiliferous, gray limestone locally interbedded with sandy shale. Its thickness at the site ranges from 2 to 8 feet. Although it is exposed at the surface east of the site and is present both at the surface and in the subsurface in the western portion of the site area, it has been removed by erosion at the plant site. It yields less than 1 gallon per minute to wells;

d. The Jackson Park Shale Member of the Kanwaka Shale Formation is a laminated, calcareous, gray shale with a basal, fine-grained, silty sandstone which locally exceeds 10 feet in thickness. The total thickness at the site ranges from 23 to 30 feet. At the plant site, only the lower portion of the Jackson Park Shale Member is present as the overlying portion has been removed by erosion. It yields less than 3 gallons per minute to wells;

e. The Heumader Shale Member of the Oread Formation is a laminated, fossiliferous, dark gray, clayey shale with fine-grained, thin-bedded calcareous zones, and occasional gray limestone lenses. Near the site this unit ranges from 0 to 25 feet in thickness. It is moderately to highly weathered to depths of as much as 20 feet. Yields to wells of less than 3 gallons per minute are obtained from this unit.

None of the deep bedrock units near the site are capable of yielding large quantities of potable water to wells. Listed below are the hydrogeologic characteristics of the deep bedrock units that yield small quantities of water at the site (Table 2.4-28) and Figure 2.4-51), based on the results of site investigations (Section 2.5.4):

a. The Plattsmouth Limestone Member of the Oread Formation is a fine-grained, medium-bedded, fossiliferous, slightly fractured limestone with thin shale and silty clay layers. It has occasional vertical fractures near the surface. At the plant site, the top of the Plattsmouth Limestone is about 34 feet below the plant grade elevation of 1,099.5 feet. Its thickness at the site ranges from 11 to 14 feet. The Plattsmouth Limestone Member yields less than 1 gallon per minute to wells;

b. The Toronto Limestone Member of the Oread Formation is a fine-grained, thin- to thick-bedded limestone with fossil fragment beds. Pinpoint vugs are present at some horizons within the unit. At the plant site, the top of the Toronto Limestone is about 64 feet below the plant grade elevation of 1,099.5 feet. Its thickness at the site ranges from 14 to 19 feet. It generally yields less than 2 gallons per minute to wells;

c. The Ireland Member of the Lawrence Formation is a fine-grained, calcareous sandstone with interbedded siltstone and laminated with clayey shale layers. It has some fractured zones and coal seams. At the plant site, the top of the Ireland Sandstone is about 111 feet below the plant grade elevation of 1,099.5 feet. Its thickness at the site ranges from 40 to 117 feet, and it yields up to 0.5 gallons per minute to wells;

d. The Tonganoxie Sandstone Member of the Stranger Formation is a fine-grained, slightly calcareous, micaceous sandstone. Interbedded with shale and siltstone, it has some vertical fractures. At the plant site, the top of the Tonganoxie Sandstone is about 290 feet below the plant grade elevation of 1,099.5 feet. Its thickness in this area ranges from 42 to 142 feet, and it rarely yields over 3 gallons per minute to wells.

During the boring and aquifer testing program (described in Section 2.5.4), none of the deep bedrock formations yielded more than 2 gallons per minute in a 3-inch test hole; only slightly higher yields could be expected with larger diameter wells. The flow rate was measured by air lifting the water out of the hole. The rate of water-level recovery was timed and measured to determine the permeability. Water-level readings in the piezometers show that leakyartesian conditions exist in the deeper bedrock strata below the weathered bedrock. The Toronto Limestone Member and younger strata are recharged principally by local precipitation. Much of the precipitation first recharges the overlying weathered bedrock aquifers which in turn provides some leakage to the deeper units including the Toronto Limestone Member. Pressure tests indicate that the permeability of the deeper bedrock shale units below the Toronto Limestone Member ranges from 10^{-7} to 10^{-8} centimeters per second (Section 2.5.4).

Ground-water and rock samples from the weathered Jackson Park Shale and Heumader Shale members, and ground water from the Plattsmouth Limestone Member in the Category I area were tested for water-soluble sulfate. It was determined that sulfate concentrations exhibit considerable horizontal and vertical variation within the vicinity of the plant site. The sulfate concentrations in soil and rock samples ranged from 3.1 to 535.0 milligrams per kilogram. Ground-water samples contained sulfate concentrations which ranged from 78.5 to 346.0 milligrams per liter (mg/l). At Well D-26, which was monitored by a water-level recorder during 1973 and 1974 and is located less than one mile northeast from the center of the plant site, sulfate concentrations range from 66 to 71 mg/l. At Well C-2, located approximately 1.75 miles northwest of the plant site, sulfate concentrations have varied between 764 and 1,050 mg/l. For well location and inventory data refer to Figure 2.4-52 and Table 2.4-29.

The criterion used for well sealing was in accordance with Sargent & Lundy's Specifications A-3854, (Section 304.1). This specification is reproduced as Table 2.4-29a.

The status of well sealing is presented in Tables 2.4-29b and 2.4-29c.

2.4.13.1.2 Onsite Use

There is no anticipated use of ground water at or near the site during plant operation.

2.4.13.2 <u>Sources</u>

Although most of the public water supplies in the vicinity of the site are derived from surface-water sources, ground water accounts for a small amount of both municipal and private water needs. Information was obtained from public agency contact and a local water well inventory. A discussion of regional and local ground-water flow regimes is also included in this section.

2.4.13.2.1 Regional Public Ground-Water Use

This discussion of regional public ground-water use applies to a 20-mile radius of the site (Figure 2.4-53). Table 2.4-30 summarizes the information available regarding the municipal supplies in this region.

2.4.13.2.1.1 Present Use

The amount of ground water used for public supplies within a 20-mile radius of the plant site is small. The city of Waverly, Kansas, about 10 miles north-northeast of the site, has five wells (228 to 300 feet deep) (References 19 and 15) which obtain water from the Tonganoxie Sandstone (Figure 2.4-53). An average of 39,000 gallons per day (about 5 gallons per minute per well) is pumped from this system (Reference 15). Bailer tests performed by the driller produced 10-25 gallons per minute, but a sustained yield of 5 gallons per minute is typical. A sanitary seal is installed in each well to prevent pollution from the surface from entering the well through the weathered rock zone.

The municipalities of Williamsburg, 20 miles northeast, and Melvern, 18 miles north of the site, also obtain water supplies from deep wells in the Tonganoxie Sandstone Member (Table 2.4-30). Borehole tests in the Tonganoxie Sandstone near the site produced yields of less than 3 gallons per minute (Section 2.4.13.1.1.2).

The municipalities of New Strawn, located 3 miles west of the site, and Hartford in Lyons County, located 15 miles west-northwest of the site, obtain ground water from wells less than 40 feet deep in the Neosho River alluvium (Reference 21). At Hartford, the static water level is about 32 feet below ground surface; it is about 12 feet below ground surface in the New Strawn well (Reference 20).

The only known ground-water supply being used for industrial purposes within a 20-mile radius of the site is from one well owned by the Atchison Topeka and Santa Fe Railway located about 15 miles northwest of the site (Well No. 39, Table 2.4-4 and Figure 2.4-8). The user has a water right for 10 gallons per minute.

2.4.13.2.1.2 Future Use

The use of ground water for public supplies in Coffey County is not expected to increase significantly as a result of population changes (Section 2.1.3). Total projected use (as estimated in 1979) is presented in Table 2.4-31 and shows a decrease in ground-water pumpage between 1965 and 1980 followed by an increase to slightly above 1965 levels in 2020 (Reference 22). The current (February, 1984) projected use of water in Coffey County is shown in Table 2.4-31a. The total use of water for domestic and manufacturing purposes increased by 159 acre-feet between 1965 and 1980, largely due to the increased domestic use of water by both the City of New Strawn, which obtains ground water from the alluvium along the Neosho River and the City of Burlington and the water districts around the site which used treated surface water, during the short term growth between 1970 and 1980. Although the projections shown in Table 2.4-31a for the year 2000 and after are preliminary and are subject to change, the 1984 projections of Table 2.4-31a for the year 2000 are consistent with the 1979 projections of Table 2.4-31, and show a gradual increase in the use of water for domestic and manufacturing purposes through the year 2035.

2.4.13.2.2 Local Ground-Water Use

A well inventory was made of 198 wells within 5 miles of the plant site. A summary of the well inventory is listed in Table 2.4-29.

2.4.13.2.2.1 Present Use

The local wells are used for domestic and livestock purposes. The 198 wells are reported to produce a total of about 73,400 gallons per day or an average of 382 gallons per day per well. Table 2.4-29 lists the pertinent data collected on each well, and Figure 2.4-52 shows the locations of the property owners of the wells.

The wells supply small quantities of water (1/2 to 10 gallons per minute) from the weathered bedrock and larger quantities from the alluvium. The shallow dug wells have diameters of 3 to 6 feet; the drilled wells have diameters of 6 to 8 inches. Most wells in the area intercept ground water in the weathered bedrock zone where the permeability has been increased by weathering.

There are three water districts within a 5-mile radius of the site. The City of New Strawn is the smallest district and serves the residents of the New Strawn area. This district obtains ground water from the alluvium along the Neosho River below the John Redmond Reservoir near New Strawn. Rural Water Districts No. 2 and 3 serve numerous residents around the site, encompass a larger geographical area than the City of New Strawn, and both obtain treated surface water from the City of Burlington.

2.4.13.2.2.2 Future Use

Information obtained during the well inventory indicates a trend away from domestic ground-water usage and towards the use of treated surface water. Continued local use of ground water for domestic and livestock use is anticipated as shown in the long-term projections (1979 projections) of Table 2.4-31 (References 29 and 11).

District No. 2 plans a gradual increase in participants as the general trend from ground water to treated surface water continues.

2.4.13.2.3 Ground-Water Flow Regimes

This section describes the regional and local potentiometric surfaces and ground-water gradients. Regional conditions within 20 miles of the site are based on a literature search, and a site investigation, detailed in Section 2.5.4, was performed to describe local conditions. The weighted average permeability is given for each water-bearing soil and bedrock unit, and ground-water recharge is discussed. The effects of local pumping on ground-water levels at the plant site are also discussed.

2.4.13.2.3.1 Regional Conditions

Within 20 miles of the site, the shallow ground-water table basically conforms to the topography of the region which has a gradient to the east and south in eastern Kansas. About 15 miles north of the site, shallow ground water in the weathered bedrock zone drains into the Marais des Cygnes River which flows eastward through Osage and Franklin counties, and into Miami County where the river assumes a southeastward course into Missouri (Figure 2.4-53).

To the west and south of the site, the shallow ground water drains into the Neosho River which flows southeastward at a gradienet of about 4 feet per mile through Morris, Lyon, Coffey, Woodson, and Allen counties, where it continues southward into Oklahoma (Figure 2.4-53).

2.4.13.2.3.2 Local Conditions

Surface drainage of the site area is generally to the south by way of Wolf and Long creeks. The gradient of Wolf Creek is about 10 feet per mile, and the gradient of Long Creek is about 7 feet per mile.

2.4.13.2.3.2.1 Potentiometric Surfaces

The locations of the B-boring piezometers are shown on Figure 2.4-54. The P-, HS-, and ESW-series piezometers are shown on Figure 2.4-55. Graphs of water-level variations in the piezometers for the various rock units are shown on Figure 2.4-56. The piezometer water-level graphs generally show little change of water levels after the effects of drilling and permeability testing have dissipated, and it may be concluded that the ground-water level in the bedrock units is relatively stable.

Water levels in the inventoried wells (Table 2.4-29) show that the shallow ground-water table closely parallels the topography within at least a 5-mile radius of the plant site. The gradient of the water table, as determined from the water-table contour map, Figure 2.4-50, ranges from 20 to 160 feet per mile, depending on the topography. Direction of ground-water flow is perpendicular to the ground-water elevation contour lines (Figure 2.4-50).

The potentiometric surface maps for the Plattsmouth Limestone, the Toronto Limestone, and the Ireland Sandstone members (Figures 2.4-57, 2.4-58, and 2.4-59, respectively) are based on piezometer readings for the individual rock units (Tables 2.4-32 and 2.4-33). The gradient of each of the potentiometric surfaces measured from these figures generally dip west and south away from the plant site at approximately 20 feet per mile. The average potentiometric surface gradient of these three units is about one half the average gradient of the ground-water table as measured in the weathered Jackson Park Shale and Heumader Shale members.

The ground-water gradient in the shallow, unweathered bedrock generally reflects surface topography more than regional structural trends. Figure 2.4-57 illustrates the potentiometric surface of ground water in the Plattsmouth Limestone Member. This surface is related to the local topography which indicates that there is some hydraulic connection between the Plattsmouth

Limestone Member and the weathered bedrock zone. Recharge to the Plattsmouth occurs in the upland areas mainly through cross-bed leakage while discharge occurs in the lower areas.

An analysis of the piezometer readings shows that water in the deeper, unweathered bedrock units is under semiconfined conditions. The shale units between the deeper limestone and sandstone units (such as the Ireland and Tonganoxie sandstones) retard vertical water movement.

Potentiometric contours for ground water in the Toronto Limestone Member, determined from piezometer readings, are shown on Figure 2.4-58. The potentiometric surface also reflects the topographic surface, but the relationship is more subdued than for the Plattsmouth potentiometric surface.

The potentiometric surface of the Ireland Sandstone is more dependent upon the westerly regional dip than are the potentiometric surfaces for the shallower units. The configuration of the potentiometric contours (Figure 2.4-59) bears little resemblance to the potentiometric contours of either the Plattsmouth or Toronto Limestone members.

Figures 2.4-57, 2.4-58, and 2.4-59 show the potentiometric surface contours prior to filling the cooling lake. After the cooling lake was filled, the ground-water elevations adjacent to the cooling lake in the Plattsmouth, Toronto, and Ireland members gradually rose to the normal operating level of the cooling lake, elevation 1,087 feet. Ground water discharged into Wolf Creek and, after the cooling lake was filled, ground-water gradients in those units along the lake perimeter were reversed. Ground water at elevations above 1,087 in other units were not affected. Because of the low permeability of the inundated bedrock units, the ground-water gradients are steep between the cooling lake level and the undisturbed ground-water levels in the hill slope opposite the lake to the east and west. The steepened gradients affect ground-water conditions only immediately adjacent to the cooling lake.

2.4.13.2.3.2.2 Weighted Average Permeabilities

The permeability in the weathered Jackson Park Shale Member ranges from about 5×10^{-7} to 5×10^{-5} centimeter per second (cm/sec) with a weighted average of about 4 x 10-5 cm/sec or 0.8 gallons per day per foot^2 (gpd/ft^2) (Table 2.4-34). At depths greater than 20 feet, the permeability ranges from 9×10^{-7} to 1×10^{-5} cm/sec6(0.02 to 0.2 gpd/ft^2) and the weighted average is 4×10^{-6} cm/sec (0.08 gpd/ft^2).

As listed on Table 2.4-34, the weighted average permeability for the Plattsmouth Limestone Member (at 0 to 20 foot depths) is 2×10^{-5} cm/sec (0.4 gpd/ft^2). Where the Plattsmouth is found at depths greater than 20 feet the weighted average permeability decreases to 2×10^{-6} cm/sec (0.04 gpd/ft^2). The two ranges (0-20 feet and greater than 20 feet) for the Toronto Limestone Member have weighted averages of 2×10^{-5} cm/sec (0.4 gpd/ft^2) and 1×10^{-6} cm/sec (0.02 gpd/ft^2), respectively. The average permeability for the Ireland Sandstone Member is 4×10^{-6} cm/sec (0.08 gpd/ft^2). Throughout the site area the Ireland Sandstone Member is found at depths greater than 20 feet.

The weighted average permeabilities range from 6×10^{-7} cm/sec (0.01 gpd/ft^2) to 2×10^{-6} cm/sec (0.04 gpd/ft^2) for the following unweathered shales found below the Plattsmouth Limestone Member: Heebner Shale, Snyderville Shale, Unnamed Lawrence Shale, and Robbins Shale members. They serve as confining beds between more permeable limestone and sandstone beds.

Within the site area and surrounding region there are impoundments of surface water for watering stock. A field survey of ponds within Sections 5, 6, 7, and 8 (T 21 S, R 16 E), indicates that in the area of the wolf Creek watershed. All ponds in this area are associated with natural drainage courses on side slopes of hills, and are not the result of seepage from lithologic contacts. Occasional seepage that collects near contacts is due to differential surface weathering at these contacts is due to differential surface weathering. Slightly higher permeabilities are developed by weathering at these contacts but probably extend only several feet into the interior of the hills.

2.4.13.2.3.2.3 Ground-water Recharge

An automatic water-level recorder was placed in an unused, dug well (Well D-26) about 1/3-mile northeast of the site (Figure 2.4-52). The well was sealed at the surface to prevent any runoff from entering around the top. The data obtained shows a rapid response between rainfall and the shallow water table (Figure 2.4-60). Based on a map showing the geology of the area (Figure 2.5-22), the dug well extends into the sandstone unit of the Jackson Park Shale Member. The rapid rate of recharge is probably due to infiltration of water through outcrops of the sandstone unit rather than outcrops of the shale and limestone members. The rate of vertical recharge from the surface is expected to be less than the vertical water movement at a greater depth in the sandstone unit of the Jackson Park Shale Member. This is probably related to flow in shallow vertical desiccation cracks and fissures. Following a moderate intense rainfall or during an extended period of rainfall, it is anticipated that the clays in the weathered bedrock will swell, plugging most of the desiccation cracks. Well response to rainfall would be slower if the water percolated through the surface materials.

Recharge to the weathered bedrock is from precipitation. Recharge tothe unweathered Plattsmouth and Toronto Limestone members is principally from vertical downward leakage from overlying units; the Plattsmouth may also receive recharge from precipitation where it outcrops in highland areas on the east ridge which borders the cooling lake. Recharge to the Ireland and Tonganoxie sandstones is from precipitation in their area of outcrop east of the site and from vertical seepage at any place where these formations are in hydraulic connection with the weathered bedrock zone.

2.4.13.2.3.2.4 Effects of Local Pumpage

The nearest major pumpage from the bedrock (Tonganoxie Sandstone Member) is at Waverly which is located about 10 miles from the plant site. Because of the distance, and the fact that the pumpage at Waverly averages only about 25 gallons per minute total from 5 wells, the area of influence would not extend to the plant site. There are no significant cones of depression around the shallow dug wells in the weathered bedrock zone in the site area. These wells are used only intermittently for domestic and livestock purposes.

2.4.13.3 <u>Accident Effects</u>

2.4.13.3.1 Introduction

Radioactive liquids from the plant are postulated to enter the ground water as a result of the accidental rupture of specific tanks containing liquid radwaste. The effects of this accidental contamination have been examined at the nearest ground-water discharge locations: lakes, streams, or local wells.

The three tanks postulated to rupture will contain the highest curie inventory of the radioisotopes of relatively long half-lives and of concern to human health (Table 11.1-6): Sr-90, Cs-137, Co-60, and H-3. These tanks are:

a. The spent resin storage tank (Primary);

b. The boron recycle holdup tank (A or B); and

c. The refueling water storage tank.

The first two tanks are located in the radwaste building, while the refueling water storage tank is located outside, between the radwaste building and the turbine-reactor complex. Highest curie contents for Sr-90, Cs-137, and Co-60 are expected in the spent resin storage tank (Primary). The highest concentration of H-3 is expected in the boron recycle holdup tank (A or B), while the greatest curie content of H-3 is expected in the refueling water storage tank. In this accident analysis, we have postulated the rupture of each of these three tanks, as separate isolated events. Rupture of the refueling water storage tank is unlikely because it is a Category I structure. Details of the tanks and their curie content for important radionuclides are given in Table 2.4-35.

Once a tank ruptures, the liquid contents are conservatively assumed to merge immediately with the ground water. Ground water may move initially into the radwaste building and into the spent resin storage tank (primary) and the boron recycle holdup tank (A or B) through the cracks postulated to develop during the accident. Such ground-water movement would occur until the water level in the radwaste building attains the ground-water level existing outside the building. Significant ground-water movement away from the building will occur only after this hydraulic head equilibrium is achieved. To be conservative, the water table at the plant is assumed to be at plant grade, elevation 1,099.5 feet, which is about 5 feet above historical ground-water elevations (Table 2.4-33). The bases of the spent resin storage tank and the boron recycle holdup tank are approximately at elevation 1,071 feet, which is within the Heumader Shale Member. Thus, liquid contents of these tanks would flow down-gradient in the ground water within that unit. The base of the refueling water storage tank is approximately at elevation 1,095 feet. Thus, the liquid radwaste from that tank would seep directly into the adjacent overburden soil and weathered bedrock, as well as possibly into the upper portion of the underlying Heumader Shale Member, and flow down-gradient in these units.

The nearest surface-water body that can be affected by accidental releases at the plant is the cooling lake. The normal operating water level of the lake is at elevation 1,087 feet. The nearest down-gradient location to the shoreline is toward the southeast, about 640 feet from the radwaste building and 770 feet from the refueling water storage tank. Water in the cooling lake enters Wolf Creek from blowdown discharge through the outlet works or by flowing over the service spillway of the main cooling lake dam, located approximately 3.1 miles south of the plant site. At the normal operating level, the cooling lake will contains approximately 111,280 acre-feet of water. The spillway crest has been established one foot above the normal operating level, or at elevation 1,088 feet. Water-level determinations for the cooling lake are presented in USAR Sections 2.4.3.5 and 2.4.11.3.2.

This analysis shows that the average time of contaminant travel to the cooling lake is at least equal to half the expected life of the plant (Table 2.4-37). For this reason, an analysis has also been made for the case of an accidental release toward the end of the life of the plant. Although there are no plans to drain the cooling lake after decommissioning of WCGS, the conservative assumption is made that by the time the contaminants reach the shoreline after such an accident, the cooling lake may have been drained. Thus, consideration was given to contaminant transport down-gradient to the closest discharge point on the tributary to Wolf Creek, approximately 2,450 feet southwest of the radwaste building.

Wells C-20 and C-50 (Table 2.4-29 and Figure 2.4-52) are the nearest wells in the down-gradient direction that were not purchased by the Licensees or inundated by the cooling lake. They are the nearest potable water supplies. These wells are located approximately 10,500 and 13,700 feet, respectively, from the radwaste building. The shallow ground water that flows by these wells in the over-burden soils and the underlying Heumader Shale is physically separated from the plant site by the valleys of Wolf Creek and its tributaries, and by the cooling lake. Ground water coming from the direction of these two wells tends to flow toward the plant and discharge into the intervening streams. For this reason, analysis of ground-water transport from the radwaste tanks to the wells was not performed.

In the analysis which follows, it is shown that, with the exception of tritium concentrations, ground water contaminated at the plant site by accidental radioactive releases will have radionuclide concentrations below the maximum permissible concentrations of 10 CFR 20, Appendix B, Table II, for unrestricted areas by the time the contaminated ground water reaches the nearest surface water (the cooling lake or the Wolf Creek tributary). However, it is noted that tritium is a very weak beta emitter (decay energy for total disintegration = 0.0186 MeV) and also, the tritium-related offsite doses from this postulated accident will be a very small fraction of the 10 CFR Part 100 dose limits. The following analysis also shows that the tritium concentration in the cooling lake and the Wolf Creek tributary will be well below the 10 CFR 20 limits for unrestricted areas. The effects of hydrodynamic dispersion, fluid convection, cation exchange, and radionuclide decay were included in the analysis.

2.4.13.3.2 Description of Analytical Model

The model used in this analysis conservatively assumes an instantaneous release of effluent to the ground-water system. Effluent from the refueling water storage tank, because it is a seismic Category I structure, may be released at a slower rate, but the model conservatively assumes an instantaneous release from the tanks. In the case of a slug of solution containing radionuclides which is introduced instantaneously into the ground-water system in an infinitesimally small volume, the following equation is applicable (Reference 2):

$$\frac{c}{m} = \frac{\frac{1}{n}}{(4\pi D't)^{3/2}} \exp -\left(\frac{(x - u_x't)^2}{4D't} + \frac{(y - u_y't)^2}{4D't} + \frac{(z - u_z't)^2}{4D't} + \lambda t \right) \quad [2.4\text{-}4]$$

where:

- c = quantity of radionuclide cation per milliliter of interstitial solution, at any time, t, and at any point x, y, z;
- m = total quantity of radionuclide introduced with the slug (microcuries);
- n = total porosity of the aquifer (dimensionless);
- t = time since introduction of the slug (days);
- x = distance from point of injection in direction of ground-water flow (centimeters);
- y = distance laterally, perpendicular to ground-water flow (centimeters);
- z = distance vertically, from center of slug (centimeters);
- λ = decay coefficient = $0.693/T_{1/2}$ where $T_{1/2}$ is the radionuclide half-life, in days;
- D' = reduced dispersion coefficient

  = DR_f (Reference 33),

  where:

D = the average dispersion coefficient

$= (D_x D_y D_z)^{1/3}$, and

D_x, D_y, D_z = the dispersion coefficients valid for the x, y, and z directions, respectively.

u_x', u_y', u_z' = the average velocities of the radionuclide in the x, y, and z directions, respectively (centimeters per day);

For example, $u_x' = u_x \ R_f$

where:

u_x = average velocity of water in the pores (cm/day)

R_f = the reduction factor due to cation exchange (Reference 32):

$$R_f = \frac{1}{1 + \frac{\rho_b}{n} \frac{Q}{C_{ca}} E},$$

where:

ρ_b = bulk density of the aquifer (grams per milliliter);

Q = concentration of calcium adsorbed on the exchange complex of the aquifer material (milliequivalents per gram) (closely approximated by the cation exchange capacity, for cases where the radionuclide concentration is low relative to the cation concentration of the native ground water);

C_{Ca} = total concentration of dissolved native cations in the ground water at equilibrium (milliequivalents per milliliter), assumed conservatively to consist entirely of calcium;

E = equilibrium exchange constant for exchange process for the radionuclide displacing calcium on the exchange complex;

By integrating Equation 2.4-4 over the dimensions x_o, y_o, and z_o of a slug of finite prismatic volume, we obtain Equation 2.4-5, the analytical model used in this analysis:

$$c = \frac{m}{8nx_o y_o z_o} \left(\mathrm{erf}\left(\frac{x + \frac{x_o}{2} - u_x' t}{\sqrt{4D_x' t}} \right) - \mathrm{erf}\left(\frac{x - \frac{x_o}{2} - u_x' t}{\sqrt{4D_x' t}} \right) \right)$$

$$\cdot \left(\mathrm{erf}\left(\frac{Y + \frac{Y_o}{2}}{\sqrt{4D_y' t}} \right) - \mathrm{erf}\left(\frac{Y - \frac{Y_o}{2}}{\sqrt{4D_y' t}} \right) \right)$$

$$\cdot \left(\mathrm{erf}\left(\frac{Z + \frac{Z_o}{2}}{\sqrt{4D_z' t}} \right) - \mathrm{erf}\left(\frac{Z - \frac{Z_o}{2}}{\sqrt{4D_z' t}} \right) \right)$$

$$\cdot \exp(-\lambda t) \qquad [2.4\text{-}5]$$

where:

x_o, y_o, z_o = the dimensions of the slug in the soil at time 0, along the respective axes, and $Dx' = D_x R_f$, $D_y' = D_y R_f$, and $D_z' = D_z R_f$. The Equation 2.4-5 parameters are as defined for Equation 2.4-4 above. Equation 2.4-5 was derived under the assumption that $u_y = u_z = 0$.

The analyses performed used a computer program certified by Dames & Moore (SLUG3D), which solves Equation 2.4-5, with several different output options.

2.4.13.3.3 Selection of Model Parameters

A summary of the discharge points, flow paths, and parameter values selected for the model simulations is provided in Table 2.4-36.

Average Hydraulic Gradient (i) - To be conservative, the water-table level at the plant was assumed to be a maximum, at plant grade (elevation 1,099.5 feet). The ground-water elevation assumed at the cooling lake discharge point is the normal operating lake level (1,087 feet), and that at the Wolf Creek tributary to the southwest is 1,048 feet. Thus, for example, the average gradient (i) from the radwaste building to the cooling lake was computed to be:

$$i = \frac{1,099.5 - 1,087}{640} = 0.0195 \qquad [2.4\text{-}6]$$

where 640 feet (approximately 19,500 cm) is the shortest distance from the radwaste building to the shoreline of the cooling lake. The average hydraulic gradients from the tanks to the Wolf Creek tributary and the cooling lake are listed in Table 2.4-36.

Horizontal Permeability (K_h) - Of the shallow geologic units at the site, the Plattsmouth Limestone Member has the highest measured permeability (2×10^{-4} cm/sec). This is higher than the values for the overlying Heumader Shale Member as shown in Table 2.4-34. There is a possibility that accidentally introduced liquid radwaste could migrate below the Heumader Shale into the Plattsmouth Limestone and flow laterally at least in part in the latter unit. For this reason, and to be conservative, the value of 2×10^{-4} cm/sec (17.3 cm/day) was used for the average coefficient of horizontal permeability.

Porosity - Total porosity was estimated on the basis of bulk density measurements on nine samples of Heumader Shale obtained at the site. The average density was found to be 2.29 g/cm^3. Then, total porosity (n) was computed from Equation 2.4-7.

$$n = 1 - (\rho_b / \rho_s) \qquad [2.4\text{-}7]$$

where:

ρ_b = the bulk density, and

ρ_s = the specific gravity of the solids, assumed to be 2.7 g/cm^3.

The result was a computed total porosity of 0.15.

Effective porosity (n_e) was estimated to be 80 percent of total porosity (Reference 41). Thus, n_e was assumed to be 0.12. This is the value used to compute u_x in Equation 2.4-5, in which:

$$u_x = \frac{K_h^i}{n_e} \qquad [2.4\text{-}8]$$

Dispersion Coefficients (D) - The dispersion coefficient in the direction of flow (D_x) was estimated using the approximate equation given by Reference 13:

$$D_x = \left(0.67 + 0.5 \left(\frac{u_x\ d_{50}}{D_m}\right)^{1.2} D_m\right) \qquad [2.4\text{-}9]$$

where:

d_{50} = the median grain size; and

D_m = the molecular diffusion coefficient in water, 0.864 cm^2/day.

Particle size analyses on test pit samples showed that the d_{50} of the Heumader Shale and the overlying soil and weathered rock was about 0.0005 cm.

For all the flow paths examined, D_x was computed to be equal to 0.58 cm^2/day. The dispersion coefficient (D_m) is slightly less than the molecular diffusion coefficient in water (D_x) because the median grain size (d_{50}) is very small. As d_{50} increases, D_x also increases.

Based on Figure 7 of Reference 34, the ratio of D_x /D_{y2} was estimated to be 1.0 in each case. Thus, D_y = 0.58 cm/day.

The value for D_z was set arbitrarily low, 1.0 x 10^{-6} cm^2/day cm^2/day, to ensure that no dispersion would occur vertically beyond the upper or lower boundary of the water-table aquifer.

Cation Concentration (C_{Ca}) - Water-quality data for the period 1976-1978 were available for five wells located within 3 miles of the center of the site. To be conservative, the highest cation concentration values were selected, because the value of R_f increases as C_{Ca} increases.

CATION	MAXIMUM VALUE IN 3-YEAR PERIOD (mg/l)	(meq/ml)
Ca	320	0.016
Mg	68	0.0057
K	7.2	0.00018
Na	280	0.012
Total		0.03388

It is a conservative simplification to assume that calcium is the only native cation in the soil exchange complex with which injected strontium, cesium, and cobalt cations would have to compete. The concentration term (C_{ca}) in the reduction factor (R_f) refers to the equilibrium concentration of calcium in interstitial fluids. Thus, C_{Ca} was set equal to 0.034 meq/ml.

Cation Exchange Capacity (Q) - The approximate composition of the clay minerals of the Heumader Shale and other shale members at the site is 48.3 percent illite, 33.3 percent chlorite, and 18.3 percent kaolinite (Table 2.5-44).

As the clay minerals make up about 70 percent of the mineral composition of the shales (Figure 2.5-90), the approximate bulk composition of the shales by clay mineral is 34 percent illite; 23 percent chlorite, and 13 percent kaolinite.

Reference 16 states that the range of cation-exchange capacities for the three clay minerals are:

a. Illite, 10 to 40 milliequivalents per 100 grams;

b. Chlorite, 10 to 40 milliequivalents per 100 grams; and

c. Kaolinite, 3 to 15 milliequivalents per 100 grams.

To be conservative, the lowest exchange capacity for each mineral is assumed. Using the bulk percentage of each mineral results in cation-exchange capacities for illite, chlorite, and kaolinite of 0.034, 0.023, and 0.004 milliequivalents per gram, respectively. The total cation-exchange capacity of the site shales is 0.061 milliequivalents per gram.

Equilibrium Exchange Constants (E) - The equilibrium exchange constant for strontium (E_{Sr-Ca}) was estimated on the basis of experimental data for illite and kaolinite provided by Heald (Ref. 17), under the assumption that strontium exchange on chlorite will be close to that for kaolinite. The weighted average value for E_{Sr-Ca} was 1.01.

To estimate the exchange constants for cobalt and cesium, data on distribution coefficients (k_d) for cobalt and cesium, as well as strontium, were analyzed and compared. The data derived from experimental investigations reported by References 39, 43, and 74. The k_d values were obtained for each clay mineral (kaolinite or illite) from data obtained under similar experimental conditions. Then, weighted k_d values for each isotope were obtained on the basis of the proportion of the clay minerals in the shale; exchange reactions on chlorite were assumed to be the same as on kaolinite. The resulting estimated k_d values for Heumader Shale are:

$$k_d(Sr) = 2,235$$

$$k_d(Cs) = 14,087$$

$$k_d(Co) = 4,684$$

Considering that the materials and conditions of the experiments from which these values were derived were essentially the same, it is reasonable to estimate the exchange constants for Cs and Co using E_{Sr-Ca} as the standard, on the assumption that E is linearly proportional to k_d. Therefore:

$$E_{Cs-Ca} - \frac{14,087}{2,235} (1.01) = 6.30 \qquad [2.4\text{-}10]$$

and

$$E_{Co-Ca} - \frac{4,684}{2,235} (1.01) = 2.10 \qquad [2.4\text{-}11]$$

Dimensipns of Slug (V_o) - The volume (V_o) occupied by the slug in the soil at time t = 0 will be approximately:

$$V_o = \frac{\text{Volume of Liquid Contents}}{n} \qquad [2.4\text{-}12]$$

For example, for the boron recycle holdup tank, the volume of liquid contents equals 1.696×10^8 ml. Thus:

$$V_o = \frac{1.696 \times 10^8}{0.15} = 1.131 \times 10^9 \text{ ml} \qquad [2.4\text{-}13]$$

For a cuboid slug, $x_o = y_o = z_o$; hence:

$$x_o = y_o = z_o = (1.131 \times 10^9)^{1/3} = 1,042 \text{ cm} \qquad [2.4\text{-}14]$$

The dimensions of the slug for the other tanks are computed similarly.

Because of the large size of the refueling water storage tank, however, it was not reasonable to select a cuboid slug, as that would have resulted in a z_o (vertical dimension of the slug in the soil) of 2,160 cm (71 feet), greater than the saturated thickness of the water-table aquifer at the plant. Therefore, z o was taken as 1,219 cm (40 feet) the approximate saturated thickness of the water-table aquifer. This resulted in an x_o (=y_o) of 2,878 cm (94 feet).

2.4.13.3.4 Results of Analysis

The results of the postulated rupture of each of the three tanks described in USAR Section 2.4.13.3.1 are presented in Table 2.4-35. Peak concentrations at the discharge points and the time to attain these concentrations are provided for some or all of the following important radionuclides, depending upon the composition of the radwastes in each tank: H-3, Mn-54, Co-58, Co-60, Sr-89, Sr-90, Nb-95, Zr-95, I-131, Cs-134, Cs-137, Ba-140. Cation exchange (E greater than 0) was included in the simulations only for strontium, cesium, and cobalt.

As shown in Table 2.4-35, only in the case of tritium did the computed concentrations at ground-water discharge points exceed the maximum permissible concentrations set forth in Appendix B of 10 CFR 20. A peak tritium concentration of 1.21 mCi/ml and 0.57 mCi/ml was computed for ground water discharging to the cooling lake as a result of the rupture of the boron recycle holdup tank (A or B) and the refueling water storage tank, respectively. The 10 CFR 20 limits for tritium are 0.010 and 0.001 µCi/ml for restricted and unrestricted areas, respectively. The computed peak tritium concentrations for ground water discharging to the Wolf Creek tributary were 0.077 and 0.030 µCi/ml from the boron recycle holdup tank and the refueling water storage tank, respectively, which exceed the 10 CFR 20 limit for unrestricted areas.

However, the tritium concentration in the cooling lake and the Wolf Creek tributary will be well below the limits for unrestricted areas (see discussion below). Since the nearest water users are downstream of both the cooling lake and the potential discharge point on the tributary to Wolf Creek, the tritium concentrations would be within the 10 CFR 20 limits at the nearest water supply. Details of dilution within the surface-water regime of the cooling lake are discussed in USAR Section 2.4.12. Details of dilution within the Wolf Creek tributary due to ground-water discharge are discussed below.

Calculations show that the rate of addition of tritium to the cooling lake by means of ground-water discharge exceeds its radioactive decay rate. Hence, the maximum contribution to the concentration of tritium in the lake would occur when the entire tritium plume had discharged to the lake, assuming there was no significant discharge of lake water downstream of Wolf Creek in the interim. The time for the entire plume to enter the lake is calculated to be 10,665 days. At the end of this period, the total number of curies (M) of tritium can be calculated by:

$$M = M_o e^{\lambda t} \qquad [2.4\text{-}15]$$

where M_o is the initial number of curies of tritium. For this analysis, the refueling water storage tank provides the worst case, as it has a higher M_o value than does the boron recycle holdup tank.

$$M = (3.79 \times 10^9) \exp - \frac{0.693}{4{,}478} (10{,}665) \qquad [2.4\text{-}16]$$

$$= 7.275 \times 10^8 \ \mu Ci$$

At the normal operating level, the lake will hold 111, 280 acre-feet of water, or 1.3726 x 1014 ml. Assuming complete mixing, the average contribution to the tritium concentration in the lake at peak ground-water discharge concentration levels would be

$$\frac{7.275 \times 10^8}{1.3726 \times 10^{14}} = 5.30 \times 10^{-6} \ \mu Ci/ml \qquad [2.4\text{-}17]$$

which is about 200 times smaller than the 10 CFR 20 limit for unrestricted areas. This is less than the equilibrium tritium concentration in the cooling lake due to normal releases and is well below the limits of 10 CFR 20.

Significant dilution would also occur in the tributary to Wolf Creek, thus reducing the peak tritium concentration there to a figure well below the limit for unrestricted areas. A model run (Program SLUG3D) showed that at the time of the peak point concentration, resulting from the rupture of the refueling water storage tank, the average tritium concentration of ground water entering the stream would be approximately 1.62 x 10^{-2} µCi/ml over a reach of about 175 feet, the computed width of the plume. By straight-line measurement, the tributary is approximately 5,500 feet long, from a northerly point (north of which the stream is ephemeral) southward to the tributary's confluence with Wolf Creek. Dilution would occur as a result of the ground-water discharge into the stream arising from the 5,500-175, or 5,325 feet of uncontaminated reach on the east side, plus 5,500 feet of uncontaminated reach on the west side. However, allowance was made for the fact that the average ground-water discharge coming from the west side could be approximately five times less than that from the east side, because of the much smaller catchment size on the west side. The ground-water discharge rate per lineal foot of stream was assumed to be constant; thus, the dilution factor was based solely on the ratio of the length of stream receiving uncontaminated ground water to the length of stream affected by the plume. The resulting computed dilution factor was 37.3. Therefore, the expected peak concentration of tritium at the confluence of the tributary with Wolf Creek is 4.3×10^{-4} µCi/ml, compared to the 10 CFR 20 limit of 1.0×10^{-3} µCi/ml for unrestricted areas.

2.4.13.4 Monitoring or Safeguard Requirements

Construction of the plant required dewatering of the excavations which extend below the water table (USAR Section 2.5.4.6). It is demonstrated in USAR Section 2.4.13.5.1 that dewatering of plant site excavations during construction did not affect offsite ground-water users.

It is demonstrated in USAR Section 2.4.13.3 that the travel time (including the effects of ion-exchange capacity) and dilution effects for an accidental release of radioactive effluent to move from the plant along potential ground-water flow paths to existing or potential future users is sufficiently long to preclude contamination of ground- and surface-water supplies. Radioactive effluent reaching these supplies would have insignificant concentrations of radionuclides. Therefore, ground-water monitoring and safeguards are not required to protect ground-water users, and no monitoring programs or special safeguards are planned.

Piezometers and wells located in the area inundated by the cooling lake were sealed prior to filling of the lake except as described below. The piezometers in the cooling lake area which were sealed are listed in Table 2.4-38 and their locations are shown on Figures 2.4-54, 2.4-55, and 2.4-61. Private operating and abandoned wells in the cooling lake area which were sealed are listed in Tables 2.4-29b and 2.4-29c, and the well locations are shown on Figure 2.4-52.

Well D38B was not plugged due to flooding by the water storage pond at the wash plant during construction of the lake, and Wells D-58B, X-D39-1 and X-D18 which were in waste areas and could not be located. This includes all piezometers and wells within the drainage boundaries of the cooling lake below elevation 1097.5 feet (USGS) (cooling lake level under the condition of probable maximum flood and superimposed wind-wave effect) with the exception of the piezometers at Borings B-17, P-14, and LK-10. The piezometers at Borings B-17 and LK-10 have been maintained to monitor local ground-water levels during the operational phase of the plant; although these borings are above the normal pool elevation of the cooling lake, the piezometer installations are adequately protected to prevent contamination and damage from the cooling lake during flood and wave runup. Piezometer P-14 was damaged during construction and could not be located. Piezometer P-14 is currently located under a parking lot consisting of granular subbase with a 4" asphalt surface course which should protect the groundwater from contamination.

All test borings made at the site, except for those in which piezometers were installed, have previously been backfilled and sealed with cement.

The following procedures were used for sealing wells:

a. All drilled wells are sealed with a grout mix.

b. Dug wells greater than 10 feet deep are sealed with a concrete mix.

c. Dug wells or cisterns less than 10 feet deep are plugged by excavating the well or cistern and filling in the resulting hole with compacted cohesive material. During excavation, if it is found that the well or cistern is into bedrock, the hole is sealed with a concrete mix.

2.4.13.5 Design Bases for Subsurface Hydrostatic Loadings

2.4.13.5.1 Plant Site

Water levels measured in piezometers installed in the residual soil, Jackson Park Shale Member, and Heumader Shale Member were generally about 5 feet below the present ground surface; however, some seasonal variations are noted (Figure 2.4-56 and Tables 2.4-32 and 2.4-33). Data obtained from plant site piezometers measuring the composite water levels of all rock units from the Jackson Park Shale Member to the Plattsmouth Limestone Member (Table 2.4-33) show that the potentiometric water levels are near the ground surface following periods of high precipitation and snow-melt. The shallow water table in the residual soil and weathered bedrock, depending on the amount and frequency of precipitation, is partly perched on the underlying bedrock. After periods of intense precipitation, the water table in the residual soil and weathered bedrock rises at a faster rate than in the unweathered rock units. This is due to greater vertical permeability in the residual soil and weathered bedrock. Because ground-water levels occasionally rise to near the ground surface, the design water level for ground water-induced hydrostatic loading is conservatively established at plant site grade elevation, 1,099.5 feet.

The normal water table at the plant site is 5 feet below grade and all the safety-related structures are designed for full hydrostatic loading to El. 1099.5 ft. MSL which is the plant grade. No permanent underdrains or ground water dewatering systems are installed or planned at the site.

2.4.13.5.2 Uplift Pressures

The water contained in the weathered Heumader Shale Member is under water-table conditions, while the water contained in the Plattsmouth Limestone Member is under semi-confined to water-table conditions. However, uplift pressures in the Heumader Shale Member due to excess hydrostatic pressure and lack of drainage in the Plattsmouth Limestone Member will not be significant. The head in the Plattsmouth Limestone Member will equilibrate as excavation progresses. The piezometer water-level response to surface infiltration indicates that these units have sufficient vertical permeability to allow relief of excess pressure. The hydrostatic pressure in the Toronto Limestone Member is not high enough to affect excavation stability.

The drop in head from the Heumader Shale Member to the Plattsmouth Limestone Member (Figure 2.4-57) indicates a downward gradient from the ground surface to the Plattsmouth. Water levels in piezometers installed in the Toronto Limestone Member are lower than those observed in the Plattsmouth Limestone Member (Figures 2.4-57 and 2.4-58).

Both natural and recompacted cohesive soils in the site area tend to produce shrinkage or desiccation cracks upon drying. Thus, vertical downward movement of water from precipitation can be expected, even in areas where engineered cohesive fill has been properly placed. In addition, controlled rock blasting of excavations is expected to increase vertical hydraulic connection in the adjacent bedrock and allow an increased hydraulic connection between the bedrock and recompacted soils.

2.4.13.5.3 Dewatering of Excavations

Excavations extend to variable depths to attain foundation grades (USAR Section 2.5.4, Figure 2.5-45) with maximum depths of about 41 feet or to elevation 1,058.5 feet.

Dewatering of excavations within the Category I area has been accomplished by pumping from sumps in the excavation. With permeabilities averaging 4 x 10-5 cm/sec (0.8 gpd/ft^2) in the Jackson Park Shale Member, 6 x 10^{-6} cm/sec (0.1 gpd/ ft^2) in the Heumader Shale Member, and 2 x 10^{-6} cm/sec (0.04 gpd/ft^2) in the Plattsmouth Limestone Member, normal dewatering by pumping from sumps has been used to maintain dry excavations.

Where benches are established (USAR Section 2.5.4), surface-water runoff and ground-water seepage has been intercepted by ditches and directed to sumps. Water levels in weathered and unweathered shale and limestone units equilibrate during excavation. The low permeabilities of these units (Table 2.4-34) have precluded an appreciable amount of seepage into the excavations. Water from precipitation and ground-water seepage has been removed from excavations prior to placing concrete. The method of dewatering by pumping from sumps has been chosen because (1) the volume of ground-water seepage is small, (2) uplift pressures will not be significant, and (3) it is necessary to remove water from precipitation.

At the plant site, the Jackson Park Shale Member was dewatered during excavation. During construction dewatering, the potentiometric level within the Heumader Shale Member is locally lowered to the bottom of that unit at about elevation 1,064 feet, a depth of 35.5 feet below plant grade. The potentiometric level of the Plattsmouth Limestone Member is lowered from about 1,068 to 1,057 feet, or about 11 feet.

The lateral extent of dewatering during construction was evaluated by use of an equation cited by Reference 9 as follows:

$$s = s_o \quad 1 - \frac{2}{\sqrt{p}} \int_0^{\frac{x}{\sqrt{Tt/S}}} e^{-u^2} du$$

where:

$u^2 = x^2S/(4Tt)$

s_o = water-level decline in the excavation, in feet;

s = net decline in ground-water levels, in feet;

x = distance from the excavation to a hypothetical observation well, in feet;

t = time lapsed, in days;

S = storage coefficient of strata, dimensionless;

T = transmissivity of the strata (permeability times saturated thickness in feet - assumed to be constant away from the excavation), gallons per day per foot (gpd/ft).

Assuming an average thickness of 26 feet, a storage coefficient (S) of 0.05, a permeability (k) of 6 x 10^{-6} cm/sec (0.1 gpd/ft^2), a transmissivity (T) of 3.3 gpd/ft and using the Ferris equation above the following water-level changes are calculated to occur in the Heumader Shale Member after 2 years of dewatering:

Distance From Excavation (feet)	Decline in Water Level (feet)
50	23.5
100	13.5
200	2.9
500	< 0.03

The above tabulation indicates that beyond a distance of about 500 feet from the excavation, construction dewatering has a negligible effect on the water table.

A similar analysis was performed for the Plattsmouth Limestone Member. Because of low permeability and semi-confined conditions, the storage coefficient (S) of the Plattsmouth Limestone Member is conservatively taken as 0.0001. The permeability (k) is taken as 2 x 10^{-6} cm/sec (0.04 gpd/ft^2) (Table 2.4-34). Thus, assuming a 12-foot thickness of this unit, the transmissivity is 0.51 gpd/ft. Water-level changes in the Plattsmouth Limestone Member after 2 years of dewatering are calculated with the Ferris equation and the above input data as:

Distance From Excavation (feet)	Decline in Water Level (feet)
50	10.6
100	10.1
200	9.2
500	6.6
1,000	3.5
2,000	0.44
3,000	< 0.01

The above tabulation indicates that beyond a distance of about 2,000 feet from the excavation, construction dewatering will have a negligible effect on the water levels in the Plattsmouth Limestone Member. Ground-water level readings in the Plattsmouth from piezometer P-14 about 800 feet from the excavations show that the dewatering calculations are accurate (Table 2.4-33). Present and future ground-water users were not affected by dewatering excavations at the plant site. The nearest wells outside the site boundary are more than 6,000 feet east of the excavations. Completion of construction has allowed the local water table to recover to its original level.

2.4.13.5.4 Essential Service Water System (ESWS) Pumphouse

Borings ESW-28 and ESW-29 were drilled at the location of the essential service water system (ESWS) pumphouse (Figure 2.5-25). Logs of borings ESW-28 and ESW-29 are presented in USAR Section 2.5, and a cross section through those borings is shown on Figure 2.5-50.

Ground-water conditions in the ESWS pumphouse area were monitored by piezometers installed in Borings ESW-10, ESW-23, HS-29, and HS- 10. The piezometer in ESW-10 measures the potentiometric surface in the Plattsmouth Limestone Member. The ground-water level was at about elevation 1,075 under artesian conditions. The piezometer installed in Boring ESW-23 was isolated in the Plattsmouth Limestone Member, but the water level had not stabilized before it was destroyed in 1975 (Table 2.4-33). Two piezometers have been installed in Boring HS-29. The lower piezometer measures the potentiometric level of the Toronto Limestone Member, while the upper piezometer measures the composite potentiometric level of the overburden through the Plattsmouth Limestone Member. The upper piezometer in Boring HS-29 indicates a stabilized water-level elevation at about 1,050 feet (Figure 2.4-56). About 1,000 feet to the east of the ESWS pumphouse location, at Boring HS-10, a piezometer is isolated in the Plattsmouth Limestone Member. Its hydrograph (Figure 2.4-56) suggests that the Plattsmouth Limestone Member at and near the ESWS pumphouse is under semi-confined conditions with the potentiometric level near the top of the Plattsmouth Limestone Member.

The excavation for the ESWS pumphouse extends to about elevation 1,053 feet which is near the base of the Plattsmouth Limestone Member. However, the low permeability of the Plattsmouth Limestone Member and the overlying Heumader Shale Member [2×10^{-6} and 8×10^{-7} cm/sec (0.04 and 0.02 gpd/ft^2), respectively] indicates that only minor amounts of ground-water seepage entered the excavation. Dewatering during construction was accomplished by pumping from sumps. As demonstrated in USAR Section 2.4.13.5.3, the area of influence of dewatering was small.

The design water level for the ESWS pumphouse is conservatively established at the ground-surface grade or the Probable Maximum Flood level in the lake (elevation 1,095.0) whichever is greater.

2.4.13.5.5 Category I Pipelines

Data obtained from piezometers (Tables 2.4-32 and 2.4-33 and Figure 2.4-56) measuring the composite water levels of all units from the overburden to the Plattsmouth Limestone Member show that the potentiometric water levels are near the ground surface (generally within 5 feet) following periods of high precipitation. Piezometers tapping only the Plattsmouth Limestone Member indicate a water level near the top of the unit. Therefore, the design water level along the ESWS pipelines has been established conservatively at the ground surface or at the maximum cooling lake elevation of 1,095.0 feet, whichever is greatest at any point along the pipeline routes.

The cross sections of the ESWS pipeline alignments (Figures 2.5-47 and 2.5-51) indicate that the pipeline excavations only partially penetrate the Plattsmouth Limestone Member. The low permeability of the near-surface rock units [8×10^{-7} to 4×10^{-5} cm/sec (0.02 to 0.8 gpd/ft^2)] indicated that the amount of seepage into the ESWS pipeline excavations during construction was very low. When the excavations were first opened, ground-water inflows originate from the weathered sandstone unit of the Jackson Park Shale Member. These inflows locally dewatered the Jackson Park Shale Member as the excavation proceeded. Ground water in the Heumader Shale and Plattsmouth Limestone members which seeped into excavations were removed by a system of ditches and sump pumps. As demonstrated in USAR Section 2.4.13.5.3, the area of influence of dewatering during construction was small.

2.4.13.5.6 ESWS Discharge Structure

Boring ESW-17 was drilled at the location of the ESWS discharge structure.

Two piezometers were installed in Boring HS-8, about 600 feet west of Boring ESW-17, which monitor ground-water conditions near the location of the ESWS Discharge Structure. The lower piezometer measures the potentiometric level of the Toronto Limestone Member while the upper piezometer measures the composite potentiometric level of the overburden and Plattsmouth Limestone Member. The hydrograph (Figure 2.4-56) for the upper piezometer indicates that the water levels near the discharge structure are near the existing ground surface. Marshy conditions at the ground surface near the discharge structure suggest a water-table condition. The ground-water level in the Toronto Limestone Member is at about elevation 1,057 under artesian conditions.

The final adjacent ground surface elevation is at the base of the ultimate heat sink (UHS) pond, elevation 1,065 feet. The foundation grade is at about elevation 1,059 feet within the Heebner Shale Member (Figure 2.5-51). The low permeability of the Plattsmouth Limestone and Heebner Shale members [averaging about 2×10^{-5} and 4×10^{-6} cm/sec (0.4 and 0.08 gpd/ft^2), respectively; see Table 2.4-34 indicates that the rate of ground-water seepage into the excavation during construction was slow and could be removed by pumping from sumps. As demonstrated in Section 2.4.13.5.3, the area of influence of dewatering during construction was small.

The design water level for the ESWS discharge structure is conservatively established at the maximum cooling lake elevation of 1,095.0 feet.

2.4.14 REFERENCES

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7. Chow, ed., 1964, Handbook of applied hydrology: McGraw-Hill Book Company, Inc., New York, Sections 14-6, 21-37, 25-5.

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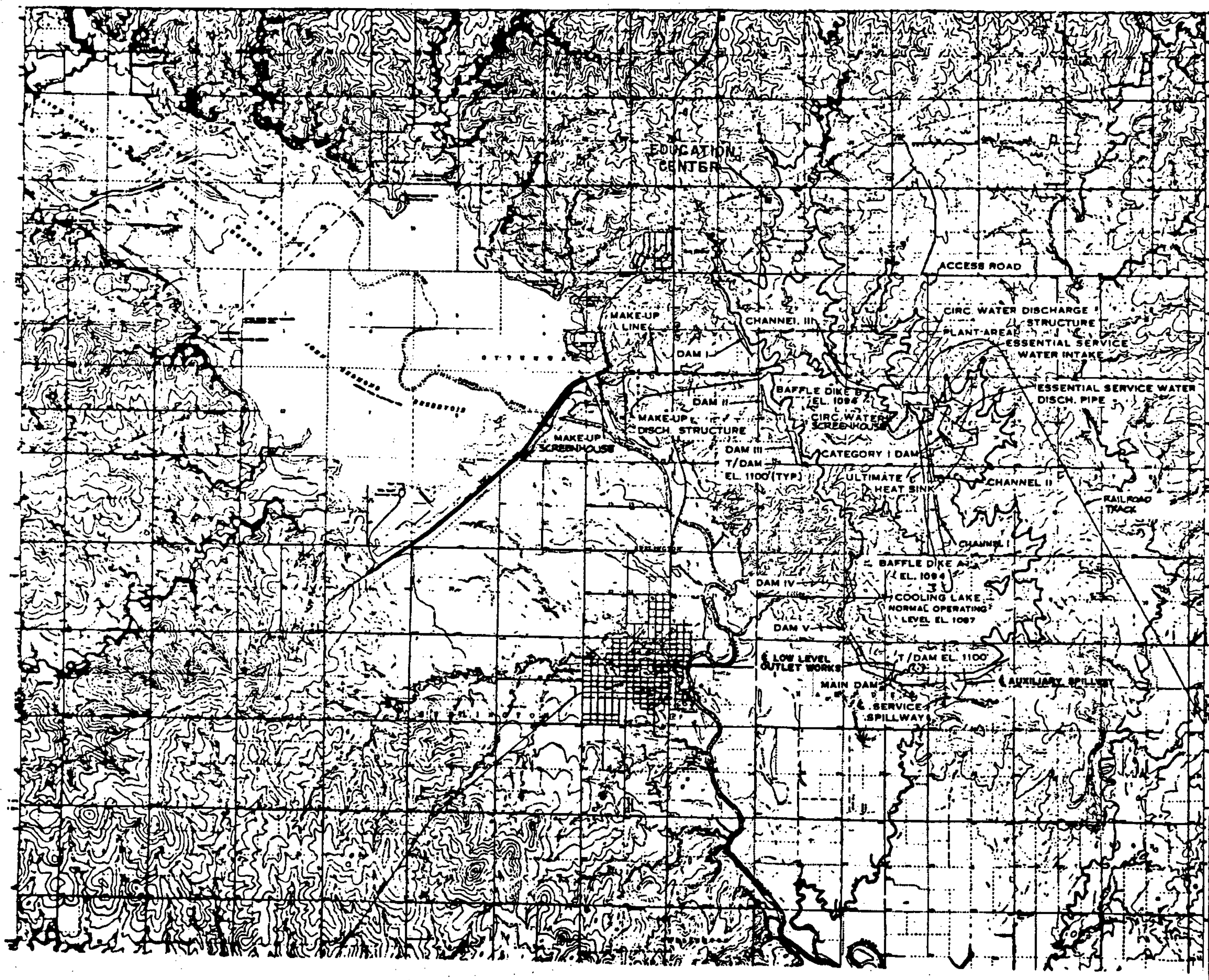

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Figure 2.4-1

General Arrangement

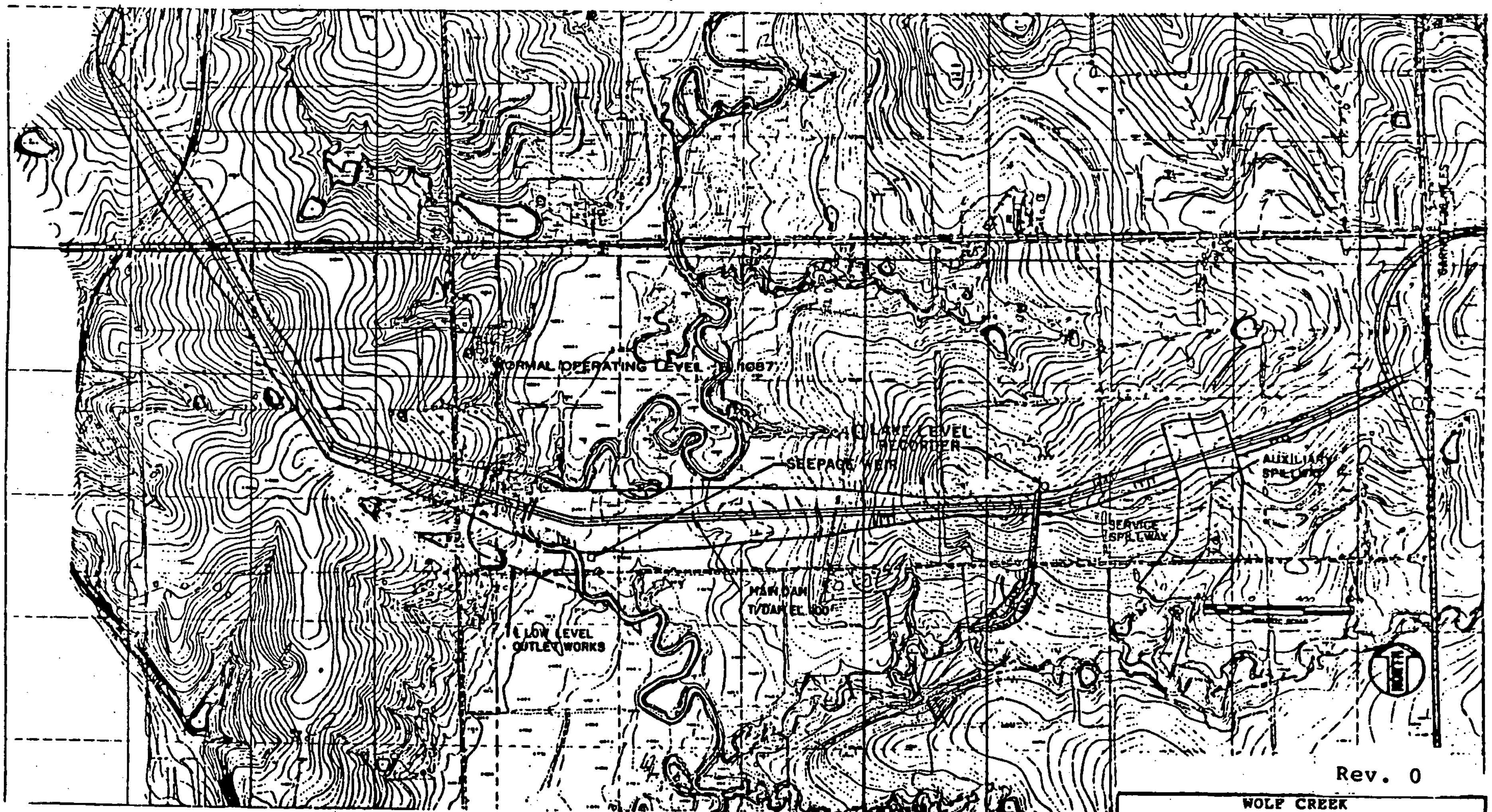

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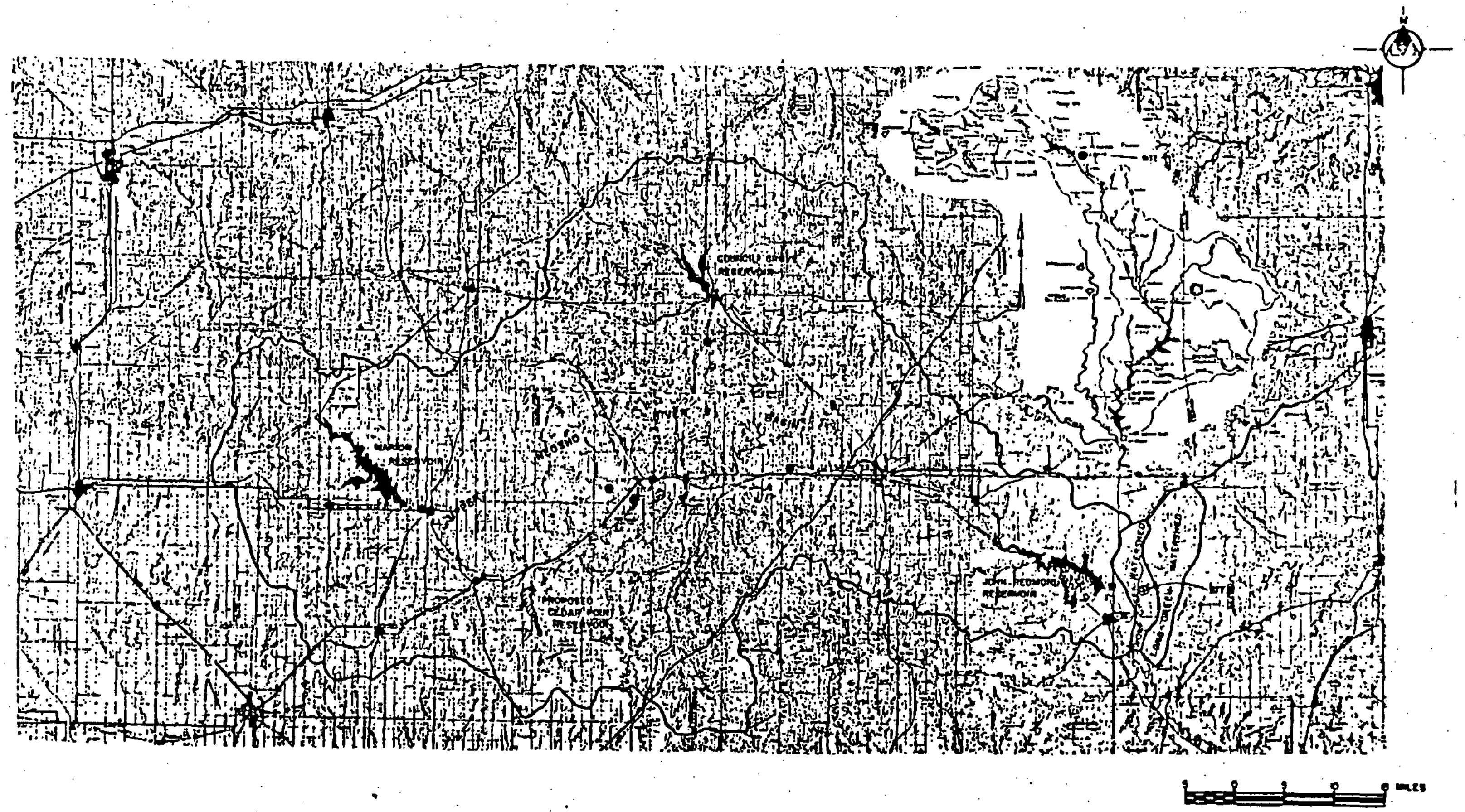
Figure 2.4-2

Main Dam and Appurtenant Structures



LEGEND

▲ EXISTING USGS STREAM-GAGING STATIONS

● DISCONTINUED USGS STREAM-GAGING STATIONS

■ USGS. RESERVOIR WATER-STAGE RECORDERS

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Figure 2.4-5-

Neosho River Basin in Kansas

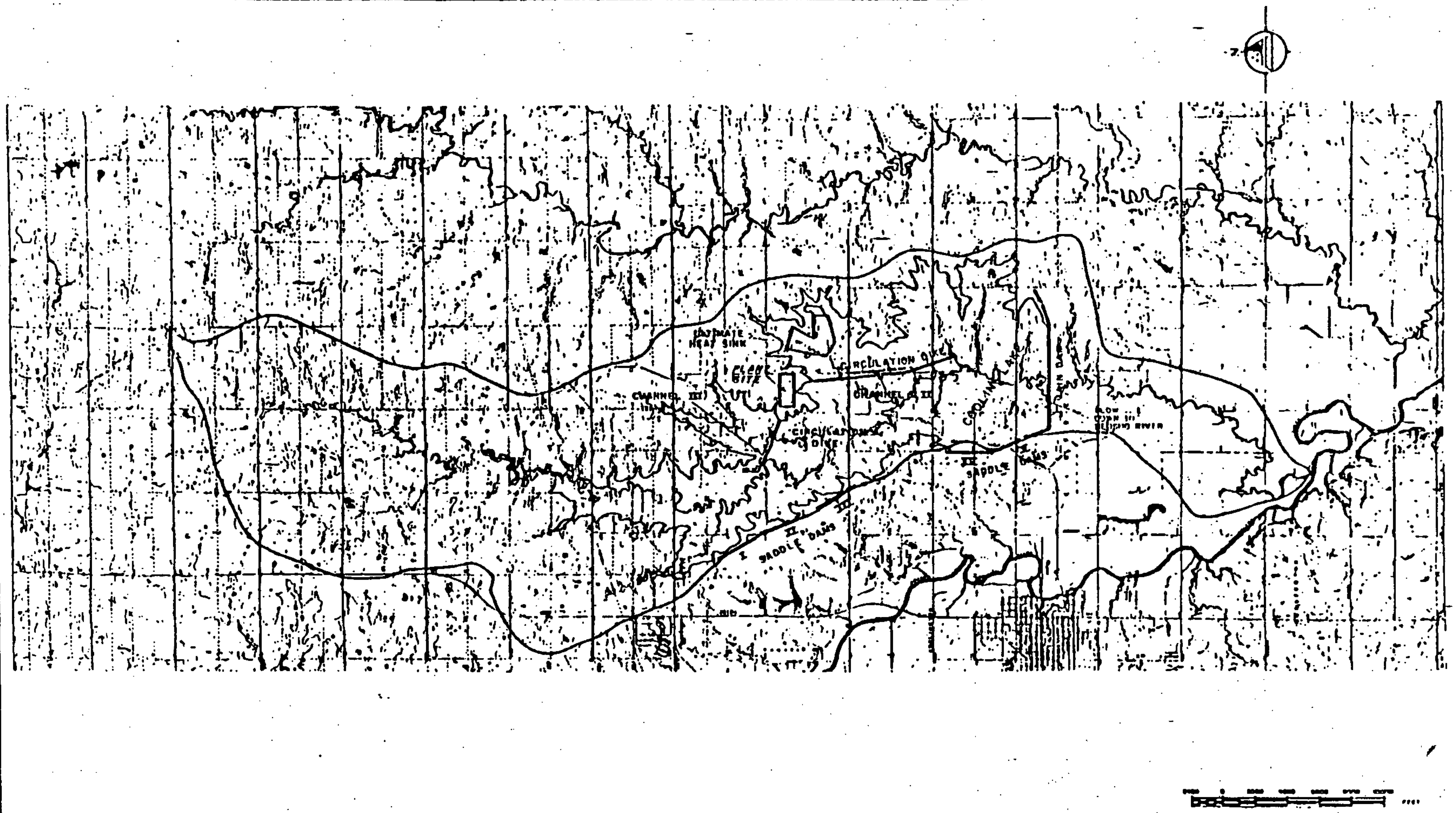

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Figure 2.4-6

Wolf Creek Watershed

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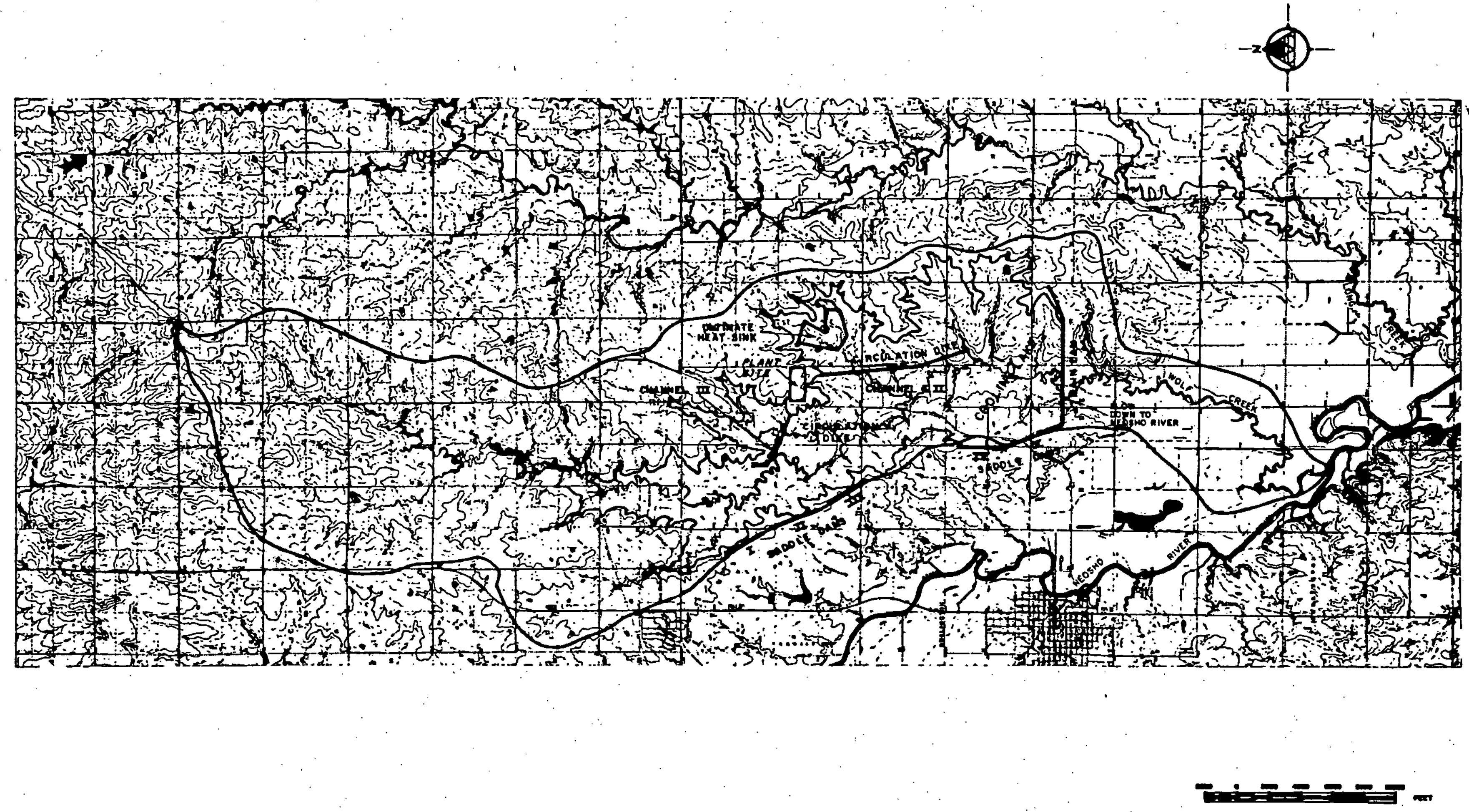

MAP REFERENCE:

THIS MAP TAKEN FROM U.S.G.S. QUADRANGLES: BURLINGTON, KANSAS AND NEW STRAWN, KANSAS DATED 1971.

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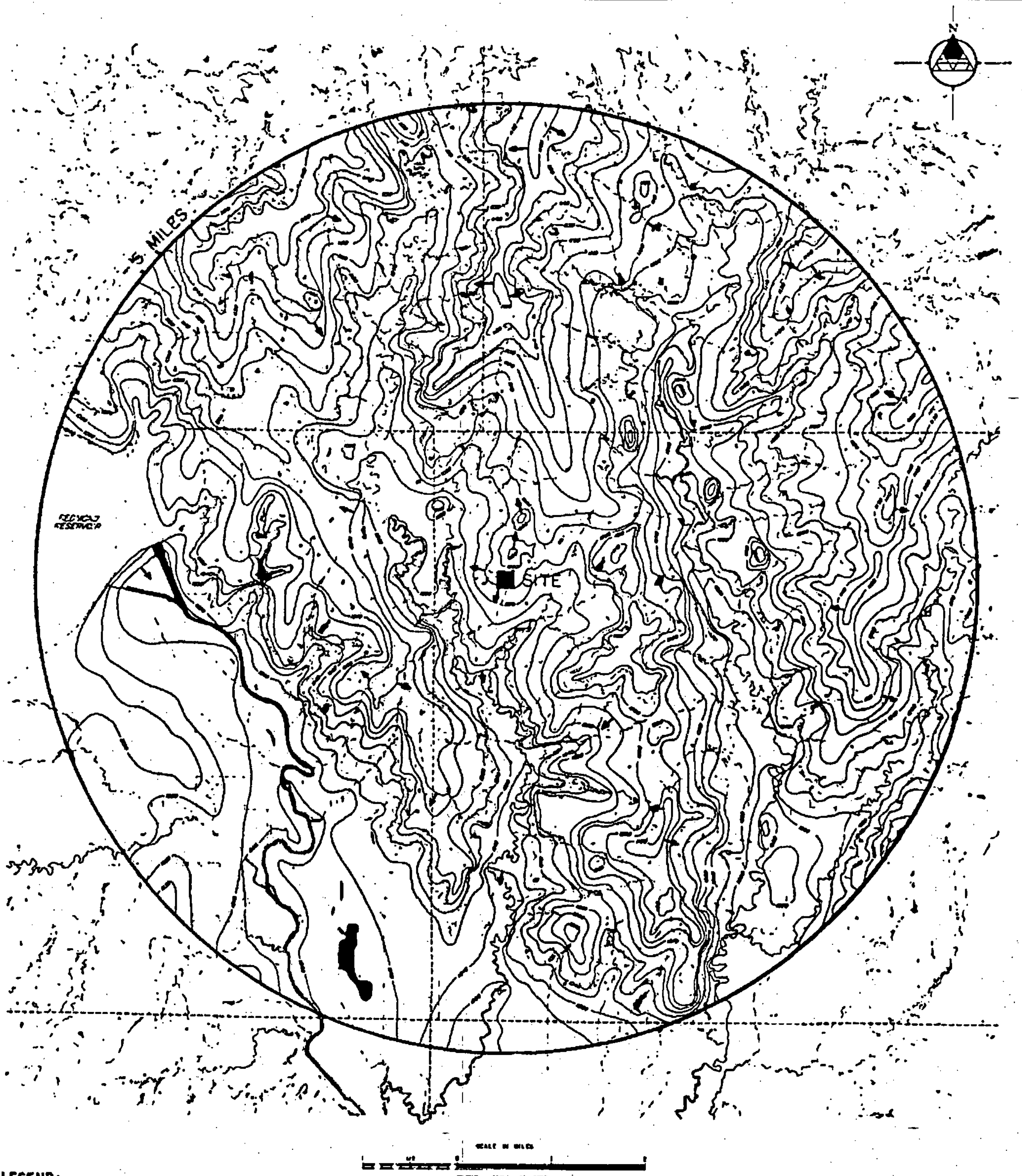
FIGURE 2.4-1

WOLF CREEK WATERSHED



LEGEND:

—1100— TOPOGRAPHIC CONTOURS (50 FOOT INTERVALS)

—1000— WATER TABLE ELEVATION CONTOURS (10 FOOT INTERVALS) FROM DATA GATHERED DURING WELL INVENTORY. (SEE TABLE 2.4-29).

↓ ARROWS SHOW DIRECTION OF GROUND-WATER FLOW.

REFERENCE:

FIFTY-FOOT TOPOGRAPHIC CONTOURS FROM U.S. GEOLOGICAL SURVEY QUADRANGLES FOR NEW STRAWN (1971); OTTUMWA (1970), WAVERLY SE (1971), ALICEVILLE (1971), BURLINGTON (1971) AND JOHN REDMOND DAM (1966); 7.5 MINUTE SERIES.

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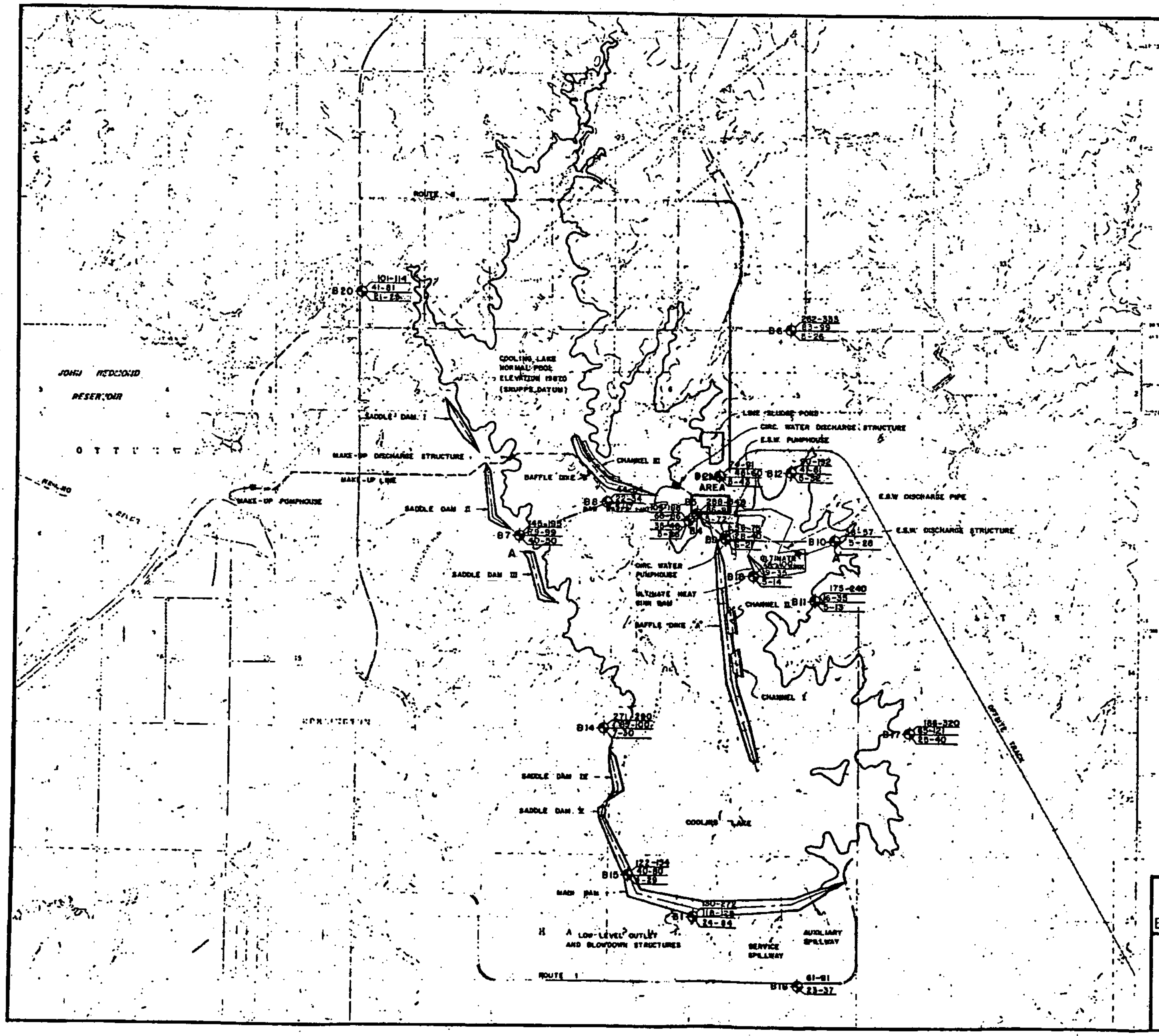
FIGURE 2.4-6
WATER TABLE CONTOURS WITHIN A 5-MILE RADIUS OF THE SITE



EXPLANATION:

BORING NUMBER — B-10 38-57 5-28 — DEPTH TO TOP OF EFFECTIVE INTERVAL — DEPTH TO BOTTOM OF EFFECTIVE INTERVAL

NOTE:

CROSS-SECTION A-A' SHOWN ON FIGURE 2.4-4.

DRAWING REFERENCE:

TITLE: GENERAL ARRANGEMENT, WOLF CREEK GENERATING STATION UNIT I
FOR: KANSAS GAS AND ELECTRIC COMPANY AND KANSAS CITY POWER AND LIGHT COMPANY
BY: SARGENT AND LUNDY ENGINEERS, CHICAGO
DRAWING NO. S-1, Rev. B
DATED: 12/17/76

MAP BASE PREPARED FROM U.S.G.S. TOPOGRAPHIC QUADRANGLES, 7.5' SERIES; BURLINGTON, KANSAS, 1971; JOHN REDMOND DAM, KANSAS, 1966; NEW STRAWN, KANSAS, 1971; OTTUMWA, KANSAS, 1970.

FEET

0 2000 4000 6000 8000

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ENVIRONMENTAL REPORT (OPERATING LICENSE STAGE)

FIGURE 2.4-14

LOCATION OF PIEZOMETERS

B - SERIES

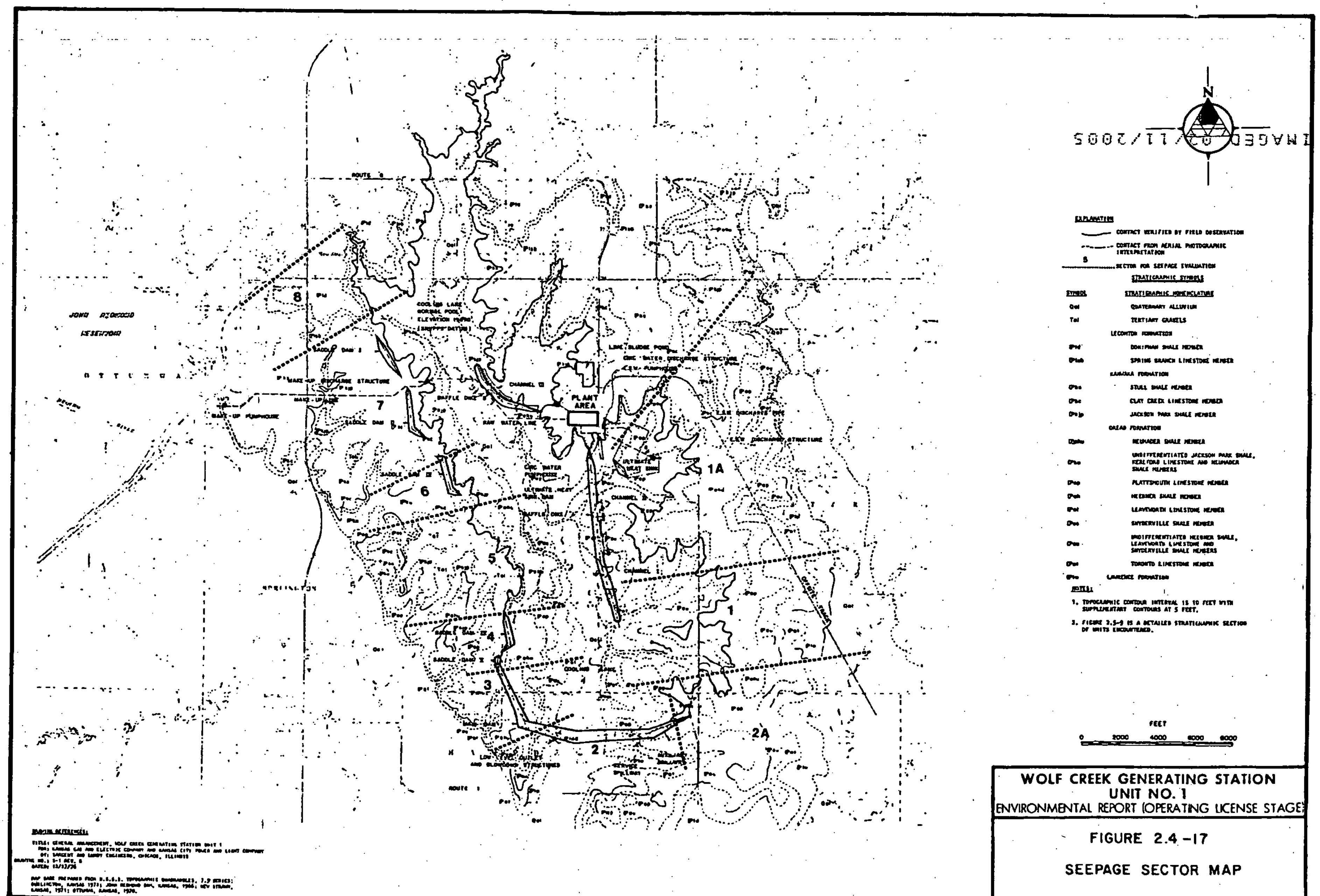

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FIGURE 2.4-17

SEEPAGE SECTOR MAP

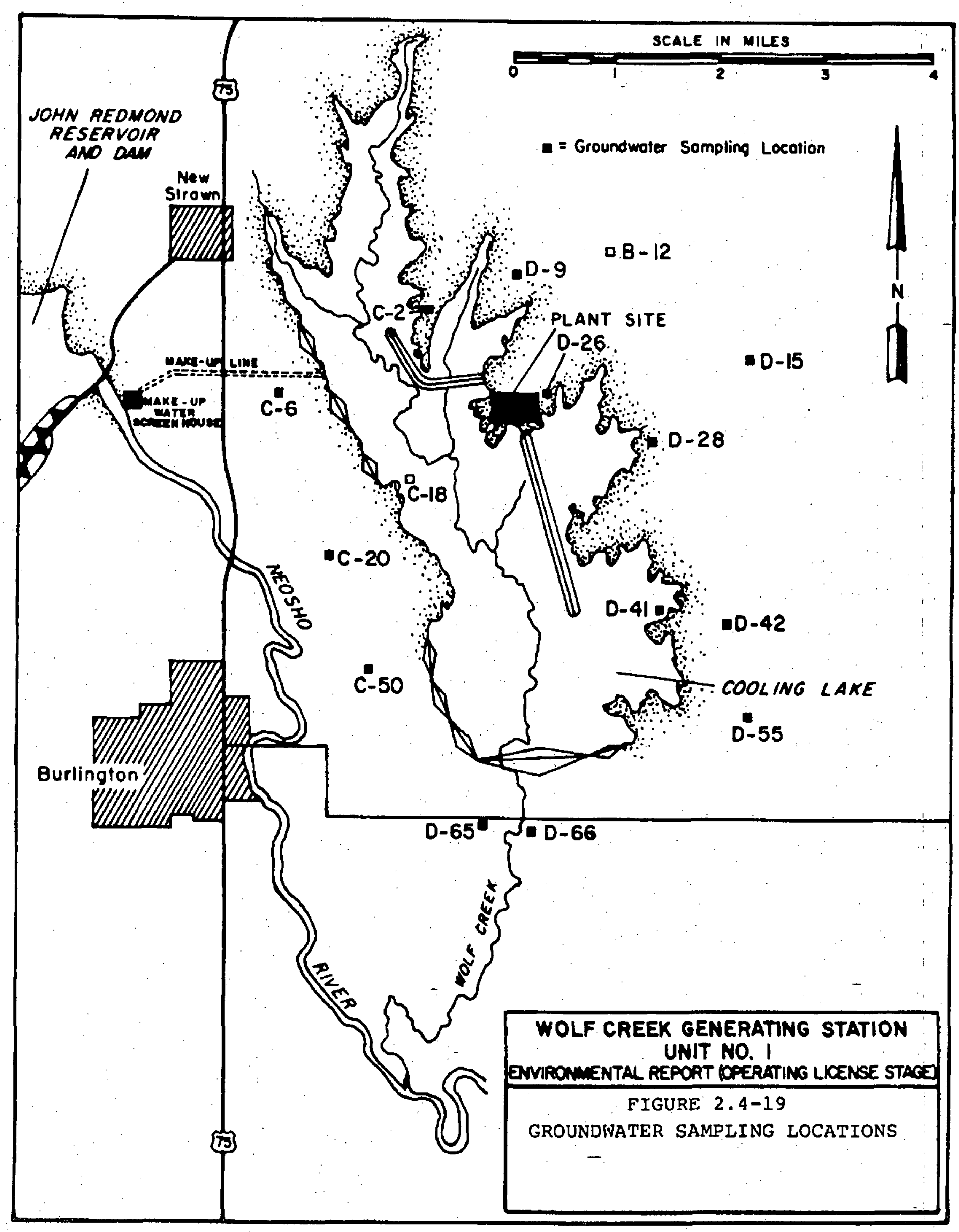

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FIGURE 2.4-19
GROUNDWATER SAMPLING LOCATIONS

48. Documentation of any environment releases, including any evaluations of the incident with respect to the nature, extent, and impact of the release.

• Site-specific hydrogeological information, including: groundwater depth(s) at site; aquifer(s) present at site; location, elevation, construction, and historical analyses on current and past monitoring wells (including B-12, C-10, C-49, J-1, J-2, G-2, and F-1); details of the current monitoring and analytical program; flow direction information (direction, rate, fate); and comprehensive local production information (locations, construction information, history of analysis, pump rates, use).

• Documentation of any environment releases, including any evaluations of the incident with respect to the nature, extent, and impact of the release.

• Locations, volumes, and existing chemical and radiological analytical data on drinking water intakes for Burlington, Neosho Falls, Iola, and any other intakes on the Neosho River between JRR and Iola.

• Correspondence, reports, and any other information related to any past restrictions on water withdrawal, if any have occurred. If none have occurred, a statement that these restrictions have never been implemented.

• More detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells included in the study, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

• A map showing the locations of all groundwater monitoring or production wells in the local area, including their depths, rates of production, and use of water, if known. Section 2.9.1 states that 80% of water use in the basin is from surface sources – describe the source, location, and use of the other 20%.

• More detailed meteorological data, including historic rainfall data, to provide additional information for the evaluation of water use conflicts in Section 2.10 of the ER (WCGS, 1980). Include average rainfall, seasonal variations, and information on extreme conditions. Please provide the average peak and low-flow values for the Neosho River. Also provide information on seasonal variability, if it exists.

• Clarification of the relationship between the WCNOC contract with the Kansas Water Resources Board, versus the "Certificate of Appropriation" discussed in ER Section 4.1. It appears that the contract has controls based on available supply within the reservoir, while certificate has controls based on the flow rate in the river. Please verify if this is correct. Also identify if a different agency implements the controls in either case, or if this is a single agency.

Water Use/Water Quality	
77	.....If at any time a release to the environment has been documented, then any evaluations of this information with respect to the nature, extent, and impact of the release.

Reportable Releases of Oil and Hazardous Substances

- 5/22/1985 – approx. 50 gal. water soluble oil; to lake
- 1/2/1987 – approx. 35 gal. oil past weir below site oil/water separator
- 8/13/1987 – approx. 3 gal. oil from bucket falling off truck; to public road
- 10/1988 – unknown quantity diesel fuel from underground piping; subsequent remediation project completed
- 10/3/1990 – discovered leaking underground piping from diesel fuel storage tank; local groundwater contamination; remediation process recovered approx. 175 gal. of diesel fuel; remediation considered complete in 1998 (per 11/5/98 KDHE letter)
- 3/15/1991 – approx. 1125 gal. acidic wastewater (RCRA D002) released to storm drain system; pH of water where this system drained to lake (NPDES outfall) was 8.0
- 12/20/1991 – approx. 1 qt. oil past weir below site oil/water separator
- 1/10/1992 – approx. 1 qt. oil past weir below site oil/water separator
- 7/6/1992 – oil sheen past weir below site oil/water separator
- 7/25/1992 - < 1 qt. oil to MUSH pump bay from screenwash drive chain sump
- 3/17/1993 – approx. 1 pt. oil past weir below site oil/water separator
- 3/29/1993 – approx. 1 pt. oil past weir below site oil/water separator
- 4/13/1993 – approx. 1 qt. oil past weir beow site oil/water separator
- 4/21/1993 – approx. 30 gal. diesel fuel; overflow from storage tank; to soil
- 5/10/1993 – oil sheen past weir below site oil/water separator
- 5/17/1993 – approx. 1 qt. oil past weir below site oi/water separator
- 12/14/1994 – approx. 15 gal. hydraulic oil from truck; to soil
- 7/22/1995 – oil sheen on lake at intake from leaking lube oil reservoir
- 11/5/1995 – approx. 3 pts. gear oil to lake from intake chain drive sump
- 5/27/1997 – oil sheen (< 4 oz.) past weir below site oil/water separator; to lake
- 11/11/1997 – approx. 1 gal. oil past weir below site oil/water separator
- 7/1/1998 – oil sheen past weir below site oil/water separator
- 7/7/1998 – oil sheen past weir below site oil/water separator
- 12/25/1998 – approx. 300-500 gal. kerosene from tank to earthen berm (contained within berm); soil was remediated
- 6/4/1999 – 1694 lbs. sodium hypochlorite (15% or less) solution released to lake
- 7/16/2000 – approx. 15 gal. sodium bromide (40% sol.) released to soil
- 8/26/2001 – approx. 2 oz. oil; from grease on dredge equipment; to lake

- 1/31/2002 – oil sheen reached lake past weir below site oil/water separator
- 3/15/2002 – approx. 10 gal. diesel fuel from offloading; some may have reached lake via storm drain
- 4/16/2004 – approx. 20 gal. hydraulic oil from compressor transfer line; to soil
- 7/26/2004 – approx. 2 gal. diesel fuel from offloading; to soil
- 10/15/2005 – approx. 2 gal. diesel fuel from filling generator fuel tank; to soil
- 1/26/2006 – approx. 3 gal. hydraulic oil from truck; to soil
- 4/3/2006 – approx. 2.5 gal. hydraulic oil from truck; to soil

49. Locations, volumes, and existing chemical and radiological analytical data on drinking water intakes for Burlington, Neosho Falls, Iola, and any other intakes on the Neosho River between JRR and Iola.

• Site-specific hydrogeological information, including: groundwater depth(s) at site; aquifer(s) present at site; location, elevation, construction, and historical analyses on current and past monitoring wells (including B-12, C-10, C-49, J-1, J-2, G-2, and F-1); details of the current monitoring and analytical program; flow direction information (direction, rate, fate); and comprehensive local production information (locations, construction information, history of analysis, pump rates, use).

• Documentation of any environment releases, including any evaluations of the incident with respect to the nature, extent, and impact of the release.

• Locations, volumes, and existing chemical and radiological analytical data on drinking water intakes for Burlington, Neosho Falls, Iola, and any other intakes on the Neosho River between JRR and Iola.

• Correspondence, reports, and any other information related to any past restrictions on water withdrawal, if any have occurred. If none have occurred, a statement that these restrictions have never been implemented.

• More detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells included in the study, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

• A map showing the locations of all groundwater monitoring or production wells in the local area, including their depths, rates of production, and use of water, if known. Section 2.9.1 states that 80% of water use in the basin is from surface sources – describe the source, location, and use of the other 20%.

• More detailed meteorological data, including historic rainfall data, to provide additional information for the evaluation of water use conflicts in Section 2.10 of the ER (WCGS, 1980). Include average rainfall, seasonal variations, and information on extreme conditions. Please provide the average peak and low-flow values for the Neosho River. Also provide information on seasonal variability, if it exists.

• Clarification of the relationship between the WCNOC contract with the Kansas Water Resources Board, versus the "Certificate of Appropriation" discussed in ER Section 4.1. It appears that the contract has controls based on available supply within the reservoir, while certificate has controls based on the flow rate in the river. Please verify if this is correct. Also identify if a different agency implements the controls in either case, or if this is a single agency.

Personal Communication

Date: April 21, 2005

Source – Person's name, title, and phone number: Kelly Kelsey (man), 785-296-6340.

Title of place contacted: Kansas Department of Health and Environment. Enforcement and Regulation Development. Public Water Supply Section.

Subject discussed: Water Supply Data for the Cities of Emporia and Burlington.

Personal communication with E. N. Hill, TtNUS.

Detailed description of the information sought:

I contacted Mr. Kelsey to obtain the current water supply data for the Cities of Emporia and Burlington. He gave me the water data for the City of Emporia (see below), but did not have information for the City of Burlington. He suggested that I contact Jack Sowder, Water Superintendent, for the City of Burlington data.

Mr. Kelsey reported the following:

City of Emporia:

Maximum Capacity = 12.5 MGD
Average Daily Production = 9.4 MGD
Total Design Capacity = 15 MGD

Personal Communication

Date: May 5, 2005

Source – Person's name, title, and phone number: Jack Sowder, Water Superintendent for City of Burlington, wk - 620-364-8332 or cell – 620-364-6432.

Title of place contacted: City of Burlington water supply facility.

Subject discussed: Water Supply Data for the City of Burlington.

Personal communication with E. N. Hill, TtNUS.

Detailed description of the information sought:

I contacted Mr. Sowder to obtain the current water supply data for the City of Burlington.

Mr. Sowder reported the following:

City of Burlington:

Maximum Capacity = 1.8 MGD
Average Daily Production = 0.6 to 0.7 MGD
Total Design Capacity = 2.0 MGD (however, if you subtract process water, TDC = 1.8 MGD.

IMAGED 04/28/2006

K01-017

WOLF CREEK
NUCLEAR OPERATING CORPORATION

Kevin J. Moles
Manager Regulatory Affairs

April 27, 2006

RA 06-0066

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Subject: Docket No. 50-482: 2005 Annual Radiological Environmental Operating Report

Gentlemen:

Enclosed is the Annual Radiological Environmental Operating Report, which is being submitted pursuant to Wolf Creek Generating Station (WCGS) Technical Specification 5.6.2. This report covers radiological environmental monitoring around WCGS for the period of January 1, 2005, through December 31, 2005.

No commitments are identified in this correspondence. If you have any questions concerning this matter, please contact me at (620) 364-4126, or Ms. Diane Hooper at (620) 364-4041.

Sincerely,

Kevin J. Moles

Kevin J. Moles

KJM/rlt

Enclosure: 2005 Annual Radiological Environmental Operating Report

cc: J. N. Donohew (NRC), w/e
W. B. Jones (NRC), w/e
B. S. Mallett (NRC), w/e
Senior Resident Inspector (NRC), w/e

WOLF CREEK NUCLEAR OPERATING CORPORATION

WOLF CREEK GENERATING STATION

2005 ANNUAL RADIOLOGICAL

ENVIRONMENTAL OPERATING REPORT

April 15, 2006

IMAGED 04/28/2006

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EXECUTIVE SUMMARY

Plant-related activation, corrosion or fission products were not detected during 2005 in airborne particulate and radioiodine filters, ground water, drinking water, shoreline sediment, broadleaf vegetation, crops, terrestrial vegetation, aquatic vegetation, or soil samples. Activation, corrosion or fission products attributable to plant operation were detected during 2005 in surface water, fish, and bottom sediment samples.

Nuclides detected in REMP samples were below applicable NRC reporting levels, and program lower limits of detection were met.

Based upon the radiological environmental monitoring results, it was concluded that station operations has had no significant radiological impact on the health and safety of the public or the environment.

INTRODUCTION

The 2005 Annual Radiological Environmental Operating Report for Wolf Creek Generating Station (WCGS) covers the period from January 1 through December 31, 2005. WCGS is located in Coffey County, Kansas, approximately five miles northeast of Burlington, Kansas.

Fuel loading commenced at WCGS on March 12, 1985. The operational phase of the Radiological Environmental Monitoring Program (REMP) began with initial criticality on May 22, 1985, and the first detectable quantities of radioactivity were reported in plant effluents in June 1985.

This report contains a description of the REMP conducted by Wolf Creek Nuclear Operating Corporation (WCNOC), results of sample analyses, a discussion of monitoring program results, a description of revisions to and deviations from the program, and the results of Interlaboratory Comparison Programs. Individual sample results and a summary of results in the Nuclear Regulatory Commission (NRC) Branch Technical Position specified format are included as appendices.

I. PROGRAM DESCRIPTION

Radiological environmental samples were collected according to the schedule in WCGS procedure AP 07B-004, *Offsite Dose Calculation Manual (Radiological Environmental Monitoring Program)*. Environmental samples were collected by the WCGS Environmental Management group and were analyzed by Environmental, Inc. Detroit Edison processed environmental thermoluminescent dosimeters (TLDs) at the Enrico Fermi 2 plant. Table 1 lists sampling pathways and frequencies of sampling and analysis. Table 2 lists each sample location's distance and direction from the plant. Samples in addition to those required by the WCGS Offsite Dose Calculation Manual (ODCM) were also obtained and analyzed.

The following is a description of the sampling and analysis program by individual pathways.

A. Airborne Pathway

Low volume air sampling pumps collected particulate and radioiodine samples on 47 mm glass fiber filters and charcoal canisters, respectively. The filters and charcoal canisters were changed out weekly, labeled, and shipped to Environmental, Inc. for analysis. The volume of air sampled was calculated from the average of initial and final flow rates and the total time of collection. Each pump was equipped with a time totalizer that was checked weekly against the elapsed time to identify electrical power outages.

Gross beta analysis of the air particulate samples was performed after a nominal 72-hour period to allow the radon and thoron daughter products to decay.

Weekly air particulate filters were combined into quarterly composites for each location and analyzed for gamma emitting isotopes.

Charcoal canisters were routinely counted in groups of five to determine the presence or absence of I-131. Positive indication of I-131 would have resulted in analysis of each individual charcoal canister.

Air samples were collected from six locations. Indicator locations 2, 37 and 49 are located in the three sectors with the highest ground level deposition constants (D/Q). Air sampling stations are also located in the community of New Strawn (indicator location 32) and a control location at Harris (location 48). Supplemental indicator location (location 18) was also sampled during the year. Distances and directions to sampling locations from the plant are listed in Table 2, indicator locations are shown in Figure 1, and the control location is shown in Figure 5.

B. Direct Radiation Pathway

Panasonic UD-814-AQ TLDs were used at 47 locations during the sample year. The TLDs consist of one lithium-borate element and three calcium sulfate elements in a plastic case.

TLDs were typically positioned roughly 3 to 4 feet above the ground in plastic thermostat boxes. The thermostat boxes protect the TLDs from the elements and tampering. Two TLDs were placed at each designated location. The TLDs were changed out quarterly. Indicator TLD sample locations are illustrated in Figure 2 and control locations are shown in Figure 5. Table 2 provides the distance and direction of each location from the plant. Control locations were 39 (Beto Junction) and 48 (Harris).

C. Waterborne Pathway

All water samples were analyzed to determine whether gamma emitters were present. In addition to gamma isotopic analysis, radiochemical analysis for I-131 was performed on drinking water and ground water samples. Gross beta analysis was also performed on drinking water samples. Tritium analysis was performed monthly by liquid scintillation for surface water and quarterly for drinking water. Tritium analysis was also performed on ground water samples. Water sampling locations are listed in Table 2 and are shown in Figures 3 and 5.

Monthly grab samples of surface water were collected from John Redmond Reservoir (JRR) as a control location and from the "SP" location, which is located near the spillway of Coffey County Lake, formally known as Wolf Creek Lake, as an indicator location.

Quarterly grab samples of ground water were collected from four wells. Location B-12 is hydrologically up gradient from the site and was used as a control location. Three locations (C-10, C-49, and J-1) are hydrologically down gradient from the site and were used as indicator sample locations.

Drinking water was sampled at the water treatment facilities for the towns of Burlington (control location BW-15) and Neosho Falls (indicator location NF-DW). The Burlington facility is located upstream and the Neosho Falls facility is located downstream of the confluence of the discharge from Coffey County Lake and the Neosho River. Composite samples were obtained monthly from automatic samplers at each location that collected approximately 27 ml of drinking water every two hours.

Shoreline sediments were sampled semiannually. Gamma isotopic analysis was performed on the shoreline sediment samples. Shoreline sediment sample locations were the Coffey County Lake discharge cove (DC) indicator location and at the control location (JRR).

D. Ingestion Pathway

Because no sampling locations that produce milk for human consumption were identified within five miles of the plant, milk was not collected during the sample year.

Fish were sampled semiannually from the tail waters of JRR (control, Figure 4) and from Coffey County Lake (indicator, Figure 4). Gamma isotopic analysis was performed on the boneless meat portions of the fish. Several species of game fish and rough fish were sampled. Fish were also analyzed for tritium.

Broadleaf vegetation samples were collected monthly when available during the growing season from five gardens. Three indicator (G-1, N-1 and Q-6) gardens (Figure 4) and two control (D-1 and D-2) gardens (Figure 5) were sampled. Gamma isotopic analyses were performed on all samples.

Crop samples were obtained from two indicator locations (NR-D1 and NR-D2) downstream of the confluence of Wolf Creek and the Neosho River. One crop sample was obtained from control location NR-U1. Gamma isotopic analysis was performed on each sample. Crop sample locations are identified on Figure 5.

E. Additional Samples Collected (not required by ODCM)

Drinking water indicator location IO-DW (Iola) was sampled during the year. The drinking water sample was analyzed for gross beta, gamma emitters, I-131 and tritium. This sample location was added due to the anticipated closure of the Neosho Falls drinking water treatment facility and is identified on Figure 5.

Quarterly, duplicate ground water grab samples were obtained from indicator location C-49 and were labeled L-49. These duplicate samples served as laboratory quality checks. Three indicator ground water sample locations were also sampled during the fourth quarter of 2005 (F-1, G-2 and J-2). The ground water samples were analyzed for gamma emitters, I-131 and tritium.

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Bottom sediment samples were collected at the Environmental Education Area (EEA) and from the Make-Up Discharge Structure (MUDS). Gamma isotopic analysis was performed on the bottom sediment samples. These indicator samples were collected as part of a cooperative sampling effort with the Kansas Department of Health and Environment (KDHE). The sample locations are identified on Figure 3.

Bottom sediment samples were collected semiannually at the Coffey County Lake discharge cove (DC) indicator location and the control location (JRR). Gamma isotopic analysis was performed on the bottom sediment samples. These samples were collected as part of a cooperative sampling effort with the KDHE. The sample locations are identified on Figure 3.

Aquatic vegetation was collected from indicator locations EEA and MUDS. Gamma isotopic analysis was performed on the aquatic vegetation samples. These samples were collected as part of a cooperative sampling effort with the KDHE. The sample locations are identified on Figure 3.

Terrestrial vegetation was sampled from indicator location EEA. Gamma isotopic analysis was performed on the terrestrial vegetation sample. This sample was collected as part of a cooperative sampling effort with the KDHE. The sample location is identified on Figure 4.

Soil was sampled from indicator locations MUDS and EEA. Gamma isotopic analysis was performed on the soil samples. These samples were collected as part of a cooperative sampling effort with the KDHE. The sample locations are identified on Figure 4.

Distance and direction information for the sampling locations listed in this section are outlined in Table 2.

II. DISCUSSION OF RESULTS

Analysis results for all pathways are summarized in Appendix B using the format described in Radiological Assessment Branch Technical Position, Revision 1, November 1979 (NRC Generic Letter 79-065). Results for individual samples are listed in Appendix C.

In this section, results are discussed by pathway and analysis type. Monitoring results are compared with control data, preoperational values, sources of radioactivity, and effluent releases when applicable. Trends or seasonal effects are discussed.

A. Airborne Pathway

Chart 1 graphically illustrates weekly gross beta results for the sample year. Chart 2 represents the historical smoothed averages of indicator and control gross beta data.

Charts 1 and 2 demonstrate how closely the indicator and control locations tracked together. Chart 2 reveals a seasonal cyclic trend in which gross beta values peak in the winter months (December or January) and decrease to a low point in the spring months (May or June). This trend is expected and is attributed to seasonal meteorological changes, i.e., changes in prevailing winds and precipitation.

The gross beta results of 2005 were compared to pre-operational monitoring results of 1983 and 1984. The weekly gross beta analyses range for 1983 and 1984 was 0.0064 to 0.084 pCi/m^3. The 2005 weekly gross beta analyses range for indicator locations was 0.014 to 0.055 pCi/m^3, which was within the 1983 and 1984 pre-operational range. Additionally, the annual mean for indicator locations for 2005 (0.030 pCi/m^3) was lower than the annual mean for 1983 (0.032 pCi/m^3).

The gross beta results for the indicator locations were also compared to the control location. The annual mean for indicator locations for 2005 (0.030 pCi/m^3) was similar to the annual mean of the control location (0.029 pCi/m^3).

Naturally occurring Be-7 activity was detected, as was the case during pre-operational monitoring. In 1984, the range for Be-7 detected activity was 0.024 to 0.211 pCi/m^3 for indicator locations, and the annual mean for indicator locations was 0.069 pCi/m^3. In 2005, the range for Be-7 detected activity was 0.057 to 0.107 pCi/m^3 for indicator locations, and the annual mean for indicator locations was 0.080 pCi/m^3.

The control location annual mean for Be-7 detected activity (0.076 pCi/m^3) was similar to the indicator locations annual mean (0.080 pCi/m^3).

Required lower limits of detection were met and I-131 activity was not detected in the weekly analysis of charcoal filters at any location.

No effects of plant operation were seen via the airborne pathway for the year, and no unusual trends were noted.

B. Direct Radiation Pathway

Quarterly gamma exposures measured at each location are shown in Table 3. Measured values have been converted to a standard 90-day quarter.

The annual mean of all indicator locations in 2005 was 0.271 mR/day and the annual mean for the control locations was 0.265 mR/day. The exposure measurements for the control locations and the indicator locations were elevated due to the unusually long period of time between the ship dates of the TLDs from the vendor lab and the read times by the vendor lab. This condition has been documented in the corrective action process (PIR 2006-0831).

For pre-operational comparison, in 1981, the annual mean of all indicator locations was 0.21 mR/day and annual mean for the control locations was 0.19 mR/day.

Results from TLDs located near the plant (less than three miles), which would be most affected by changes in plant operation, were combined into quarterly averages. These nearsite averages, using locations 1, 2, 7-14, 18, 26-30, 37 and 38, are compared to control location results (locations 39 and 48) in Chart 3. Chart 3 also includes preoperational data for comparison. The nearsite TLD locations have historically trended higher than the control locations both prior to and after WCGS became operational. Chart 3 also displays the elevated results for the control locations and the indicator locations.

C. Waterborne Pathway

(1) Surface Water

Tritium, attributable to WCGS operation, was detected in all surface water samples collected from Coffey County Lake during 2005. Chart 4 illustrates the yearly averages of surface water tritium data for the spillway location. It can be seen in Chart 4 that surface water tritium concentrations have trended upward since plant startup. This is expected until the average tritium concentration of the lake reaches equilibrium.

Tritium activity (219 +/- 95 pCi/L), not attributable to WCGS operation, was also detected in one surface water sample obtained from the control location (JRR) on October 20. Statistically, the tritium level observed is at the lower end of the vendor laboratory's counting system capability.

Required lower limits of detection were met.

During pre-operational environmental radiological monitoring, measured radiological activity was not detected in surface water samples.

Tritium was the only activity detected in surface water samples and no unusual trends were noted.

(2) Ground Water

Low levels of tritium, not attributable to WCGS operation, were the only activity detected in ground water samples. Two indicator locations C-10 and C-49 collected on August 11 had tritium detected at levels of 204 +/- 94 pCi/L and 217 +/- 95 pCi/L, respectively. These analysis results were verified by a laboratory re-analysis. Statistically, the tritium levels observed were at the lower end of the vendor laboratory's counting system capability. Additionally, a split sample had been obtained from location C-49 and was labeled L-49. The tritium result for the sample collected on August 11 and labeled location L-49 was <173 pCi/L.

Required lower limits of detection were met.

During pre-operational environmental radiological monitoring, measured radiological activity was not typically detected in ground water samples.

Low levels of tritium were the only activity detected in ground water samples and no unusual trends were noted.

(3) Drinking Water

Chart 5 illustrates the drinking water gross beta results for the last five years and how closely the gross beta results compared for the indicator and control locations.

Gross beta activity was detected in all drinking water samples. The annual mean of the control location gross beta activity (3.9 pCi/L) was higher when compared to the annual mean of the indicator locations (3.6 pCi/L). The 2005 annual means of gross beta activity for both the control and indicator locations were lower than those of the pre-operational monitoring year of 1984. In 1984, the annual mean of the control location gross beta activity was 6.4 pCi/L, and the annual mean of the indicator location gross beta activity was 7.5 pCi/L.

During the third quarter of 2005, low levels of tritium activity were detected in the two indicator location samples (Iola: 207 +/- 83 pCi/L; Neosho Falls: 243 +/- 85 pCi/L) as well as the control location sample (Burlington: 245 +/- 85 pCi/L). The analysis results were verified by a laboratory re-analysis. Statistically, the tritium levels observed were at the lower end of the vendor laboratory's counting system capability.

Required lower limits of detection were met. Additionally, radionuclides were not detected by the I-131 or gamma isotopic analyses.

Activity due to plant operation was not evident in drinking water samples during 2005 and no unusual trends were noted.

(4) Shoreline Sediment

Naturally occurring K-40 (10,382–10,953 pCi/kg, dry) was detected in samples obtained from the indicator location (DC) and in samples obtained from the control location (8,643-11,846 pCi/kg, dry). K-40 was also detected during pre-operational shoreline sediment monitoring.

Cs-137 activity was detected in the samples obtained from the control location (JRR). The indicator location (DC) samples did not have Cs-137 activity detected.

Required lower limits of detection were met. Activity due to plant operation was not evident in shoreline sediment samples during 2005 and no unusual trends were noted.

D. Ingestion Pathway

(1) Milk

Milk was not collected during the sample year since no indicator locations within five miles of the plant were identified during the Land Use Census.

(2) Fish

Naturally occurring K-40 activity was detected in all fish samples. K-40 activity was also detected during pre-operational fish monitoring.

During 2005, fish were also analyzed for tritium. All fish samples taken from Coffey County Lake had tritium activity detected (7,699.7 pCi/kg annual mean). The detected tritium activity was attributable to plant operation. An adult consuming 21 kilograms of fish, at the maximum measured tritium concentration for 2005 (9,479 pCi/kg), would receive a committed effective dose equivalent of 0.013 mRem.

Tritium activity was not detected in the control samples collected from JRR.

No other radionuclides were detected in fish during the year. The ODCM required lower limits of detection were met and no unusual trends were noted.

(3) Broadleaf Vegetation

Gamma analyses of broadleaf vegetation samples obtained from indicator and control locations detected naturally occurring gamma emitters Be-7 and K-40. Be-7 and K-40 activity were also detected pre-operationally.

The ODCM required lower limits of detection were met and no unusual trends were noted. Activity attributable to plant operation was not detected.

(4) Crop Samples

Gamma analysis detected naturally occurring K-40 to be present in all of the samples. K-40 activity was also detected during pre-operational crop monitoring. K-40 was the only activity detected in crop samples. The ODCM required lower limits of detection were met and no unusual trends were noted.

E. Additional Samples Collected (not required by ODCM)

(1) Bottom Sediment

Naturally occurring K-40 was detected in all of the bottom sediment samples. K-40 activity was also detected during pre-operational bottom sediment monitoring.

Co-60 activity (159.7 and 182.8 pCi/kg) was detected in the samples obtained from the Coffey County Lake discharge cove. Co-60 activity was attributable to plant operation and has been identified in plant effluents. Co-60 activity was not detected in pre-operational environmental monitoring and was not detected in samples collected from control location JRR during 2005. Chart 6 plots the Co-60 detected activity from the discharge cove and reflects a decreasing trend.

Cs-137 activity (208.9 and 234.4 pCi/kg) was detected in the indicator samples obtained from the Coffey County Lake discharge cove. A portion of this activity is due to fallout and a portion of this activity is likely plant-related since Cs-134 activity has been detected in the past. Cs-137 activity was detected in pre-operational samples, and the results for 2005 indicator bottom sediment samples were within the pre-operational range. (Cs-137 activity detected in 1981 and 1982 was in the range of 79 to 953 pCi/kg. The decay corrected range of pre-operational Cs-137 activity detected is approximately 45 to 542 pCi/kg.) Cs-137 activity has been identified in plant effluents. Cs-137 activity (154.5 and 127.6 pCi/kg) was also detected in the control location samples and in the samples obtained from the indicator location EEA (83.7 and 77.3 pCi/kg).

Chart 7 plots the Cs-137 detected activity from the discharge cove indicator location and JRR control location bottom sediment samples. The detected Cs-137 activity measured from the discharge cove location reflects a decreasing trend. The Chart 7 trend line indicates that as expected, Cs-137 activity detected at the JRR control location has been decreasing.

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No other radionuclides were detected in bottom sediment samples and no unusual trends were noted.

(2) Aquatic Vegetation

Naturally occurring Be-7 and K-40 activity were detected in samples collected in 2005. Be-7 and K-40 activity were also detected during pre-operational monitoring.

No other radionuclides were detected in aquatic vegetation samples and no unusual trends were noted.

(3) Terrestrial Vegetation

Naturally occurring Be-7 and K-40 activity were detected in samples collected in 2005. No other radionuclides were detected. No unusual trends were identified.

(4) Soil

Naturally occurring K-40 activity was detected in both of the soil samples. K-40 activity was also detected during pre-operational soil monitoring.

Cs-137 (557.5 pCi/kg) activity was detected in one soil sample obtained from the indicator location EEA. The pre-operational Cs-137 results (255 to 2,160 pCi/kg) for soil samples were decay corrected. The decay corrected pre-operational range is approximately 160 to 1355 pCi/kg. The measured Cs-137 activity of the soil samples obtained during 2005 are within the decay corrected pre-operational range. Cs-137 activity was not detected in air samples collected during 2005. The measured Cs-137 activity in the soil sample was likely due to previous fallout and not to a recently produced fission product associated with plant operation.

No unusual trends were identified.

III. PROGRAM REVISIONS/CHANGES

No sample locations were changed during the 2005 monitoring period.

IV. PROGRAM DEVIATIONS

Air Samples

The air sample locations listed below failed to meet the requirement for "continuous sampler operation." As described in footnote (1) of AP 07B-004, Table 5-1, deviations are permitted from the required sampling schedule due to malfunction of sampling equipment and other legitimate reasons. Discrepancies greater than five percent between Total Military Time and Total Meter Time, which resulted in a loss of air sample collected, are listed in the following table.

Location	Sample Period	Percent Discrepancy/ Hours Unavailable	Explanation of Deviation
48	01/04/05 – 01/12/05	11.80/23.3	Electrical Power Outage
37	06/28/05 – 07/06/05	11.06/21.0	Electrical Power Outage

During 2005, no other deviations from the AP 07B-004, Offsite Dose Calculation Manual (Radiological Environmental Monitoring Program) sampling schedule occurred.

V. INTERLABORATORY COMPARISON PROGRAM RESULTS

During 2005, Environmental, Inc., Midwest Laboratory was contracted to perform radiological analysis of environmental samples for WCNOC. The lab participated in the intercomparison studies administered by Environmental Resources Associates. Appendix A is the Interlaboratory Comparison Program Results for Environmental, Inc., Midwest Laboratory. Intercomparison results, in-house spikes, blanks, duplicates and mixed analyte performance evaluation program results are also contained in Appendix A.

VI. COMPARISON TO THE RADIOACTIVE EFFLUENTS RELEASE PROGRAM

As described in the section discussing radioisotopes found in fish from Coffey County Lake, dose that may be received as a result of tritium released from WCGS is comparable with the theoretical doses calculated by the Radioactive Effluent Release Program.

The theoretical doses calculated by the Radioactive Effluent Release Program assume that a person drinks the water from Coffey County Lake and eats the fish from Coffey County Lake. Based upon these assumptions the dose to man from both pathways was calculated to be 0.286 mRem for 2005.

Using sample data obtained from the REMP, an adult drinking 2 liters per day of surface water from Coffey County Lake, using the average tritium activity (12,855 pCi/L), would receive a committed effective dose equivalent of 0.587 mRem per year. For an adult eating 21 kg of fish per year from Coffey County Lake, using the average tritium activity (7,699 pCi/kg), would receive a committed effective dose equivalent of 0.010 mRem per year. Based upon the REMP results, the dose from both pathways was calculated to be 0.597 mRem per year.

It should be noted that the Coffey County Lake is not a drinking water source. Calculating the dose to man for tritium detected in the Coffey County Lake surface water is for comparison purposes only.

The tritium dose values are being compared on a qualitative basis. It is not expected that the annual doses, as calculated in the Annual Radioactive Effluent Release Report, would compare directly to those calculated from the REMP. The Annual Radioactive Effluent Release Report provides a 'snap shot' of potential dose resulting from the year's releases. The REMP data indicates the accumulated result of releasing tritium into the lake since the start of plant operation.

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TABLE 1

2005 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM DESCRIPTION (SAMPLE COLLECTION SPECIFIED BY ODCM)

EXPOSURE PATHWAY/ SAMPLE TYPE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS	SAMPLE COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
AIRBORNE	**(See Figures 1 & 5)**		
Radioiodine and Particulates	Samples from six locations	Continuous sampler operation with sample collection weekly, or more frequently if required, by dust loading.	Analyze radioiodine canister weekly for I-131
	Samples from locations near the site boundary in three sectors having the highest calculated annual average D/Q (Locations 2, 37, 49 and supplemental location 18 on Figure 1)		Analyze particulate filter weekly for gross beta activity; perform quarterly gamma isotopic analysis composite (by location)
	Sample from the vicinity of a community having the highest calculated annual average D/Q (Location 32 on Figure 1, New Strawn)		
	Sample from a control location 9.5 to 18.5 miles distant in a low ranked D/Q sector (Location 48 on Figure 5)		

TABLE 1 (Cont.)

EXPOSURE PATHWAY/ SAMPLE TYPE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS	SAMPLE COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
DIRECT RADIATION	**(See Figures 2 & 5)**		
	42 routine monitoring stations with two or more dosimeters measuring dose continuously, placed as follows: An inner ring of stations, one in each meteorological sector 0-3 mile range from the site (Locations 1, 7-9, 11-13, 18, 26, 27, 29-31, 37, 38 and 47 on Figure 2). An outer ring of stations, one in each meteorological sector in the 3-5 mile range from the site (Locations 4-6, 15-17, 19-25, and 33-36 on Figure 2). Six sectors [A, B, C, D, G, and L] contain an additional station (Locations 2, 3, 10, 14, 28 and 49). The balance of the stations to be placed in special interest areas such as population centers (Locations 23 and 32), nearby residences	Quarterly	Gamma dose quarterly

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TABLE 1 (Cont.)

EXPOSURE PATHWAY/ SAMPLE TYPE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS	SAMPLE COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
DIRECT RADIATION (cont.)	(many locations are near a residence), schools (Location 23), and in two areas to serve as control stations 10-20 miles distant from the site (Locations 39 and 48 on Figure 5).		
WATERBORNE	(See Figure 3)		
Surface	One sample upstream (Location JRR on Figure 3) and one sample downstream (Location SP on Figure 3).	Monthly grab sample	Monthly gamma isotopic analysis and composite for tritium analysis quarterly
Ground	Samples from one or two sources only if likely to be affected. Indicator samples at locations hydrologically down gradient of the site (Locations C-10, C-49 and J-1 on Figure 3); control sample at a location hydrologically up gradient of the site (Location B-12 on Figure 3).	Quarterly grab sample	Quarterly gamma isotopic and tritium analysis

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TABLE 1 (Cont.)

EXPOSURE PATHWAY/ SAMPLE TYPE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS	SAMPLE COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
WATERBORNE (cont.)			
Drinking	Sample of municipal water supply at an indicator location downstream of the site (Location NF-DW on Figure 5); control sample from location upstream of the site (Location BW-15 on Figure 3).	Monthly Composite	Monthly gamma isotopic analysis and gross beta analysis of composite sample. Quarterly tritium analysis of composites.
Shoreline Sediment	One sample from the vicinity of Coffey County Lake discharge cove (Location DC on Figure 3); control sample from John Redmond Reservoir (Location JRR on Figure 3).	Semiannually	Semiannual gamma isotopic analysis
INGESTION	(See Figures 4 & 5)		
Milk	Samples from milking animals at three indicator locations within 5 miles of the site having the highest dose potential (currently there are no locations producing milk for human consumption within 5 miles of the site); one sample from a control location greater than 10 miles from the site if indicator locations are sampled.	Semimonthly April to November; monthly December-March	Gamma isotopic analysis and I-131 analysis of each sample

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TABLE 1 (Cont.)

EXPOSURE PATHWAY/ SAMPLE TYPE	NUMBER OF SAMPLES AND SAMPLE LOCATIONS	SAMPLE COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
INGESTION (cont.)			
Fish	Indicator samples of 1 to 3 recreationally important species from Coffey County Lake; control samples of similar species from John Redmond Reservoir spillway (Figure 4).	Semiannually	Gamma isotopic analysis on edible portions
Broadleaf Vegetation	Samples of available broadleaf vegetation from two indicator locations (using the criteria from the "Land Use Census" section) with highest calculated annual average D/Q (Locations G-1 and Q-6 and alternate location N-1 on Figure 4); sample of similar broadleaf vegetation from a control location 9.5 to 18.5 miles distant in a low ranked D/Q sector (Location D-1 or alternate location D-2 on Figure 5).	Monthly when available	Gamma isotopic analysis on edible portions
Irrigated Crops	Sample of crops irrigated with water from the Neosho River downstream of the Neosho River - Wolf Creek confluence (Location NR-D1 and NR-D2 on Figure 5).	At time of harvest	Gamma isotopic analysis on edible portions

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TABLE 2
SAMPLE LOCATION IDENTIFIERS, DISTANCES (Miles) AND DIRECTIONS (Sectors)

Sample Type	Location Identifier	Distance from Reactor	Direction	Sector
Air Particulates and Radioiodine	2	2.7	N	A
	18	3.0	SSE	H
	32	3.1	WNW	P
	37	2.0	NNW	R
	48	14.7	ENE	D
	49	0.8	NNE	B
TLDs	1	1.4	N	A
	2	2.7	N	A
	3	3.1	NE	C
	4	4.1	NNE	B
	5	4.1	NE	C
	6	4.6	ENE	D
	7	2.1	NE	C
	8	1.7	NNE	B
	9	2.0	ENE	D
	10	2.4	ENE	D
	11	1.7	E	E
	12	1.9	ESE	F
	13	1.6	SE	G
	14	2.5	SE	G
	15	4.6	ESE	F
	16	4.3	E	E
	17	3.7	SE	G
	18	3.0	SSE	H
	19	3.9	SSE	H
	20	3.3	S	J
	21	3.8	S	J
	22	3.9	SSW	K
	23	4.3	SW	L
	24	4.1	WSW	M
	25	3.4	W	N
	26	2.4	WSW	M
	27	2.2	SW	L
	28	2.6	SW	L
	29	2.7	SSW	K
	30	2.5	W	N
	31	3.0	WNW	P
	32	3.1	WNW	P
	33	3.6	WNW	P
	34	4.4	NW	Q
	35	4.6	NNW	R
	36	4.2	N	A
	37	2.0	NNW	R
	38	1.2	NW	Q

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TABLE 2 (Cont.)
SAMPLE LOCATION IDENTIFIERS, DISTANCES (Miles) AND DIRECTIONS (Sectors)

Sample Type	Location Identifier	Distance from Reactor	Direction	Sector
TLDs	39	13.1	N	A
	41	0.8	NNW	R
	42	0.8	SSE	H
	43	0.7	WNW	P
	44	3.0	NNW	R
	46	1.6	WNW	P
	47	0.16	S	J
	48	14.7	ENE	D
	49	0.8	NNE	B
Surface Water	JRR	3.7	W	N
	SP	3.2	SSE	H
Ground Water	B-12	1.9	NNE	B
	C-10	2.7	W	N
	C-49/L-49	2.8	SW	L
	F-1	2.5	ESE	F
	G-2	3.6	SE	G
	J-1	3.8	S	J
	J-2	4.3	S	J
Drinking Water	BW-15	3.9	SW	L
	IO-DW	26.1	SSE	H
	NF-DW	17.5	SSE	H
Shoreline Sediment	DC	0.8	WNW	P
	JRR	3.6	W	N
Fish	WCL	0.6	WNW	P
	JRR	3.7	W	N
Food/Garden	D-1	14.7	ENE	D
	D-2	14.8	ENE	D
	G-1	1.6	SE	G
	N-1	2.4	W	N
	Q-6	2.4	NW	Q
Crops	NR-D1	8.9	S	J
	NR-D2	11.5	S	J
	NR-U1	4.0	SSW	K
Bottom Sediment	DC	0.9	WNW	P
	EEA	3.0	NNW	R
	JRR	3.7	W	N
	MUDS	1.5	WNW	P
Aquatic Vegetation	EEA	3.0	NNW	R
	MUDS	1.5	WNW	P
Terrestrial Vegetation	EEA	3.0	NNW	R
Soil	EEA	3.0	NNW	R
	MUDS	1.5	WNW	P

TABLE 3
TLD Results
(mR/90-day qtr.)

Location	Qtr. 1 90-Day Avg.	Qtr. 1 2-std. dev.	Qtr. 2 90-Day Avg.	Qtr. 2 2-std. dev.	Qtr. 3 90-Day Avg.	Qtr. 3 2-std. dev.	Qtr. 4 90-Day Avg.	Qtr. 4 2-std. dev.	Total Annual Exposure (mR)
1	19.6	0.9	25.1	2.8	35.0	3.7	28.6	1.9	108.3
2	17.6	0.4	19.4	1.3	31.0	2.5	27.1	1.9	95.1
3	18.3	1.4	21.2	1.3	32.4	1.8	26.8	2.2	98.7
4	19.3	1.3	21.5	1.2	32.3	2.1	27.0	1.8	100.1
5	18.1	0.9	19.4	1.4	31.6	2.0	25.9	0.8	95.0
6	19.6	4.5	19.5	0.9	32.4	3.8	25.8	1.8	97.3
7	20.4	7.8	19.8	1.1	32.5	2.1	25.2	1.4	97.8
8	19.7	1.7	21.2	0.7	33.4	1.7	27.2	1.2	101.6
9	18.1	1.8	20.2	1.2	31.9	4.1	24.5	1.2	94.7
10	20.2	1.9	20.9	1.1	33.1	2.3	26.9	1.0	101.1
11	21.0	1.2	22.9	3.2	33.9	2.4	27.5	1.4	105.3
12	19.3	1.5	21.0	2.0	32.2	1.7	27.2	3.1	99.7
13	19.8	1.3	22.6	2.0	32.9	1.4	27.6	1.6	102.9
14	19.9	2.5	20.4	0.3	34.1	3.6	28.4	2.6	102.9
15	19.9	2.3	20.6	0.5	34.3	1.3	27.1	2.4	101.8
16	18.8	0.7	19.9	1.1	32.5	2.4	25.9	1.8	97.1
17	19.4	2.2	20.2	1.8	31.8	1.8	27.1	2.1	98.6
18	18.6	1.4	20.3	0.6	33.4	6.2	25.6	1.2	97.8
19	20.8	1.4	21.9	0.8	35.9	7.4	26.3	1.5	104.9
20	19.3	1.2	21.4	2.7	32.8	1.1	25.4	2.3	98.8
21	17.1	1.2	19.3	1.0	30.0	2.1	25.1	1.4	91.5
22	21.5	3.2	21.7	2.4	34.2	2.0	29.0	0.4	106.4
23	21.0	3.5	20.9	1.3	32.4	1.1	26.2	1.7	100.4
24	19.4	0.9	20.4	1.2	32.2	2.2	26.6	1.0	98.6
25	17.8	1.9	20.0	4.1	30.0	1.6	23.9	0.7	91.6
26	17.4	1.0	19.2	2.2	30.0	1.0	25.4	0.9	91.9
27	19.0	1.8	20.8	0.8	32.5	1.2	27.0	1.7	99.2
28	17.0	1.0	17.8	0.8	28.7	1.6	26.1	3.3	89.6
29	16.3	1.0	17.0	0.6	28.8	1.4	22.8	1.4	84.8
30	20.0	1.0	21.0	0.5	32.0	2.1	26.8	2.1	99.8
31	18.5	1.0	19.3	0.7	31.3	2.3	25.8	2.1	95.0
32	18.8	3.6	19.1	0.5	31.1	1.2	25.5	2.7	94.5
33	19.9	0.7	21.4	1.0	33.8	3.7	28.7	1.4	103.7
34	20.3	1.0	21.2	1.2	32.9	2.1	28.2	1.0	102.6
35	19.4	0.6	21.0	0.9	32.2	1.3	27.4	1.7	100.0
36	18.6	1.2	21.1	2.2	30.9	1.0	27.2	2.9	97.8
37	18.3	1.5	20.1	0.6	30.7	3.3	27.0	3.6	96.1
38	19.7	0.9	23.7	3.3	33.6	1.6	27.7	1.2	104.7
39	18.3	1.2	19.8	1.1	31.0	2.0	24.7	1.3	93.8
41	20.6	2.5	21.2	1.9	33.2	2.3	27.4	1.2	102.4
42	13.7	0.9	17.3	2.9	25.5	2.5	20.1	0.8	76.6
43	14.8	3.7	14.7	2.2	24.9	1.5	19.5	0.7	73.9
44	19.0	1.0	19.8	1.0	32.4	2.1	26.2	1.8	97.4
46	19.0	0.9	19.8	1.0	31.4	1.4	26.1	1.1	96.2
47	18.3	1.3	20.8	1.5	31.2	1.8	25.0	1.2	95.4
48	18.1	0.6	21.8	1.2	31.0	1.1	26.4	2.2	97.2
49	18.7	0.6	20.8	1.3	33.1	2.7	25.5	1.7	98.2

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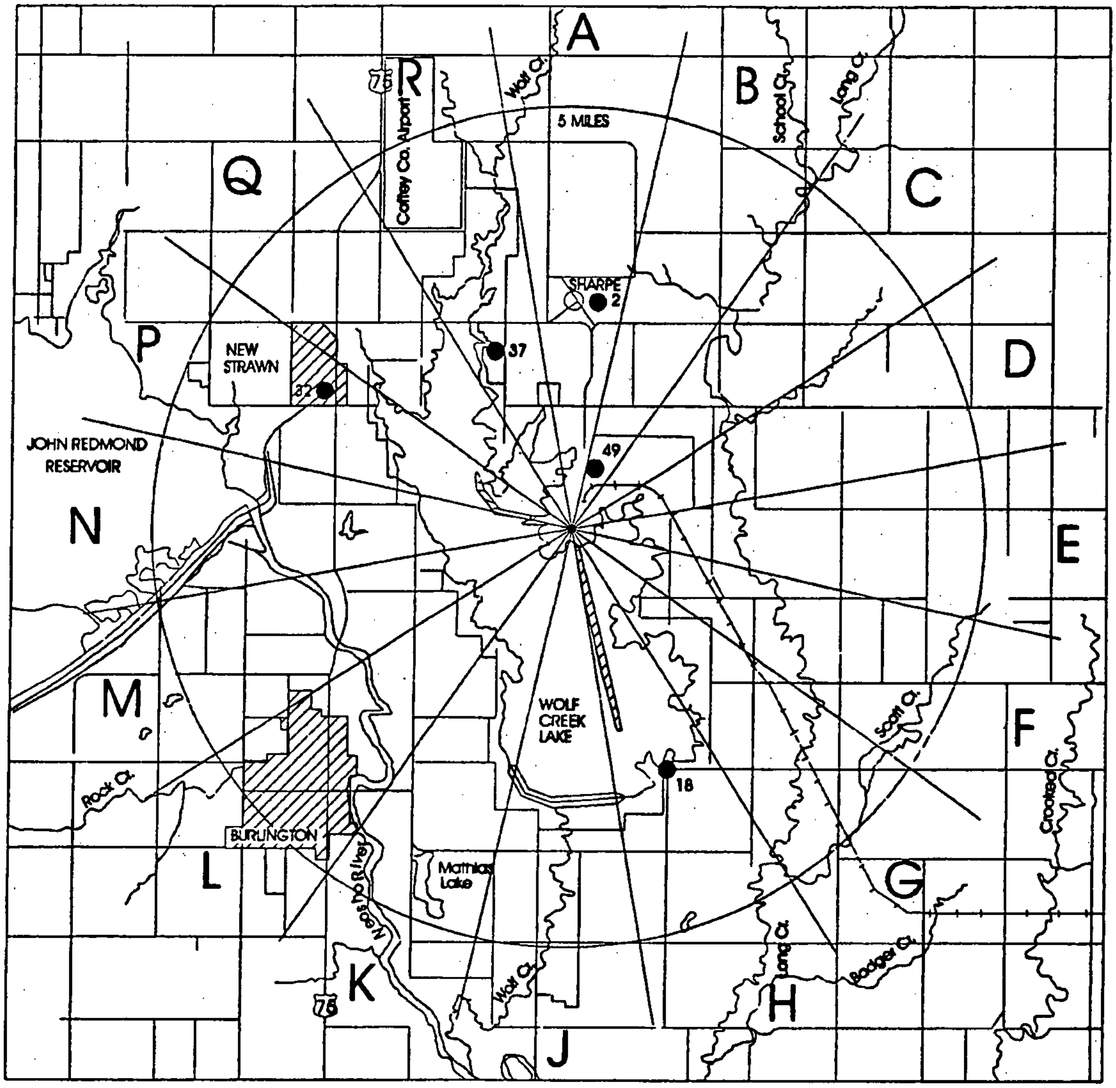
FIGURE 1



AIRBORNE PATHWAY SAMPLING LOCATIONS

● = AIRBORNE PARTICULATE AND RADIOIODINE

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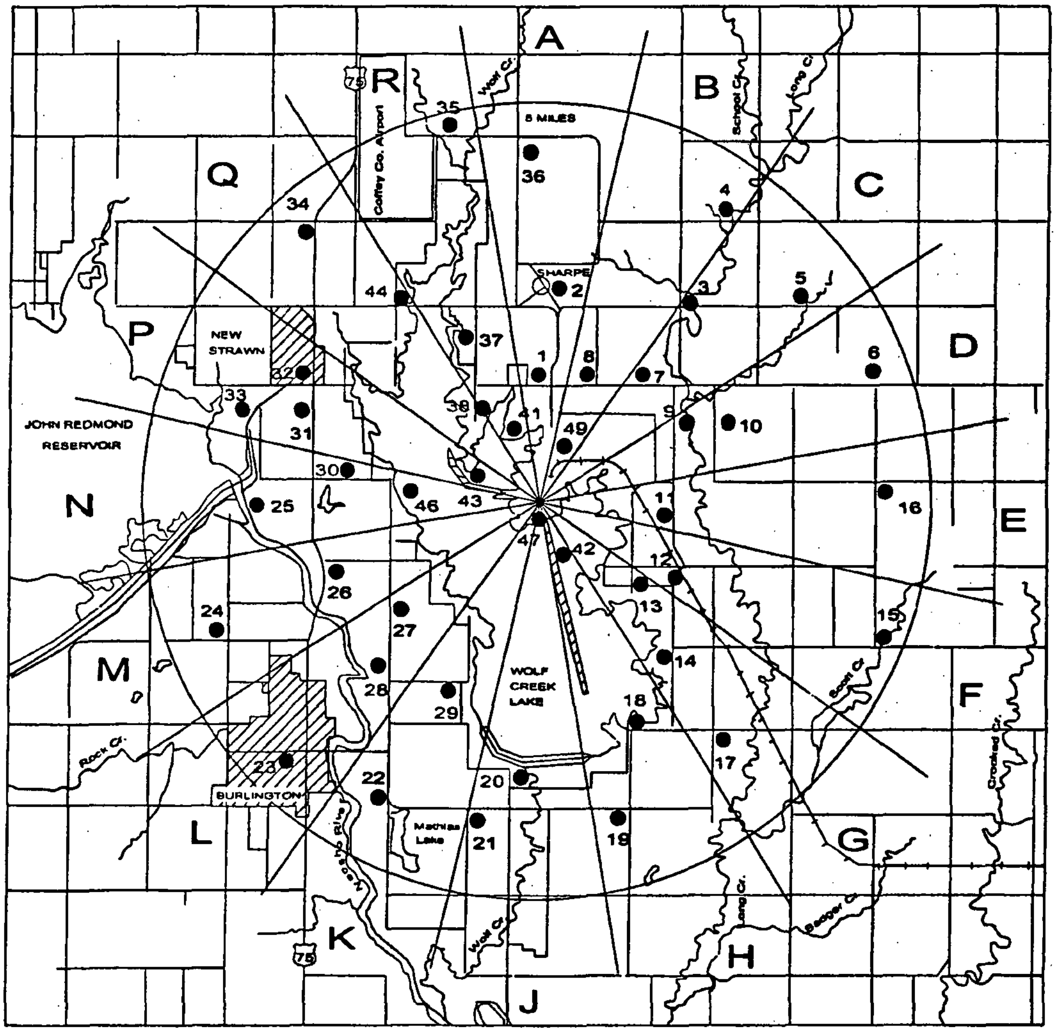
FIGURE 2



DIRECT RADIATION PATHWAY SAMPLING LOCATIONS

● = TLD LOCATIONS

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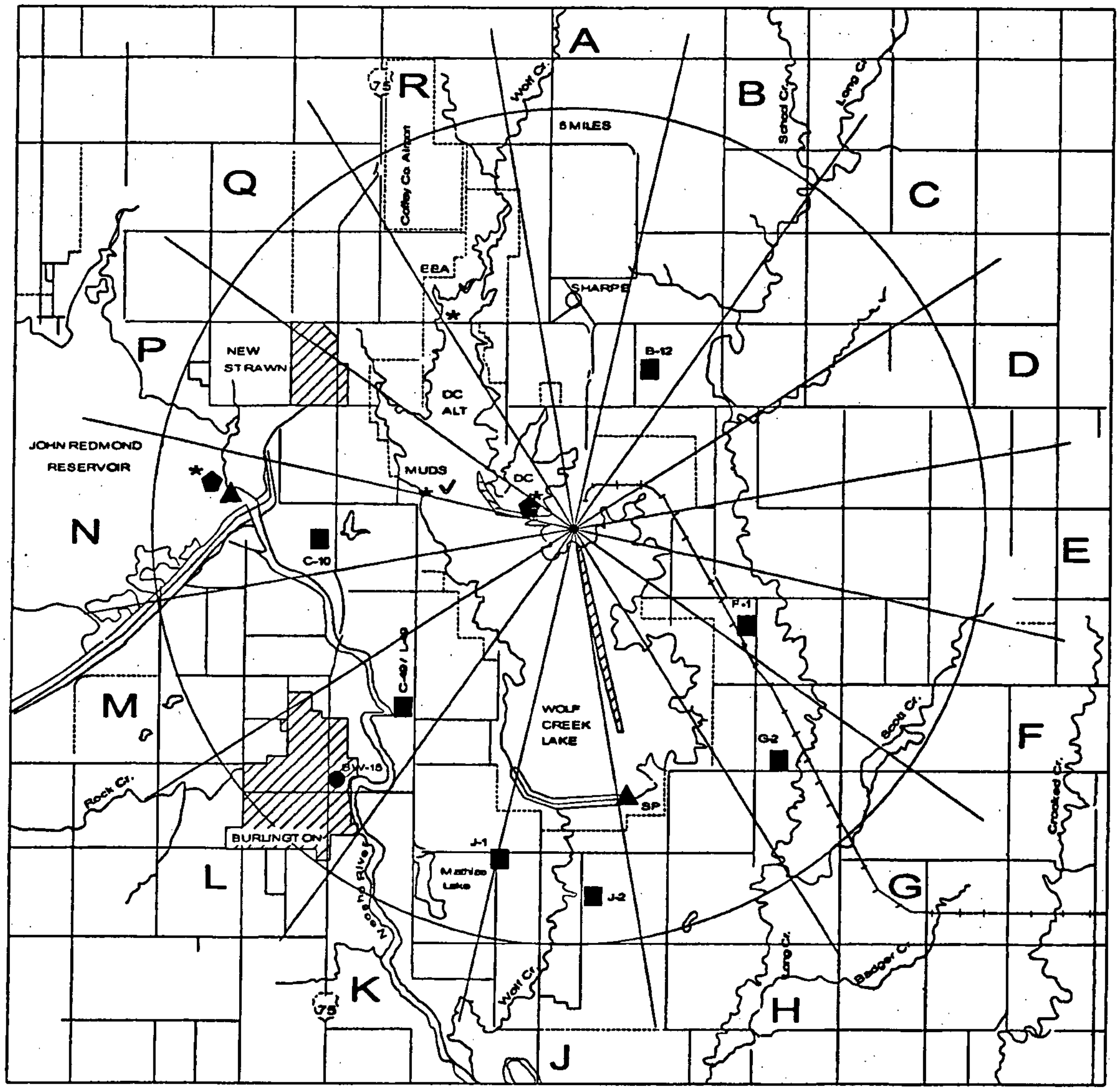
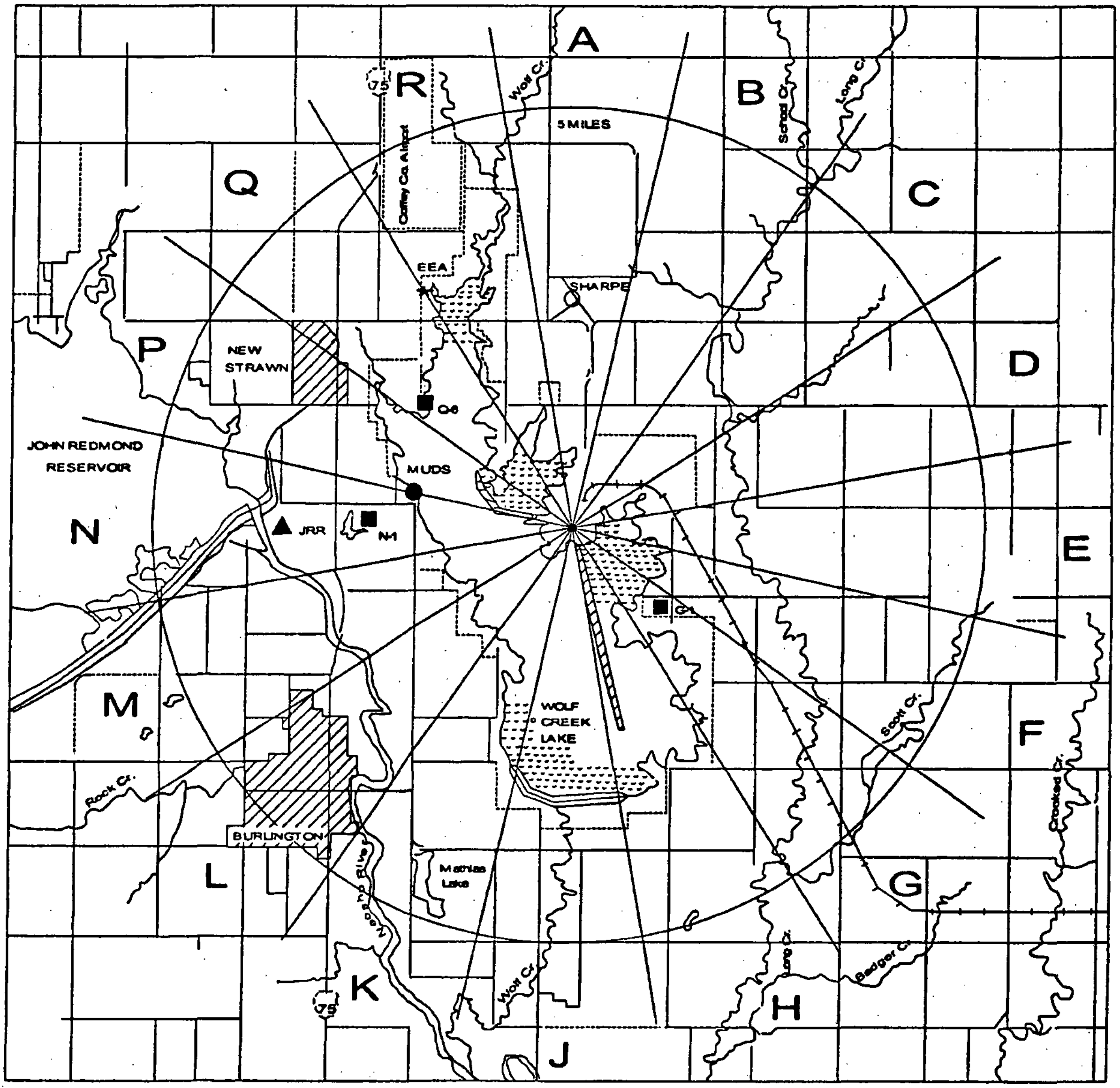
FIGURE 3



WATERBORNE PATHWAY SAMPLING LOCATIONS

● = DRINKING WATER
▲ = SURFACE WATER
■ = GROUND WATER
⬟ = SHORELINE SEDIMENT
* = BOTTOM SEDIMENT
✓ = AQUATIC VEGETATION / ALGAE

FIGURE 4



INGESTION PATHWAY SAMPLING LOCATIONS

▲ = FISH (JRR)

■ = BROADLEAF VEGETATION

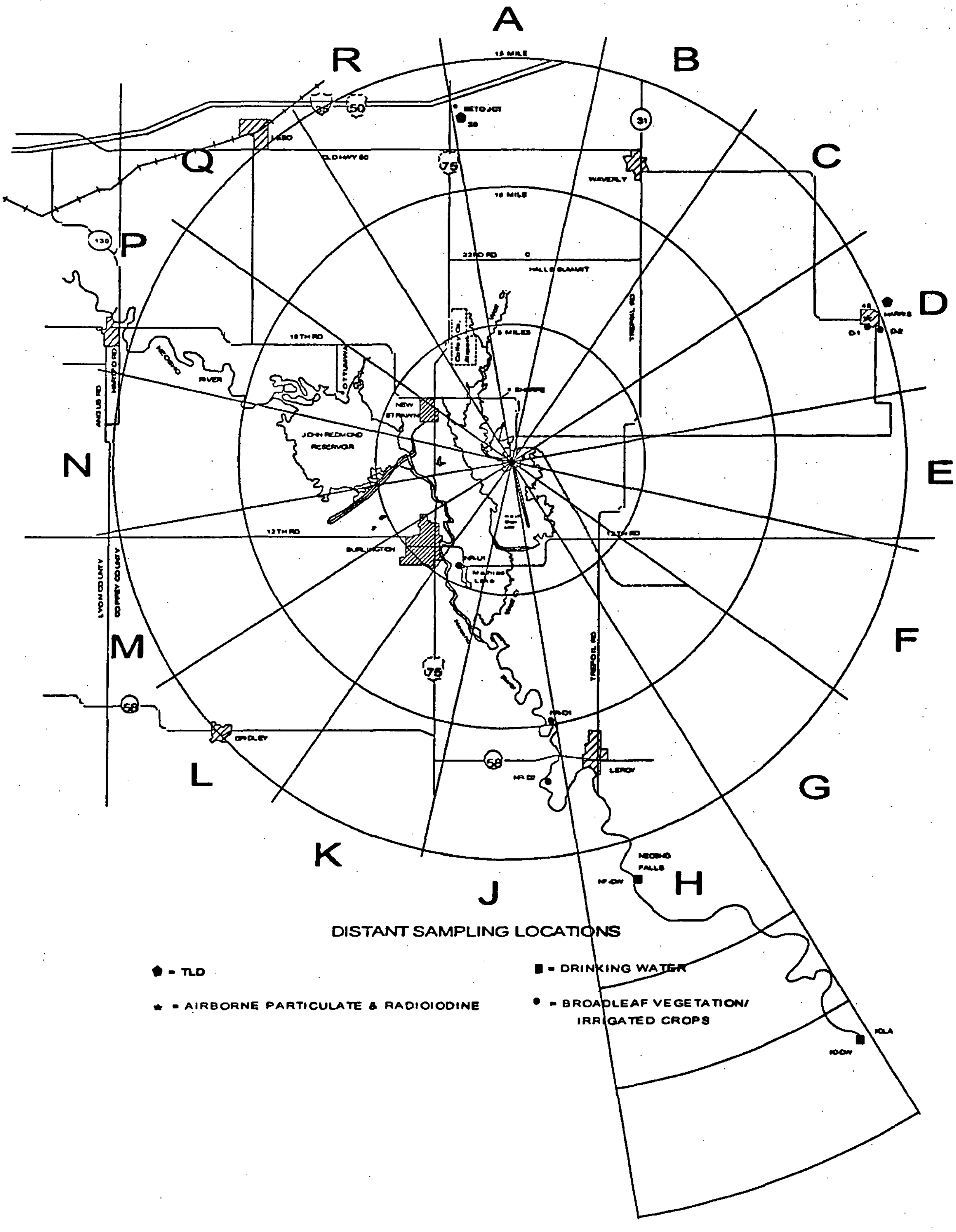
= FISH (WCL)

● = SOIL

√ = DEER

* = TERRESTRIAL VEGETATION

FIGURE 5



DISTANT SAMPLING LOCATIONS

● = TLD

★ = AIRBORNE PARTICULATE & RADIOIODINE

■ = DRINKING WATER

• = BROADLEAF VEGETATION/ IRRIGATED CROPS

CHART 1

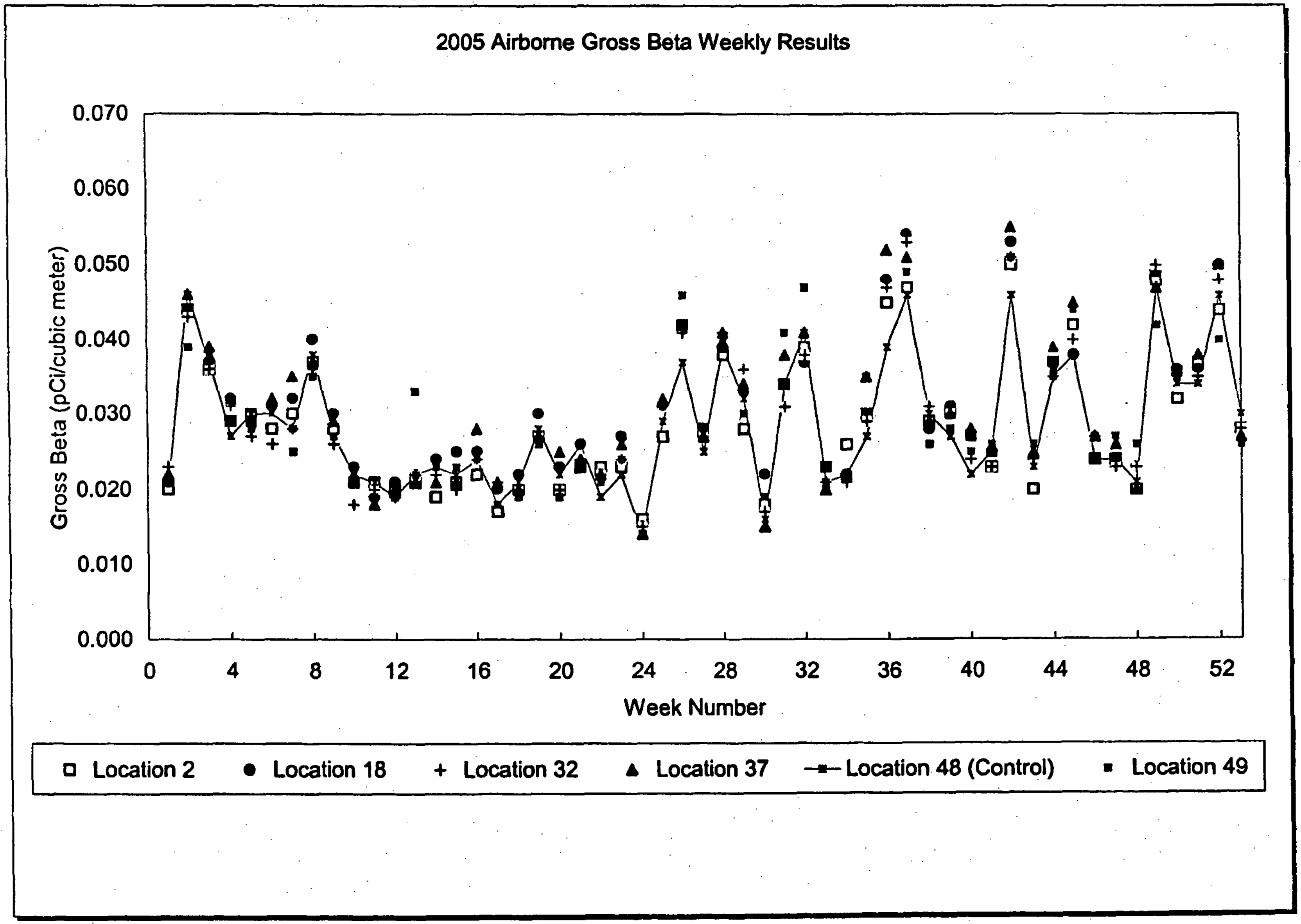

2005 Airborne Gross Beta Weekly Results
Gross Beta (pCi/cubic meter)
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0
4
8
12
16
20
24
28
32
36
40
44
48
52
Week Number
Location 2
Location 18
Location 32
Location 37
Location 48 (Control)
Location 49

CHART 2

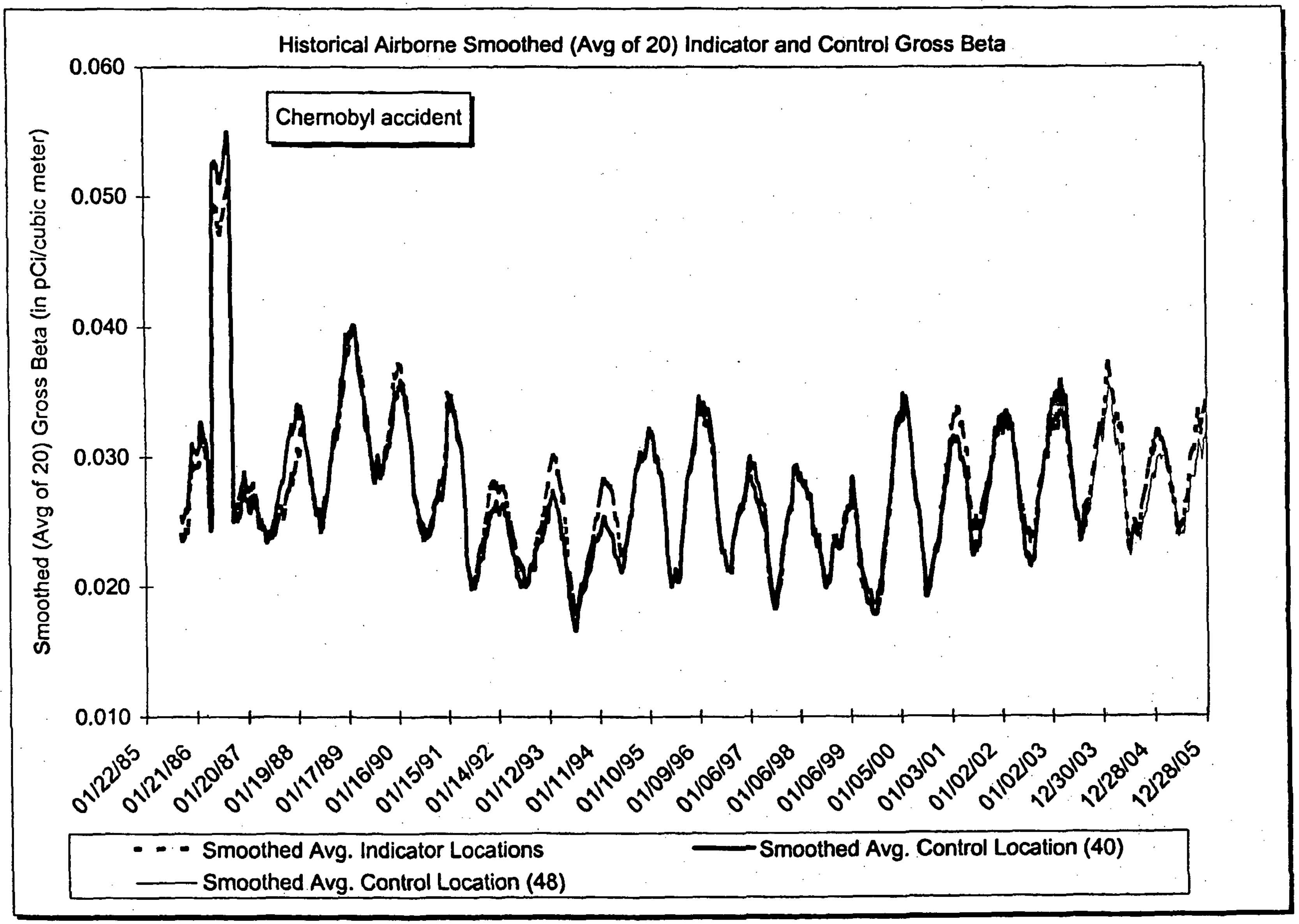

Historical Airborne Smoothed (Avg of 20) Indicator and Control Gross Beta
Chernobyl accident
Smoothed (Avg of 20) Gross Beta (in pCi/cubic meter)
0.060
0.050
0.040
0.030
0.020
0.010
01/22/85
01/21/86
01/20/87
01/19/88
01/17/89
01/16/90
01/15/91
01/14/92
01/12/93
01/11/94
01/10/95
01/09/96
01/06/97
01/06/98
01/06/99
01/05/00
01/03/01
01/02/02
01/02/03
12/30/03
12/28/04
12/28/05
Smoothed Avg. Indicator Locations
Smoothed Avg. Control Location (40)
Smoothed Avg. Control Location (48)

CHART 3

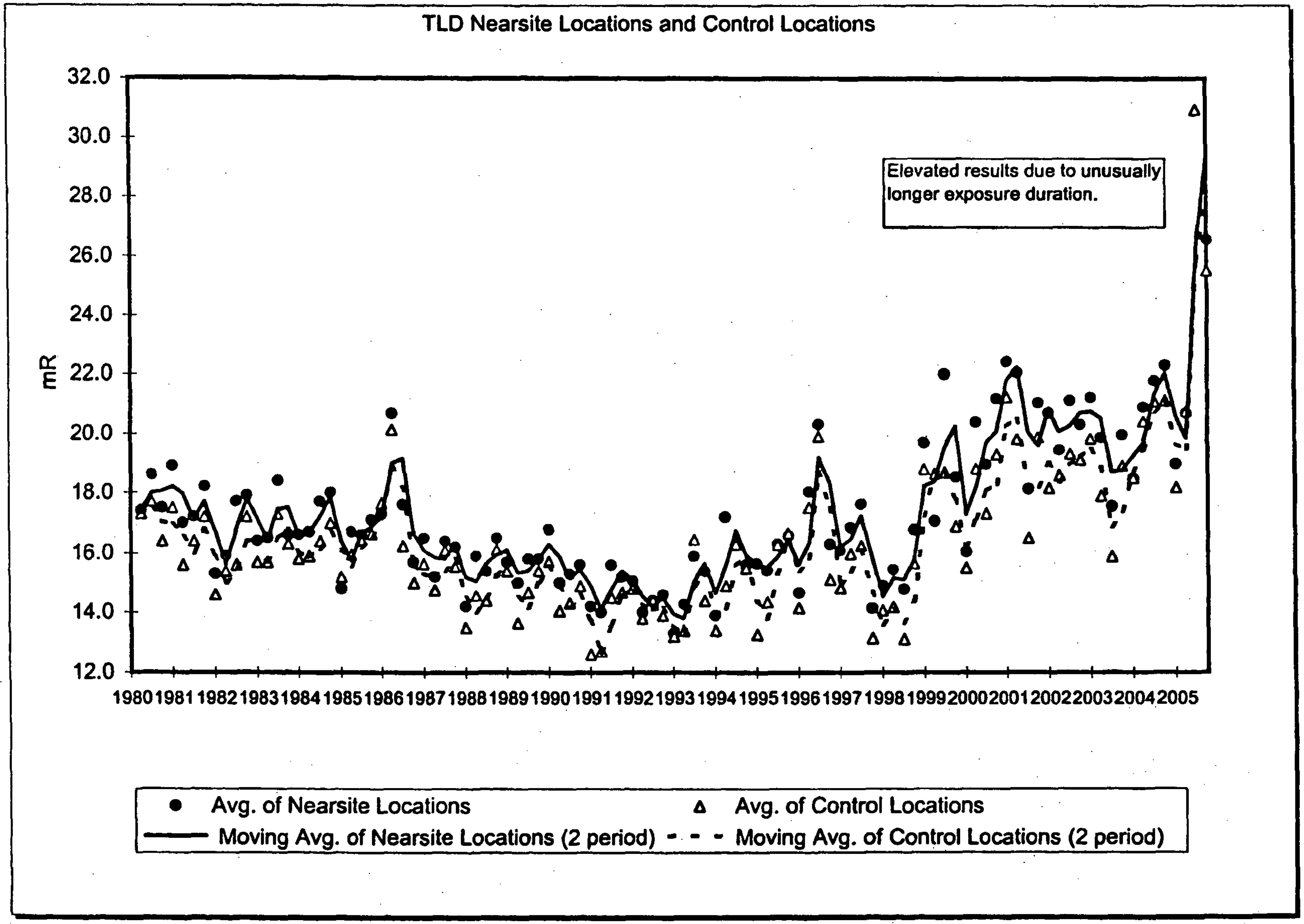

TLD Nearsite Locations and Control Locations
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
mR
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
Elevated results due to unusually longer exposure duration.
Avg. of Nearsite Locations
Avg. of Control Locations
Moving Avg. of Nearsite Locations (2 period)
Moving Avg. of Control Locations (2 period)

CHART 4

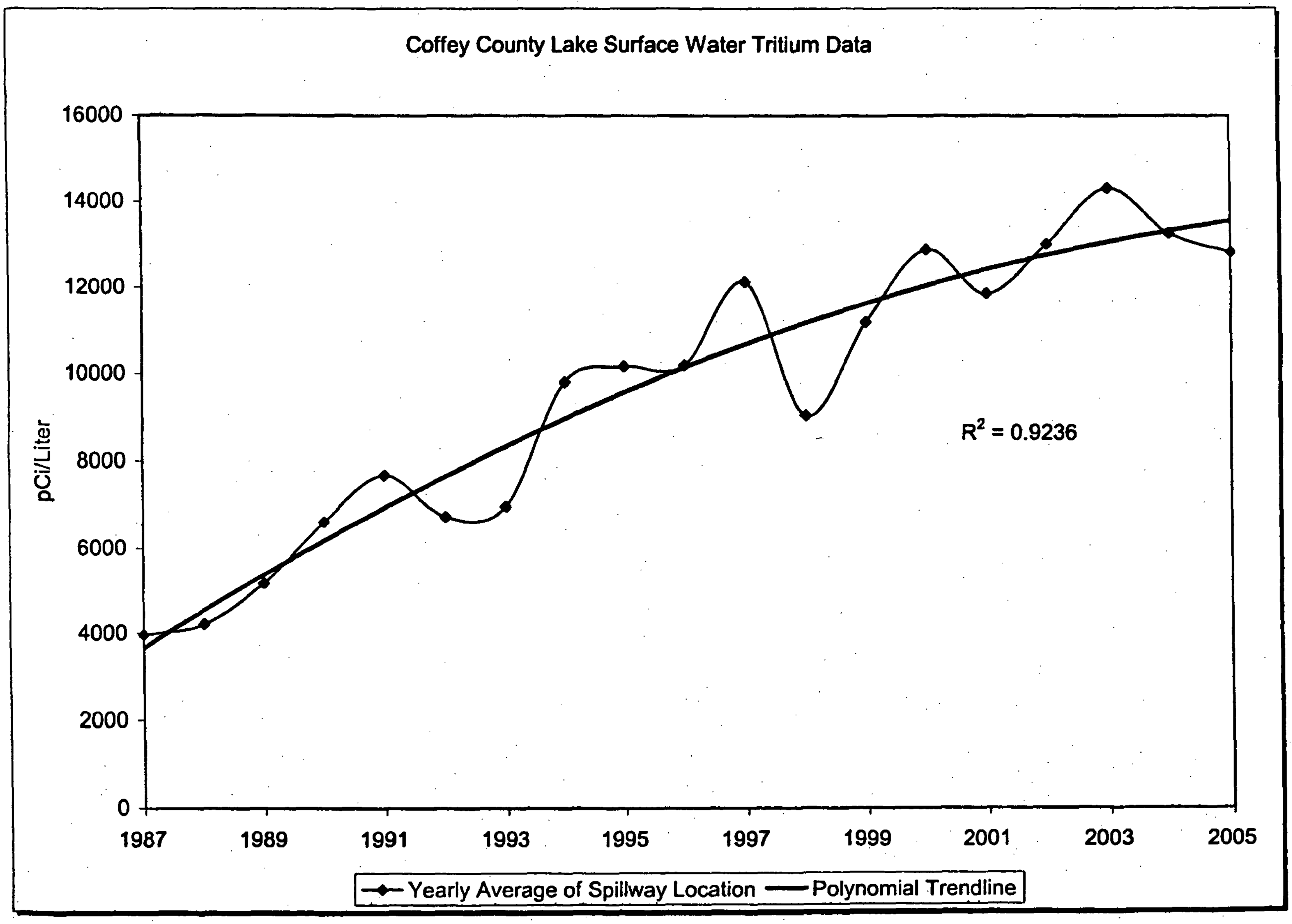

Coffey County Lake Surface Water Tritium Data
pCi/Liter
16000
14000
12000
10000
8000
6000
4000
2000
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
R^2 = 0.9236
Yearly Average of Spillway Location
Polynomial Trendline

CHART 5

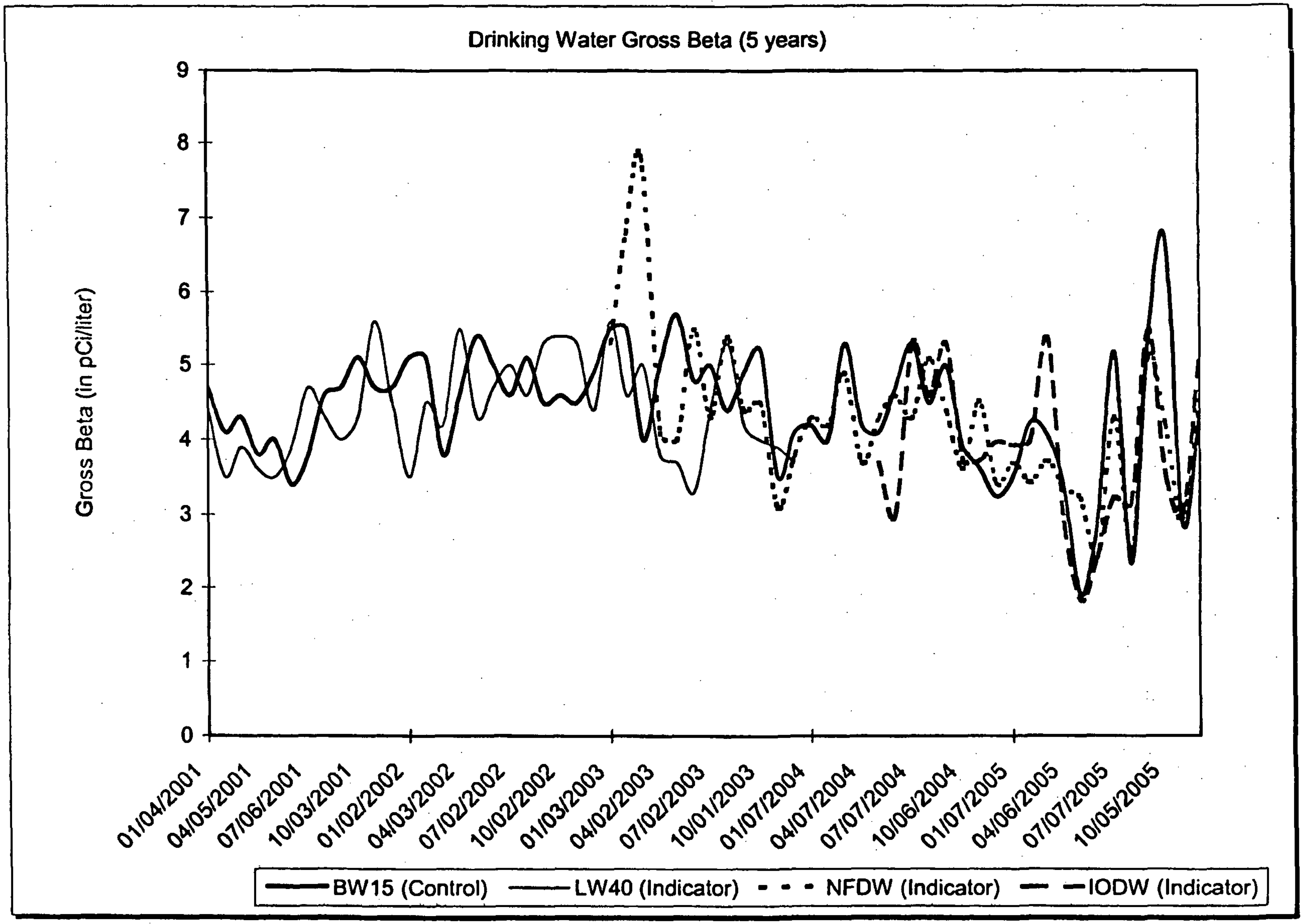

Drinking Water Gross Beta (5 years)
Gross Beta (in pCi/liter)
0
1
2
3
4
5
6
7
8
9
01/04/2001
04/05/2001
07/06/2001
10/03/2001
01/02/2002
04/03/2002
07/02/2002
10/02/2002
01/03/2003
04/02/2003
07/02/2003
10/01/2003
01/07/2004
04/07/2004
07/07/2004
10/06/2004
01/07/2005
04/06/2005
07/07/2005
10/05/2005
BW15 (Control)
LW40 (Indicator)
NFDW (Indicator)
IODW (Indicator)

CHART 6

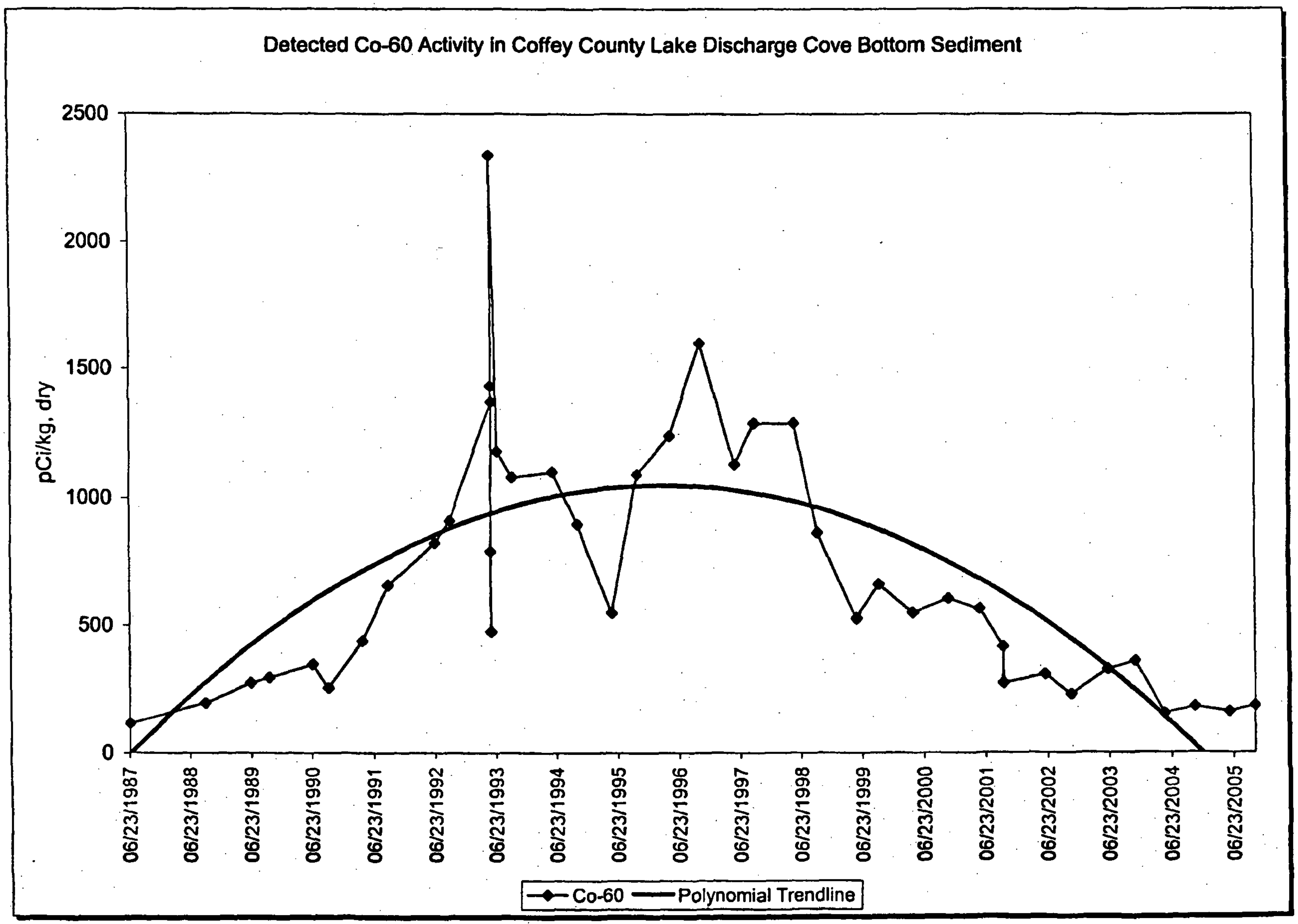
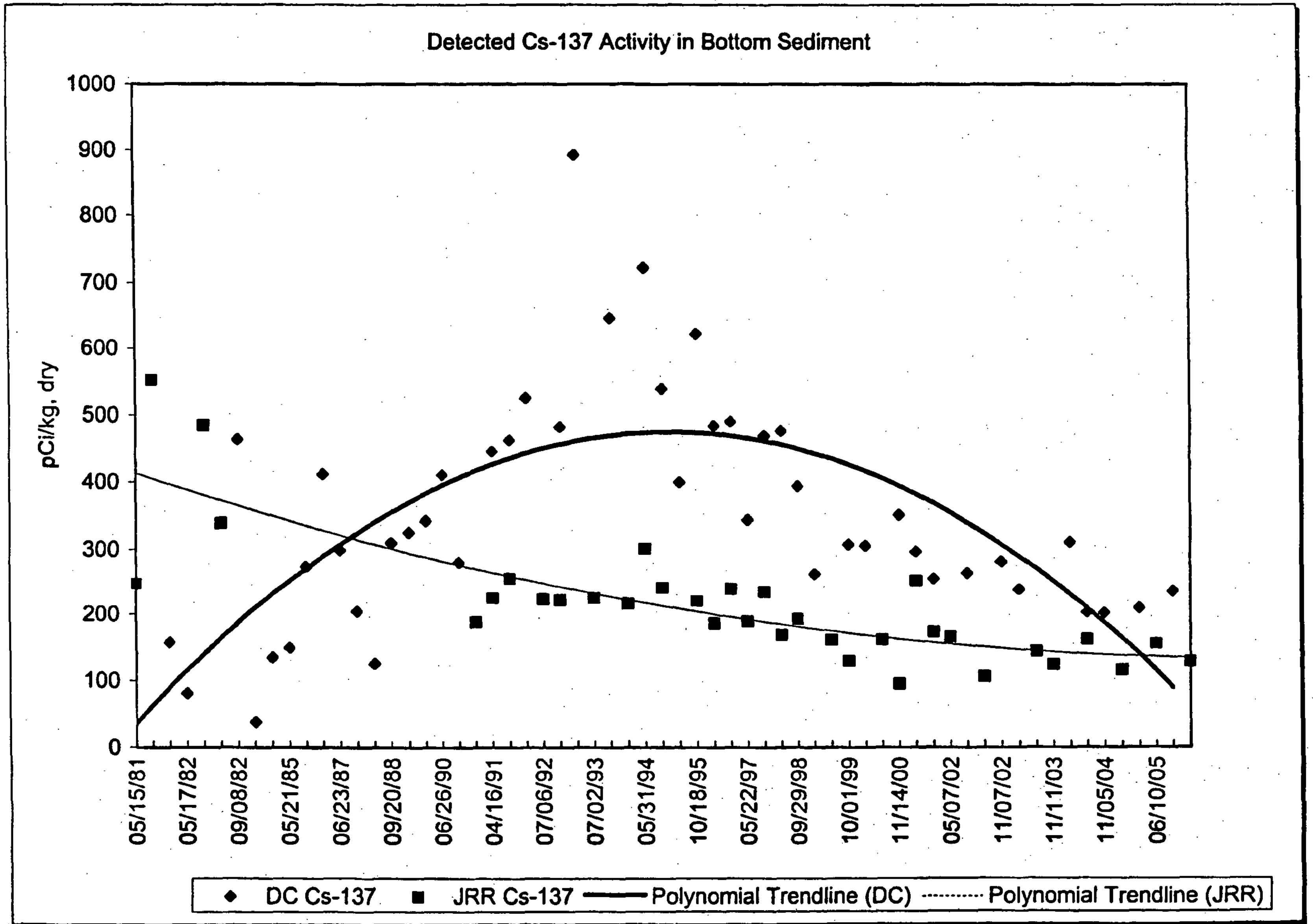

Detected Co-60 Activity in Coffey County Lake Discharge Cove Bottom Sediment
pCi/kg, dry
2500
2000
1500
1000
500
0
06/23/1987
06/23/1988
06/23/1989
06/23/1990
06/23/1991
06/23/1992
06/23/1993
06/23/1994
06/23/1995
06/23/1996
06/23/1997
06/23/1998
06/23/1999
06/23/2000
06/23/2001
06/23/2002
06/23/2003
06/23/2004
06/23/2005
Co-60
Polynomial Trendline

CHART 7


Detected Cs-137 Activity in Bottom Sediment
pCi/kg, dry
1000
900
800
700
600
500
400
300
200
100
0
05/15/81
05/17/82
09/08/82
05/21/85
06/23/87
09/20/88
06/26/90
04/16/91
07/06/92
07/02/93
05/31/94
10/18/95
05/22/97
09/29/98
10/01/99
11/14/00
05/07/02
11/07/02
11/11/03
11/05/04
06/10/05
DC Cs-137
JRR Cs-137
Polynomial Trendline (DC)
Polynomial Trendline (JRR)

50. Correspondence, reports, and any other information related to any past restrictions on water withdrawal, if any have occurred. If none have occurred, a statement that these restrictions have never been implemented.

• Site-specific hydrogeological information, including: groundwater depth(s) at site; aquifer(s) present at site; location, elevation, construction, and historical analyses on current and past monitoring wells (including B-12, C-10, C-49, J-1, J-2, G-2, and F-1); details of the current monitoring and analytical program; flow direction information (direction, rate, fate); and comprehensive local production information (locations, construction information, history of analysis, pump rates, use).

• Documentation of any environment releases, including any evaluations of the incident with respect to the nature, extent, and impact of the release.

• Locations, volumes, and existing chemical and radiological analytical data on drinking water intakes for Burlington, Neosho Falls, Iola, and any other intakes on the Neosho River between JRR and Iola.

• Correspondence, reports, and any other information related to any past restrictions on water withdrawal, if any have occurred. If none have occurred, a statement that these restrictions have never been implemented.

• More detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells included in the study, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

• A map showing the locations of all groundwater monitoring or production wells in the local area, including their depths, rates of production, and use of water, if known. Section 2.9.1 states that 80% of water use in the basin is from surface sources – describe the source, location, and use of the other 20%.

• More detailed meteorological data, including historic rainfall data, to provide additional information for the evaluation of water use conflicts in Section 2.10 of the ER (WCGS, 1980). Include average rainfall, seasonal variations, and information on extreme conditions. Please provide the average peak and low-flow values for the Neosho River. Also provide information on seasonal variability, if it exists.

• Clarification of the relationship between the WCNOC contract with the Kansas Water Resources Board, versus the "*Certificate of Appropriation*" discussed in ER Section 4.1. It appears that the contract has controls based on available supply within the reservoir, while certificate has controls based on the flow rate in the river. Please verify if this is correct. Also identify if a different agency implements the controls in either case, or if this is a single agency.

(50) 2

THE STATE OF KANSAS

WCGS

STATE BOARD OF AGRICULTURE
Harland E. Priddle, Secretary

DIVISION OF WATER RESOURCES
Guy E. Gibson, Chief Engineer-Director

CERTIFICATE OF APPROPRIATION FOR BENEFICIAL USE OF WATER

WATER RIGHT, File No. 19,882
PRIORITY DATE December 19, 1972

WHEREAS, It has been determined by the undersigned that construction of the appropriation diversion works has been completed, that water has been used for beneficial purposes and that the appropriation right has been perfected, all in conformity with the conditions of approval of the application pursuant to the water right referred to above and in conformity with the laws of the State of Kansas,

NOW, THEREFORE, Be It Known that GUY E. GIBSON, the duly appointed, qualified and acting Chief Engineer-Director of the Division of Water Resources of the Kansas State Board of Agriculture, by authority of the laws of the State of Kansas, and particularly K.S.A. 82a-714, does hereby certify that, subject to vested rights and prior appropriation rights, the appropriator is entitled to make use of natural flows in the Neosho River to be diverted at a point located near the center of the East Half of the Northwest Quarter of the Northwest Quarter (E½ NW¼ NW¼) of Section 10, more particularly described as being near a point 4,450 feet North and 4,485 feet West of the Southeast Corner of said Section, in Township 21 South, Range 15 East, Coffey County, Kansas, at a diversion rate not in excess of 76,300 gallons per minute (170.0 c.f.s.) and in a quantity not to exceed 35,120.24 acre-feet per calendar year which may be transported by means of a pipeline and stored in a reservoir identified as Wolf Creek Generating Station Cooling Lake, created by a dam located on Wolf Creek at a point in the Southwest Quarter of the Southwest Quarter of the Northeast Quarter (SW¼ SW¼ NE¼) of Section 30, Township 21 South, Range 16 East, Coffey County, Kansas, and subsequently withdrawn or released as needed for industrial use at the Wolf Creek Steam Electric Generating Station located in the Northeast Quarter (NE¼) of Section 7, Township 21 South, Range 16 East, Coffey County, Kansas.

This appropriation right is further limited to a diversion rate which when combined with the water right set forth in the Certificate of Appropriation issued pursuant to File No. 14,626, will provide a diversion rate not in excess of 76,300 gallons per minute (170.0 c.f.s.) for industrial use at the location described herein.

This appropriation is further limited to the diversion of natural flows of the Neosho River at such times and under such conditions that a minimum flow of 250 cubic feet per second (c.f.s.) remains in said river immediately downstream from the point of diversion authorized for the diversion of water for industrial use at the location described herein. When the natural flows in the Neosho River are 250 cubic feet per second or less at the intake structure, the appropriator may request permission of the Chief Engineer-Director to withdraw the natural flows not needed to satisfy vested rights, prior appropriations, and prior applications for permit to appropriate water for beneficial use. The Chief Engineer-Director may permit the requested withdrawal of such natural flows to the extent it is found to be in the public interest.

The appropriator shall furnish the Chief Engineer-Director a copy of the notice or schedule of releases (withdrawal) of water from John Redmond Reservoir any time said information is provided to the Director, Kansas Water Office, pursuant to Article 10 of Water Purchase Contract No. 76-2, executed March 13, 1976.

The appropriator shall maintain records from which the quantity of water actually diverted during each calendar year may be readily determined. Such records shall be furnished to the Chief Engineer-Director by March 1 of each year following the previous calendar year of usage.

The appropriation right as perfected is appurtenant to and severable from the land herein described.

The appropriation right shall be deemed abandoned and shall terminate when without due and sufficient cause no lawful beneficial use is made of water under this appropriation for three (3) successive years.

The right of the appropriator shall relate to a specific quantity of water and such right must allow for a reasonable raising or lowering of the static water level and for the reasonable increase or decrease of the stream flow at the appropriator's point of diversion.

In Witness Whereof, I have hereunto set my hand at my office at Topeka, Kansas, this 31st day of August, 1982.

DIVISION OF WATER RESOURCES
GUY E. GIBSON
CHIEF ENGINEER DIRECTOR
KANSAS STATE BOARD OF AGRICULTURE

Guy E. Gibson

Guy E. Gibson, P.E.
Chief Engineer-Director
Division of Water Resources
Kansas State Board of Agriculture

STATE OF KANSAS, Shawnee COUNTY, ss.

Be It Remembered, That on this 31st day of August A.D. 19 82, before me, the undersigned, a notary public in and for said County and State, came Guy E. Gibson, Chief Engineer-Director, Division of Water Resources of the Kansas State Board of Agriculture, who is personally known to me to be such duly appointed, qualified and acting official, and who is personally known to me to be the same person who executed the within instrument of writing as such official and such person duly acknowledged the execution of the same as such Chief Engineer-Director.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year last above written.

DENISE J. WATERS
NOTARY
STATEWIDE
SHAWNEE COUNTY, KANSAS

Signature: Denise J. Waters
Denise J. Waters, Notary Public

My commission expires March 1, 1986

(Record in the Office of Register of Deeds in the county or counties wherein the point of diversion is located)

WATER APPROPRIATION CERTIFICATE

No. 8581

STATE OF KANSAS

Water Right, File No. 19,882

State of Kansas, COFFEY County, ss.

Filed for record this 22nd day of September, 1982 at 8:10 o'clock A. m. and recorded in Book X-Misc. Page 112-113

Fee $ 6.00

Register of Deeds.

THE STATE OF KANSAS

(50)

STATE BOARD OF AGRICULTURE
Harland E. Priddle, *Secretary*

DIVISION OF WATER RESOURCES
Guy E. Gibson, *Chief Engineer-Director*

CERTIFICATE OF APPROPRIATION FOR BENEFICIAL USE OF WATER

WATER RIGHT, File No. 14,626
PRIORITY DATE February 21, 1968

WHEREAS, It has been determined by the undersigned that construction of the appropriation diversion works has been completed, that water has been used for beneficial purposes and that the appropriation right has been perfected, all in conformity with the conditions of approval of the application pursuant to the water right referred to above and in conformity with the laws of the State of Kansas,

NOW, THEREFORE, Be It Known that GUY E. GIBSON, the duly appointed, qualified and acting Chief Engineer-Director of the Division of Water Resources of the Kansas State Board of Agriculture, by authority of the laws of the State of Kansas, and particularly K.S.A. 82a-714, does hereby certify that, subject to vested rights and prior appropriation rights, the appropriator is entitled to make use of natural flows in the Neosho River to be diverted at a point located near the center of the East Half of the Northwest Quarter of the Northwest Quarter (E½ NW¼ NW¼) of Section 10, more particularly described as being near a point 4,450 feet North and 4,485 feet West of the Southeast Corner of said Section, in Township 21 South, Range 15 East, Coffey County, Kansas, at a diversion rate not in excess of 24,685 gallons per minute (55.0 c.f.s.) and in a quantity not to exceed 18,796.4 acre-feet per calendar year which may be transported by means of a pipeline and stored in a reservoir identified as Wolf Creek Generating Station Cooling Lake, created by a dam located on Wolf Creek at a point in the Southwest Quarter of the Southwest Quarter of the Northeast Quarter (SW¼ SW¼ NE¼) of Section 30, Township 21 South, Range 16 East, Coffey County, Kansas, and subsequently withdrawn or released as needed for industrial use at the Wolf Creek Steam Electric Generating Station located in the Northeast Quarter (NE¼) of Section 7, Township 21 South, Range 16 East, Coffey County, Kansas.

This appropriation is further limited to the diversion of natural flows of the Neosho River at such times and under such conditions that a minimum flow of 250 cubic feet per second (c.f.s.) remains in said river immediately downstream from the point of diversion authorized for the diversion of water for industrial use at the location described herein. When the natural flows in the Neosho River are 250 cubic feet per second or less at the intake structure, the appropriator may request permission of the Chief Engineer-Director to withdraw the natural flows not needed to satisfy vested rights, prior appropriations, and prior applications for permit to appropriate water for beneficial use. The Chief Engineer-Director may permit the requested withdrawal of such natural flows to the extent it is found to be in the public interest.

The appropriator shall furnish the Chief Engineer-Director a copy of the notice or schedule of releases (withdrawal) of water from John Redmond Reservoir any time said information is provided to the Director, Kansas Water Office, pursuant to Article 10 of Water Purchase Contract No. 76-2, executed March 13, 1976.

The appropriator shall maintain records from which the quantity of water actually diverted during each calendar year may be readily determined. Such records shall be furnished to the Chief Engineer-Director by March 1 of each year following the previous calendar year of usage.

The appropriation right as perfected is appurtenant to and severable from the land herein described.

The appropriation right shall be deemed abandoned and shall terminate when without due and sufficient cause no lawful beneficial use is made of water under this appropriation for three (3) successive years.

The right of the appropriator shall relate to a specific quantity of water and such right must allow for a reasonable raising or lowering of the static water level and for the reasonable increase or decrease of the stream flow at the appropriator's point of diversion.

In Witness Whereof, I have hereunto set my hand at my office at Topeka, Kansas, this 31st day of August, 1982.

DIVISION OF WATER RESOURCES GUY E. GIBSON CHIEF ENGINEER DIRECTOR KANSAS STATE BOARD of AGRICULTURE

Guy E. Gibson

Guy E. Gibson, P.E.
Chief Engineer-Director
Division of Water Resources
Kansas State Board of Agriculture

STATE OF KANSAS, Shawnee COUNTY, ss.

Be It Remembered, That on this 31st day of August A.D. 1982, before me, the undersigned, a notary public in and for said County and State, came Guy E. Gibson, Chief Engineer-Director, Division of Water Resources of the Kansas State Board of Agriculture, who is personally known to me to be such duly appointed, qualified and acting official, and who is personally known to me to be the same person who executed the within instrument of writing as such official and such person duly acknowledged the execution of the same as such Chief Engineer-Director.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year last above written.

DENISE J. WATERS NOTARY STATEWIDE PUBLIC SHAWNEE COUNTY, KANSAS

Signature: Denise J. Waters
Denise J. Waters Notary Public

My commission expires: 8 March 1986

(Record in the Office of Register of Deeds in the county or counties wherein the point of diversion is located)

RRI

WATER APPROPRIATION CERTIFICATE

No. 8580

STATE OF KANSAS

Water Right, File No. 14,626

STATE OF KANSAS, COFFEY COUNTY, ss.

Filed for record this 22nd day of September 1982

at 8:10 o'clock A. m. and recorded in Book X-Misc. Page 114-115

Fee $ 6.00

Ruth L. Stubby
Register of Deeds.

(50)

STATE OF KANSAS

Joan Finney, Governor

KANSAS WATER OFFICE
Stephen A. Hurst
Director

Suite 300
109 SW Ninth
Topeka, Kansas 66612-1249
913-296-3185

March 26, 1992

Mr. Earl Creel
Manager, Nuclear Affairs
Kansas Gas and Electric Co.
120 E. First, PO Box 208
Wichita, KS 67201

Dear Mr. Creel:

The current dispute over Kansas Gas and Electric's (KG&E) billing for water use for 1991 under contract 76-2 has brought to light certain problems relating to the measurement of water released from John Redmond Reservoir for use by KG&E.

Under Article 9 of the contract, KG&E is the party responsible for measuring water released from storage. Neither the Kansas Water Office nor the Corps of Engineers are responsible for measurement of releases (except in the case of a malfunction of KG&E's measuring device or devices--see Article 9, lines 4-7, page 8).

Currently, whenever KG&E needs water from storage in the reservoir, you call Mrs. Duvall noting the rate at which KG&E wishes to have water released. Mrs. Duvall notifies the Tulsa District Corps of Engineers of KG&E's call for water from storage. Tulsa notifies personnel at the John Redmond project office of KG&E's request. Since the valve at the Corps' end of the release pipe is left open, they merely wait for a call from KG&E personnel who report the date and time they (KG&E) opened the valve controlled by KG&E further down the release pipe.

Since, as per your claim, KG&E has assumed it was to be billed only for water passing through its pumps and meters, there apparently has been little concern for the amount of water actually being released from John Redmond storage through the pipe. It should be noted, however, evacuation of stored water lowers the amount of water available to satisfy future needs of KG&E. During extreme drought conditions, or other critical water need situations, water which might be needed by KG&E for cooling at its nuclear power plant would not be available.

Kansas Gas and Electric argues that the amount released through the pipe could be less than 120 cfs. The state can argue that an amount more than 120 cfs could be exiting the pipe. If 120 cfs or more is discharging from the pipe and KG&E is not pumping 120 cfs, the remainder of the discharge in essence, is being wasted. The current arrangements for releasing water from storage are, therefore, unacceptable to the state.

Therefore, under the provisions of Article 9 of contract 76-2, I am requiring that KG&E immediately and at its own expense, furnish, install, operate and maintain a mutually agreeable measuring device or devices in the 42 inch pipe which KG&E has connected to the 30 inch pipe located in the left non overflow section of John Redmond dam. I believe this requirement is necessary to protect the state's interest in ensuring that no water is wasted and that the water supply in storage for KG&E is available should a critical need arise.

Please inform me regarding the type of measuring device which KG&E will install and the expected installation date. If you have any questions regarding this matter, please contact me.

Sincerely,

Stephen A. Hurst
Director

SAH:dk
cc: John Campbell, Attorney General's Office
Jim Holliman, Tulsa Corps of Engineers
Dale Mahan, Division of Water Resources
Kent Weatherby, Kansas Power and Light Co.
Janet Payne, Tulsa Corps of Engineers
Terry Duvall
Margaret Fast

Jim Hockett

50

Western
Resources

818 Kansas Avenue
P.O. Box 889
Topeka, Kansas 66601
Phone (913) 575-8129
Fax (913) 575-8136

Roger K. Weatherby
Associate General Counsel, Administration
Law Division

April 18, 1994

Mr. Stephen A. Hurst, Director
Kansas Water Office
109 S.W. Ninth, Suite 300
Topeka, KS 66612-1249

Dear Mr. Hurst,

This letter confirms agreements in principal reached during our meeting on March 14, 1994, concerning Water Purchase Contract 76-2. The content of this letter goes beyond those elements of agreement in an effort to finalize the issues raised by our correspondence and conversations.

Water flow meter. While Kansas Gas and Electric Company (KGE) believes it is in full compliance with the requirements of Water Purchase Contract 76-2 as a result of the meter installed on the downstream side of the intake works pipeline, we share the concern of the Kansas Water Office (KWO) relating to the accurate metering of contract water releases. For that reason a second meter will be installed at the 42 inch outlet pipe owned by KGE which is connected to the Corps' 30 inch outlet pipe. It is agreed by KGE and KWO that the work done by KGE to investigate and document the as-built outlet works coupled with the existing meter and meter contemplated by this agreement, and the flow curve calculations made consistent with the as-built works, constitute a full and final settlement of all past, present and future issues relating to the need for installation of meters pursuant to Water Purchase Contract 76-2.

Flow curve calculation. We have attached the flow curve calculations made by Bechtel Corporation for the as built outlet works for Water Purchase Contract 76-2. These calculations will constitute a secondary means of determining the amount of water released pursuant to the contract.

Annual water delivery calculation. The meter installed pursuant to the second paragraph of this letter agreement shall be conclusive of the amount of water released from storage pursuant to Water Purchase Contract 76-2. In the event the meter so installed shall be inoperable for any reason at the time releases from storage under the contract are made then the flow curve calculation provided pursuant to the third paragraph of this letter shall be conclusive of the amount of such releases.

Maintenance of outlet works. The KWO shall undertake to coordinate with the Corps of Engineers to maintain the lake side of the outlet works for the removal of debris from the screens which will affect the flow curve calculation mentioned above. In the event the Corps is unable to maintain the lake side outlet works leading to obstruction of the works then the existing meter located on the discharge side of the intake pumps shall be conclusive as to water released from storage if the primary meter is inoperable at the time of release.

I look forward to hearing from you concerning these ideas. Once we have reached final agreements I will formalize them by a document we can both execute. I had in mind something in the nature of a memorandum of understanding.

Sincerely,

Kent Weaver

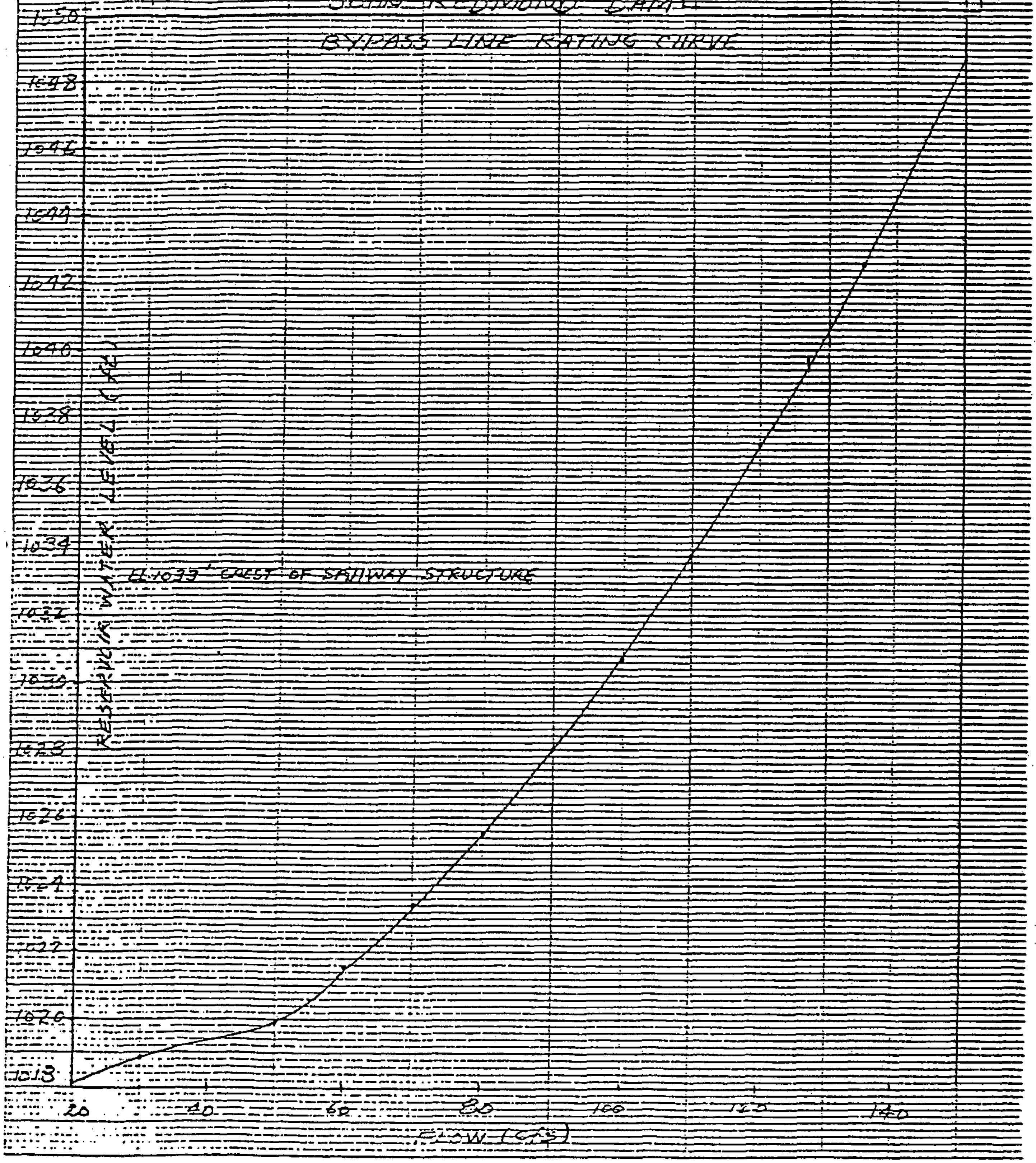
Attachment 2 to WO 93-0170

GEOTECHNICAL GROUP

JOB NO. 16577
CALC. NO. WE-M-001
DATE 1992/10/23
CALCULATOR
CHECKED BY
PAGE 26 OF 27

JOHN REDMOND DAM

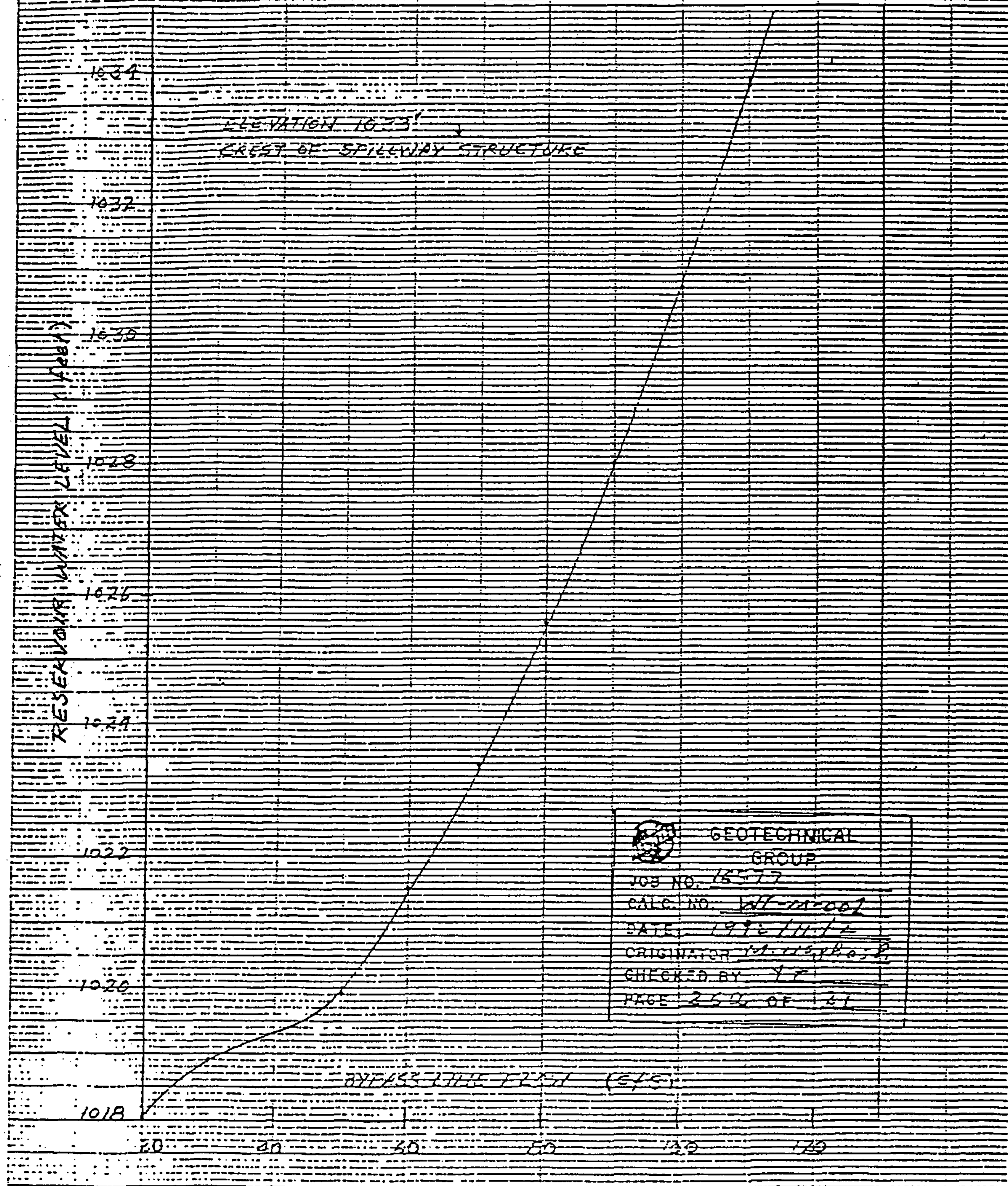
BYPASS LINE RATING CURVE



WOLF CREEK PLANT

JOHN REDMOND DAM RESERVOIR

BYPASS LINE RATING CURVE



GEOTECHNICAL GROUP
JOB NO. 15577
CALC. NO. WC-M-002
DATE [illegible]
ORIGINATOR [illegible]
CHECKED BY YF
PAGE 25[illegible] OF 41

STATE OF KANSAS

Bill Graves, Governor

KANSAS WATER OFFICE
Al LeDoux
Director

Suite 300
109 SW Ninth
Topeka, Kansas 66612-1249

913-296-3185
FAX 913-296-0878
TTY 913-296-6604

June 28, 1996

Mr. Fred Rogge
Manager, Power Contract Administration
Western Resources
818 Kansas Avenue, P.O. Box 889
Topeka, KS 66601

Dear Mr. Rogge:

The following information represents our understanding of conditions relating to water use by Western Resources and discussions and agreements reached on June 27, 1996.

Western Resources, by virtue of contract 76-2 with the State of Kansas, is authorized to withdraw from storage in John Redmond Lake up to 9,672,000,000 gallons of water per year. Under contract 76-2, Western Resources is required to make a minimum annual payment for 4,836,000,000 gallons of water per year whether or not any water is actually withdrawn from storage. Further, Western Resources is required to pay for water taken from the Neosho River under its water appropriation right as though the water were taken under contract 76-2, because their water right is junior to the State's water reservation right to store water from the Neosho River behind John Redmond Dam.

In addition, Western Resources holds a water appropriation right which allows for the withdrawal of water from stream flow in the Neosho River. However, the water right is conditioned such that when the downstream flow is below 250 cfs, Western Resources is not permitted to withdraw water under this appropriation right.

Western Resources installed a 42 inch tube along the eastern side of the outlet channel at John Redmond which was to be used for release of water from storage under contract 76-2. Recently a measuring device was installed in this tube. Western Resources conducted test releases beginning April 26, 1996, and ending May 10, 1996, to determine the accuracy of the measuring device installed in the tube. The results of this test are documented in your letter to us dated May 31, 1996.

From the information obtained through the test, it is evident that releases from storage through the 42 inch tube range from 60 to 65 million gallons per day or from approximately 93 to 101 cfs. Whenever the two large make-up pumps are running, 77 million gallons per day (approximately 119 cfs) is being withdrawn from the stream.

For the purposes of accounting for Western Resources' water use during the April 26 to May 10, 1996, period, the Kansas Water Office will count only the metered water through the 42 inch tube against storage available during this year to Western Resources (CR, contract release). The balance of water pumped will be counted as "C" (contract) use when the downstream flow is below 250 cfs as required by the Division of Water Resources.

It is our understanding that in the future Western Resources intends to use only one make-up pump throttled to match the release rate of the bypass line (42 inch tube). Should Western Resources need a larger volume of release than the tube can supply, they will contact the Kansas Water Office to request that the Corps make additional releases from storage through other means at their disposal through the dam.

If I have misunderstood or missed some point that should be documented in this letter, please let me know as soon as possible.

I appreciate your cooperation in installing the measuring device, running the test of its accuracy and meeting to discuss the issues raised by the test. As we move toward operation of the Assurance District in the Cottonwood and Neosho Basin, it is important that we agree upon appropriate record keeping procedures.

Sincerely,

Terry Duvall

Terry Duvall
Public Service Executive

TD:ROGGE628.LTR/dl
cc: Thomas Stiles, Kansas Water Office
Dale Mahan, Division of Water Resources, Topeka Field Office

STATE OF KANSAS

Bill Graves, Governor

KANSAS WATER OFFICE
Al LeDoux
Director

Suite 300
109 SW Ninth
Topeka, Kansas 66612-1249

785-296-3185
FAX 785-296-0878
TTY 785-296-6604

April 1, 1998

Fred Rogge, Manager Power Contracts
Western Resources
P.O. Box 889
Topeka, KS 66601-0889

RE: Raw Water Meter Certification Contracts 76-2 and 80-2

Dear Mr. Rogge:

In August of 1997, in accordance with express provisions of the referenced contracts, I requested certification of the raw water meters used by Western Resources. A second notice letter was sent on January 26, 1998.

Although we have discussed this issue by telephone a couple of times, and you submitted the maintenance records for the meter used under contract 89-2, neither meter has been certified as to its accuracy. Your contracts require that raw water meters be certified for accuracy.

In addition, releases made through the outlet tube at John Redmond under contract 76-2 during the last quarter of 1997 were not reported using the meter in the tube. I have asked for this information on a couple of occasions. I realize there may be a problem with the measuring device; however, it is important that any such problem be addressed and corrected by Western Resources in accordance with your contract provisions.

Meter certification is an important issue, in that water use and billings for water use are based upon meter readings as provided in your contracts. The two meters should be certified within the next 30 days in accordance with your contracts. Until the meters are certified as accurate, no further releases will be made under these two contracts.

I would appreciate your prompt attention to this matter.

Sincerely,

Terry Duvall

Terry Duvall
Public Service Executive
Water Contracts

Western Resources®

April 25, 1998

Ms. Terry Duvall
Kansas Water Office
Suite 300
109 S.W. 9th Street
Topeka, Kansas 66612-1249

Re: Meter Certification

Dear Ms. Duvall:

Enclosed is a calibration certificate for the by-pass water meter used to measure releases from John Redmond Reservoir for Wolf Creek Generating Station. As you know, we had problems with the water meter last fall while the latest release was in progress. The meter was removed and sent to Marsh-McBirney, Inc., the original equipment manufacturer, for repair and calibration. The accuracy of this meter depends on two variables, water velocity and level measurement in the pipe. The velocity accuracy is ± 2% of reading and the level accuracy is ± 0.5% of reading.

We would like to test this meter under actual conditions and I will talk with you at a later date about releasing some water through the by-pass.

You had earlier requested the accuracy of the meter at Jeffrey Energy Center. The accuracy of the annubar flow element is ± 1% and the accuracy of the transmitter is ± 0.2%.

I'm sorry for the delay in sending this meter information. If you need more information please call me at 575-6590.

Sincerely,

F. D. Rogge.

Fred Rogge
Manager, Power Contract Administration

Enclosure

818 South Kansas Avenue / P.O. Box 889 / Topeka, Kansas 66601
Telephone: (913) 575-6300

#50
2

KANSAS

DEPARTMENT OF HEALTH
AND ENVIRONMENT

Kathleen Sebelius, Governor
Roderick L. Bremby, Secretary

www.kdheks.gov

March 8, 2007

07-00131

Mr. Kevin J. Moles
Wolf Creek Nuclear Operating Corporation
P.O. Box 411
Burlington, KS 66839

RE: Wolf Creek Generating Station (WCGS) 316(b) Entrainment Study Requirements
NPDES Permit No. I-NE07-PO02

Dear Mr. Moles:

KDHE has reviewed the letter transmitted by e-mail from Ralph Logsdon on January 24, 2007, regarding performance standard requirements for existing cooling water intake structures at the referenced facility.

KDHE concurs with WCGS's finding that entrainment study requirements as described in the 316(b) Final Rule do not apply to the intake on Wolf Creek Reservoir (a.k.a. Coffey County Reservoir). Wolf Creek Reservoir is a Lake or Reservoir type water body and as such Exhibit V-1 indicates the performance standard for this intake is impingement only. As previously discussed, the entrainment data being gathered by WCNOC for this intake is voluntary and has been requested to be included in the study documentation for information only.

In light of the Court remands which essentially "gut" the 316(b) regulations, KDHE will require the permittee to finish out the sampling work already started and await EPA's response to the remand and directions from the Court. Once you have the sampling work completed we believe a meeting would be appropriate to present the information and hopefully by then we will be able to provide additional direction.

If you have any questions in regard to this issue, please feel free to call me at (785) 296-4347.

Sincerely,

Eric Staab

Eric C. Staab, P.E.
Industrial Programs Section
Bureau of Water

ECS:es
pc: Northeast District Office
Ralph Logsdon, WCGS
John Dunn, EPA Region VII
KDHE, BOW, IPS

07-00056

KANSAS

DEPARTMENT OF HEALTH
AND ENVIRONMENT

Kathleen Sebelius, Governor
Roderick L. Bremby, Secretary

www.kdheks.gov

January 23, 2007

Mr. Kevin J. Moles
Wolf Creek Nuclear Operating Corporation
P.O. Box 411
Burlington, KS 66839

RE: Wolf Creek Generating Station (WCGS) 316(b) Water Transfer Information
NPDES Permit No. I-NE07-PO02

Dear Mr. Moles:

KDHE has reviewed the letter dated January 17, 2007 regarding the referenced facility. KDHE concurs with WCGS's finding that the intake on John Redmond Reservoir constitutes a water transfer and not a direct use of water by the power plant. As such, the John Redmond Reservoir intakes are not cooling water intakes subject to 316(b).

If you have any questions in regard to this issue, please feel free to call me at (785) 296-4347.

Sincerely,

Eric Staab

Eric C. Staab, P.E.
Industrial Programs Section
Bureau of Water

ECS:es

pc: Northeast District Office
Ralph Logsdon, WCGS
John Dunn, EPA Region VII
KDHE, BOW, IPS

IMAGED 01/31/2007

WOLF CREEK
NUCLEAR OPERATING CORPORATION

Kevin J. Moles
Manager Regulatory Affairs

JAN 24 2007

RA 07-0010

Kansas Department of Health and Environment
Bureau of Water – Industrial Programs
1000 SW Jackson St., Suite 420
Topeka, Kansas 66612-1367

Attention: Mr. Eric Staab

Reference: 69FR41576 "Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; dated July 9, 2004

Subject: Entrainment Study Exemption Request.

Dear Mr. Staab:

Based on a conversation with Ralph Logsdon on January 23, 2007, Wolf Creek Nuclear Operating Corporation (WCNOC) requests a letter confirming Kansas Department of Health and Environment's (KDHE) position on exempting Wolf Creek Generating Station cooling water intake structure from an entrainment study.

Under the final rule, Environmental Protection Agency has established performance standards for the reduction of impingement mortality and, when appropriate, entrainment. The type of performance standard to a particular facility is based on several factors, including the facility's location (i.e., source waterbody). Exhibit V-1, Performance Standards Requirement, summarizes the performance standards based on waterbody type. For lakes and reservoirs Exhibit V-1 only requires an impingement mortality study to be performed.

WCNOC understands that Environmental Protection Agency final rule referenced above does not require an entrainment study on lake and reservoirs and, therefore exempt from that portion of 316(b) performance standards. WCNOC is requesting written confirmation of this position stated in the reference. If you have any questions regarding this request, please contact Mr. Ralph Logsdon at (620) 364-8831, extension 4730.

Sincerely,

Kevin J. Moles

Kevin J. Moles

KJM/rll

51. More detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells included in the study, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

• Site-specific hydrogeological information, including: groundwater depth(s) at site; aquifer(s) present at site; location, elevation, construction, and historical analyses on current and past monitoring wells (including B-12, C-10, C-49, J-1, J-2, G-2, and F-1); details of the current monitoring and analytical program; flow direction information (direction, rate, fate); and comprehensive local production information (locations, construction information, history of analysis, pump rates, use).

• Documentation of any environment releases, including any evaluations of the incident with respect to the nature, extent, and impact of the release.

• Locations, volumes, and existing chemical and radiological analytical data on drinking water intakes for Burlington, Neosho Falls, Iola, and any other intakes on the Neosho River between JRR and Iola.

• *Correspondence, reports, and any other information related to any past restrictions on* water withdrawal, if any have occurred. If none have occurred, a statement that these restrictions have never been implemented.

• More detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells included in the study, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

• A map showing the locations of all groundwater monitoring or production wells in the local area, including their depths, rates of production, and use of water, if known. Section 2.9.1 states that 80% of water use in the basin is from surface sources – describe the source, location, and use of the other 20%.

• More detailed meteorological data, including historic rainfall data, to provide additional information for the evaluation of water use conflicts in Section 2.10 of the ER (WCGS, 1980). Include average rainfall, seasonal variations, and information on extreme conditions. Please provide the average peak and low-flow values for the Neosho River. Also provide information on seasonal variability, if it exists.

• Clarification of the relationship between the WCNOC contract with the Kansas Water Resources Board, versus the "Certificate of Appropriation" discussed in ER Section 4.1. It appears that the contract has controls based on available supply within the reservoir, while certificate has controls based on the flow rate in the river. Please verify if this is correct. Also identify if a different agency implements the controls in either case, or if this is a single agency.

Request # 105
Please provide more detailed data regarding the groundwater quality study performed from 1973-87. Provide the locations of the wells studies, their depths, production rates, and water uses. Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared. Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.

Provide the locations of the wells studies, their depths, production rates, and water uses.
Request # 2 reference
<u>EA, 1988, Operational Phase Environmental Monitoring Program Final Report</u>

> Figure 1.1 "Aquatic Sampling Locations in the vicinity of WCGS", provides sample locations.
>
> Section 2.3.3 "Ground water Quality" provides a discussion of results.
>
> Table 2-6 "Mean Concentration of Water Quality Parameters", provides sample results.
>
> Depths, production rates, and water uses, could not be determined

Discuss any regulatory involvement, including the regulatory program of which the study was a part, which agency(ies) reviewed and approved workplans and conclusions, the chemical and radiological parameters that were measured, the periodicity of the sampling, and the standards to which results were compared.

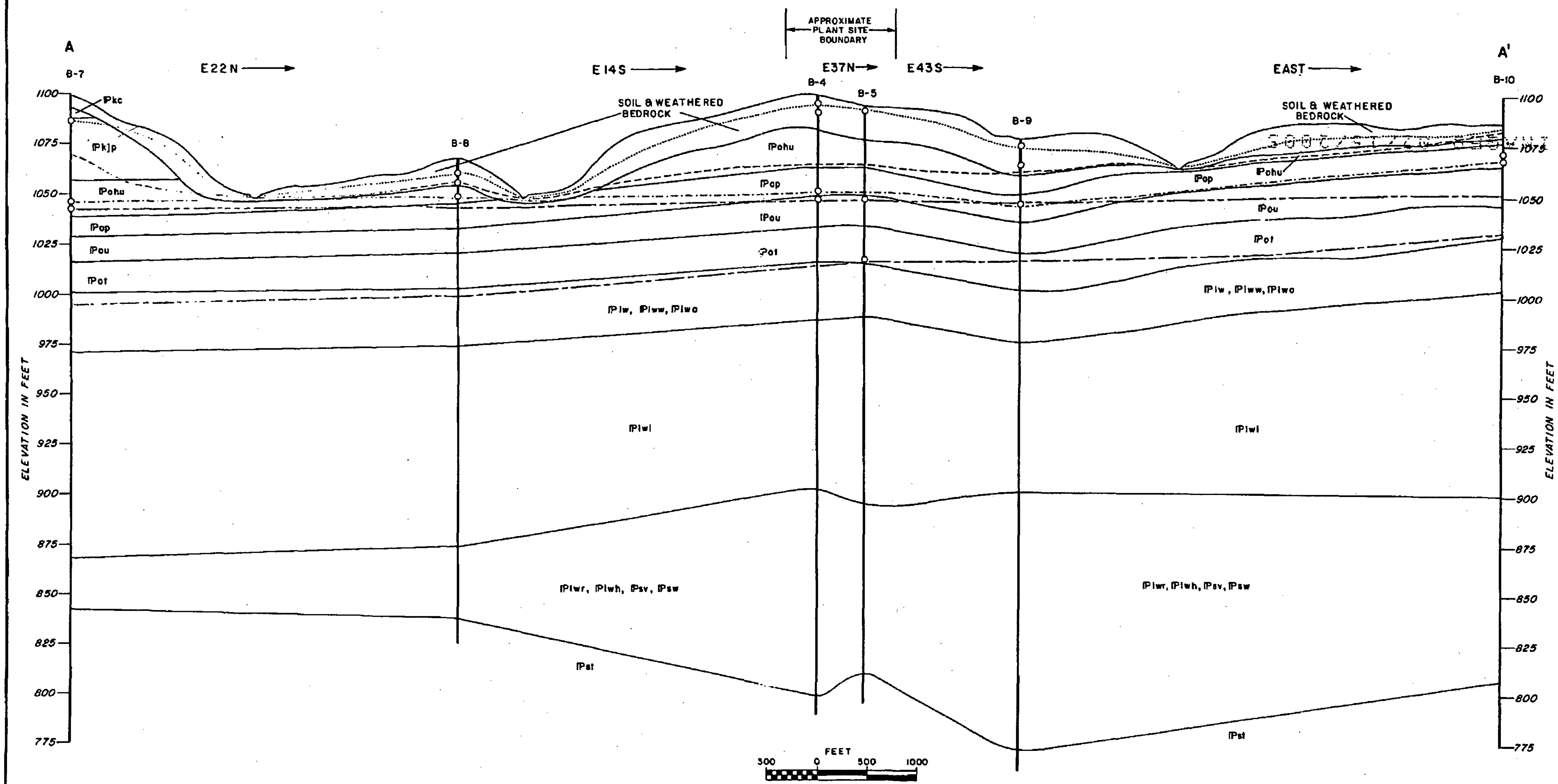
EA 1988 2.4.3, study was conducted from 1973 to 1987, two years of plant operation; conclusion was no changes in water quality since dam closure for CCL (WCCL) or after WGS operation.

Chemical parameters are listed in Table 2-6 of EA 1988.

Environmental Radiological monitoring Program (REMP)
Ref. 1982 Annual Report for REMP
Quarterly sample frequency, monitored for I-131 LLD 0.5 pCi/L, Gamma and tritium H-3, LLD 1000 pCi/L. All results less than LLD. Annual REMP reports are available through 2005.

Provide the rationale for ceasing the program only two years into operations, including any regulatory concurrence in this action.
To continue the groundwater quality study for two years after plant operation comes from ER OLS, in FES-OLS the NRC agreed with the commitment. Essentially the two years of the ground water quality study was proposed, with caveats for modifications as we determined. From the 1996 Environmental Operating Report:

The original monitoring program's objectives since plant construction were to satisfy licensing requirements and assess plant impacts. This monitoring begin in 1973 and was initiated in CCL (WCL) after impoundment to fulfill regulatory commitments (KG&E ER OLS 1981, NRC 1982 FES-OLS). The monitoring was to continue through at least two years of plant operation, which was satisfied in 1987. Since 1987 the scope was greatly reduced to target key water quality indicators chosen to either, add to baseline data or to reflect long-term operational impacts beyond monitoring commitments. With these objectives met in 1993, monitoring frequency and scope were further reduced. Frequency was changed to a biennial schedule beginning in1995 with the program scope focusing on long-term trends associated with plant operation. After analyses of 1995 data, it was determined that further water quality monitoring was not necessary and was discontinued. There was no agency concurrence to discontinue the study.



NOTES:

1. FIGURE 2.4-52 SHOWS LOCATION OF CROSS-SECTION A-A'.
2. FIGURE 2.5-26 SHOWS DETAILED SITE STRATIGRAPHIC COLUMN.
3. TABLE 2.4-29 LISTS PIEZOMETER WATER LEVEL READINGS.
4. ELEVATIONS REFER TO USGS DATUM.
5. VERTICAL EXAGGERATION EQUALS 1:20.
6. THE CROSS-SECTION AND WATER LEVELS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA AND REVIEW OF INFORMATION PRESENTED IN FIGURES 2.4-47, 2.4-48, 2.4-49, 2.5-14a, AND 2.5-14b HOWEVER, SOME VARIATION OF SUBSURFACE CONDITIONS BETWEEN BOREHOLES MUST BE EXPECTED.

EXPLANATION:

- O — AVERAGE PIEZOMETER READINGS (ALL AVERAGES FOR JUNE, 1974, EXCEPT B-7 NOT MONITORED AFTER OCTOBER, 1973.)
- WATER TABLE
- PLATTSMOUTH POTENTIOMETRIC SURFACE
- TORONTO POTENTIOMETRIC SURFACE
- IRELAND POTENTIOMETRIC SURFACE
- TONGANOXIE POTENTIOMETRIC SURFACE

STRATIGRAPHIC COLUMN:

SYMBOL	STRATIGRAPHIC MEMBER	SYMBOL	STRATIGRAPHIC MEMBER
IPkc	CLAY CREEK LIMESTONE MEMBER	IPlwo	AMAZONIA LIMESTONE MEMBER
IPkjp	JACKSON PARK SHALE MEMBER	IPlwi	IRELAND SANDSTONE MEMBER
IPohu	HEUMADER SHALE MEMBER	IPlwa	ROBBINS SHALE MEMBER
IPop	PLATTSMOUTH LIMESTONE MEMBER	IPlwh	HASKELL LIMESTONE MEMBER
IPou	UNDIFFERENTIATED HEEBER SHALE, LEAVENWORTH LIMESTONE AND SNYDERVILLE SHALE MEMBERS	IPsv	VINLAND SHALE MEMBER
IPlw	UNNAMED LAWRENCE SHALE MEMBER	IPsw	WESTPHALIA LIMESTONE MEMBER
IPlww	WILLIAMSBURG COAL BED	IPst	TONGANOXIE SANDSTONE MEMBER

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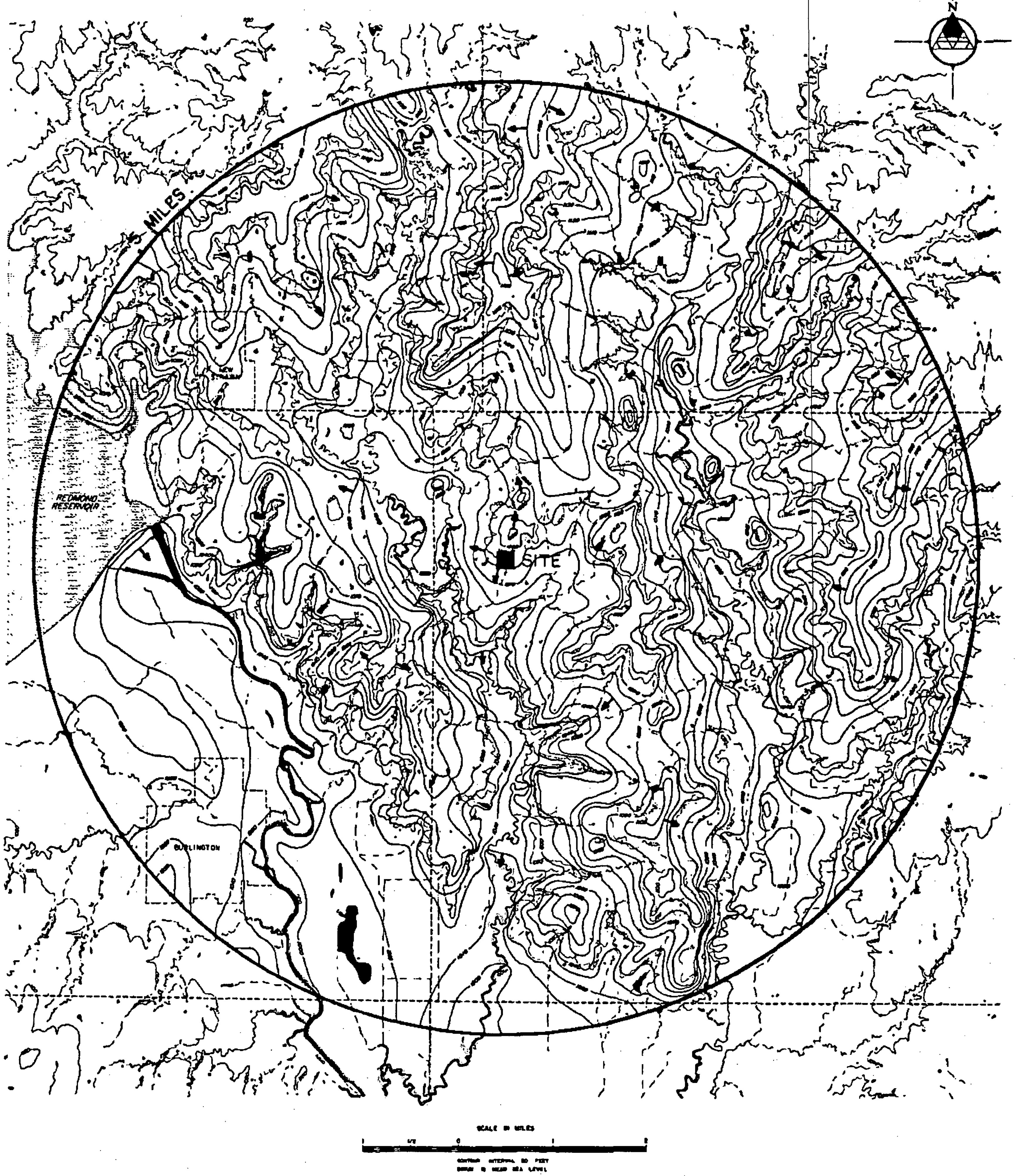
FIGURE 2.5-7

GENERALIZED EAST-WEST CROSS-SECTION THROUGH PLANT SITE SHOWING POTENTIOMETRIC WATER LEVELS



LEGEND:

TOPOGRAPHIC CONTOURS (50 FOOT INTERVALS)

WATER TABLE ELEVATION CONTOURS (10 FOOT INTERVALS) FROM DATA GATHERED DURING WELL INVENTORY. (SEE TABLE 2.2-18)

ARROWS SHOW DIRECTION OF GROUNDWATER FLOW

REFERENCE:

FIFTY-FOOT TOPOGRAPHIC CONTOURS FROM U.S. GEOLOGICAL SURVEY QUADRANGLES FOR NEW STRAWN (1971), OTTUMWA (1970), WAVERLY SE (1971), ALICEVILLE (1971), BURLINGTON (1971) AND JOHN REDMOND DAM (1964), 7.5 MINUTE SERIES.

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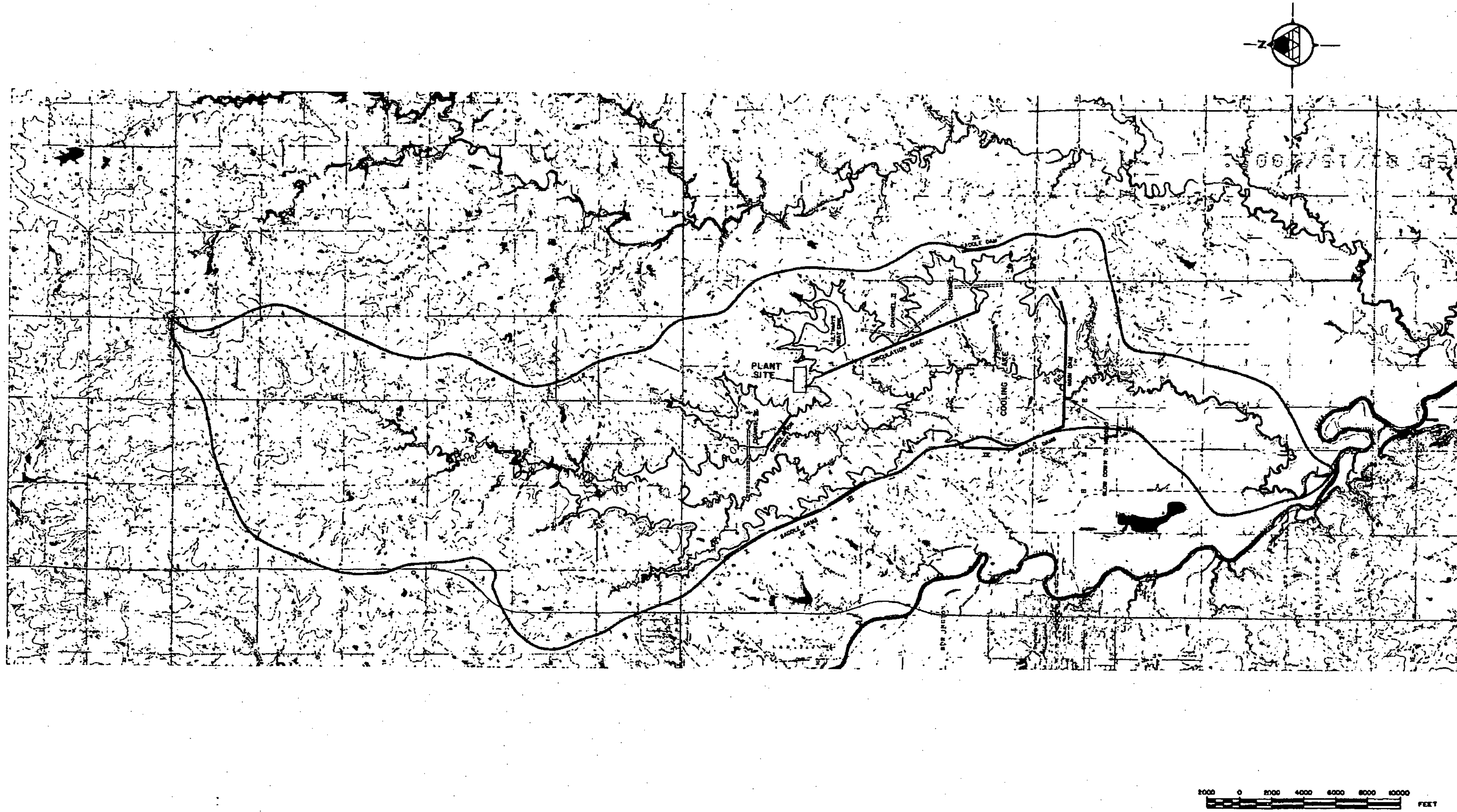
FIGURE 2.5-6

WATER TABLE CONTOUR MAP WITHIN 5 MILES OF SITE



MAP REFERENCE:

THIS MAP TAKEN FROM U.S.G.S. QUADRANGLES: BURLINGTON, KANSAS AND NEW STRAWN, KANSAS DATED 1971.

WOLF CREEK GENERATING STATION
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FIGURE 2.5-2

WOLF CREEK WATERSHED

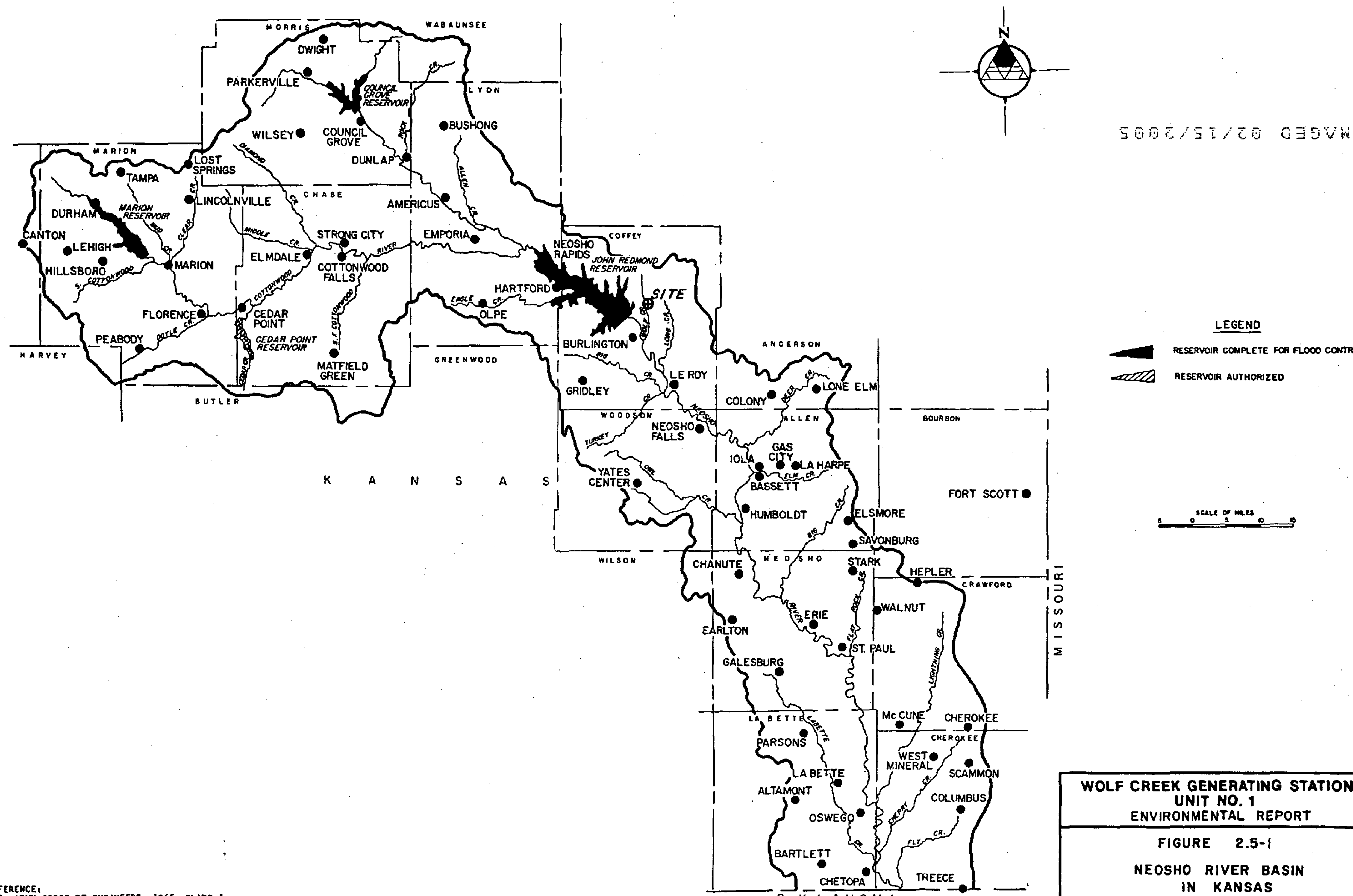

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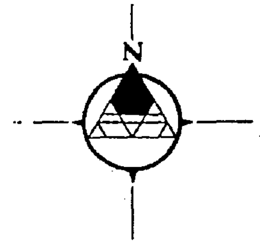
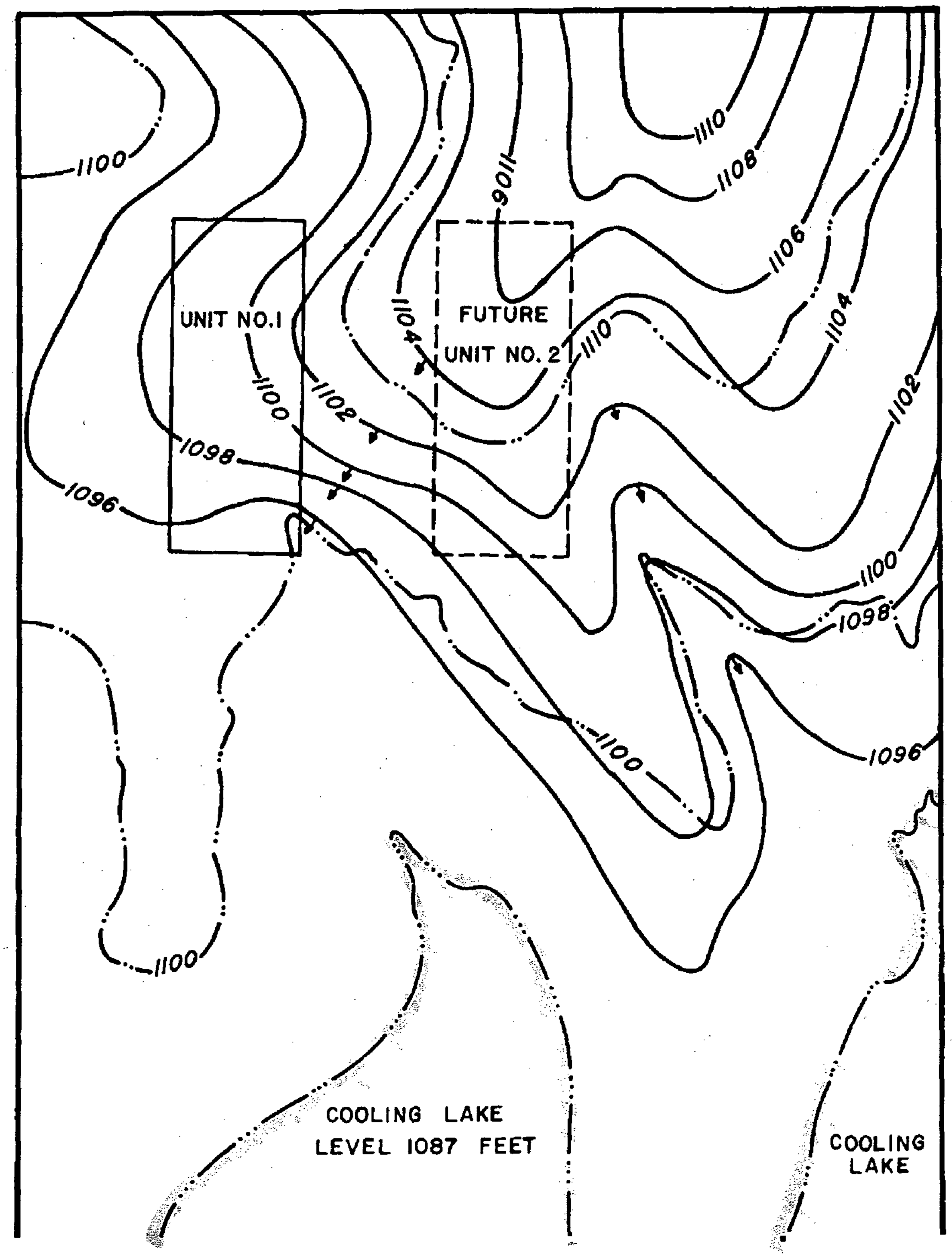
FIGURE 2.5-1

NEOSHO RIVER BASIN IN KANSAS

REFERENCE:
U.S. ARMY CORPS OF ENGINEERS, 1965, PLATE 1.





EXPLANATION:

~1100~ WATER TABLE CONTOUR, INTERVAL 2 FEET, MSL

-··-1110~ TOPOGRAPHIC CONTOUR, INTERVAL 10 FEET, MSL

DIRECTION OF GROUNDWATER FLOW

NOTE: GROUNDWATER LEVELS MEASURED ON FEBRUARY 2, 1974.

300 0 300 600

FEET

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FIGURE 2.5-6a
PLANT SITE WATER TABLE
CONTOUR MAP

EA Engineering, Science, and Technology, Inc.

WOLF CREEK GENERATING STATION
OPERATIONAL PHASE ENVIRONMENTAL MONITORING
PROGRAM, FINAL REPORT

Prepared for

Wolf Creek Nuclear Operating Corporation

Prepared by

EA Engineering, Science, and Technology, Inc.
Great Plains Regional Office

September/1988

WOLF CREEK GENERATING STATION
OPERATIONAL PHASE ENVIRONMENTAL MONITORING
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Ronald J. Bockelman   10-7-88
Ronald J. Bockelman,   **Date**
Project Manager

Barry A. Smith   10/11/88
Barry Smith, Vice President   **Date**
Director of Operations

September/1988

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1. INTRODUCTION

1.1 OBJECTIVES AND SCOPE

Annual environmental monitoring studies associated with Wolf Creek Generating Station (WCGS) have been conducted since 1973 when baseline information necessary for an Environmental Report was collected. Subsequent studies of the aquatic and terrestrial biota near WCGS fulfilled commitments made to the Nuclear Regulatory Commission (NRC) prior to issuance of a construction permit. Studies from 1974 through 1980 provided additional baseline information and monitored areas that could be impacted by construction activities (Kansas Gas and Electric 1981; Hazleton Environmental Sciences 1980; Ecological Analysts, Inc. 1981). Completion of the main dam for the WCGS cooling lake (WCCL) initiated a four-year preoperational study (1981-1984) that provided baseline water quality and biological data from the WCCL (Ecological Analysts, Inc. 1982, 1983, 1984; EA 1985). Operational studies began in 1985 and represented continuation of the 1984 WCCL study and reinstatement of the monitoring program on the Neosho River which was curtailed after 1981. This report summarizes preoperational (i.e. 1973-1984) and operational (1985 - 1987) data associated with the WCGS environmental monitoring program. Two previous annual reports (EA 1986, 1987) summarized operational data collected from August 1985 through 1986. This summary report includes additional operational data collected from February through August 1987 that met a commitment by Wolf Creek Nuclear Operating Corporation to conduct an environmental monitoring program for two years after commercial operation of WCGS commenced.

The major objective of the Operational Environmental Monitoring Program for WCGS was to document potential environmental changes in the WCCL and Neosho River which could result from operation of WCGS. Specific objectives of the study were to:

1. document concentrations of general water quality parameters, aquatic nutrients, organically-derived materials and certain trace metals in the Neosho River and WCCL

2. monitor bottom to surface dissolved oxygen profiles on WCCL

3. determine general groundwater quality in the vicinity of WCGS

4. characterize the benthic community within the Neosho River and WCCL

5. determine phytoplankton productivity of the Neosho River and WCCL

6. determine zooplankton biomass in the WCCL

7. assess fish populations in the Neosho River

In addition to the above specific objectives, the studies documented naturally occurring variations in the aquatic community of the Neosho River and WCCL.

1.2 STATION DESCRIPTION

Wolf Creek Generating Station is located in Coffey County approximately 5.6 kilometers northeast of Burlington, Kansas. Upon completion in 1985, the station employed a pressurized water reactor to produce 1,150 megawatts (net output) of electrical power. The site encompasses 9,818 acres of range, cropland, and woodland typical of southeastern Kansas. Within this, the plant site occupies 135 acres and the WCCL approximately 5,090 acres. A once-through cooling system, utilizing water from the WCCL is used by the WCGS. The cooling lake was formed by impounding Wolf Creek approximately 8.8 kilometers upstream from its confluence with the Neosho River. A surface elevation of 1,087 feet above sea level is maintained in the cooling lake by precipitation and runoff in the Wolf Creek watershed and makeup water from the Neosho River. A makeup water pump house (MUSH) on the Neosho River in the tailwaters of John Redmond Reservoir provides water to the cooling lake via an underground pipeline (Figure 1-1). The auxiliary raw water pumps have withdrawn 1 to 2 cfs from the JRR tailwaters since WCGS became operational except from 17-24 September and 15-22 October 1985; 24-26 January, 26-27 July, and 15-20 October 1986; and 14-15 January 1987. Except for testing, the make up water pumps ran only on 4-11 August 1987, when pumping rates averaged 100 cfs.

1.3 STATUS OF WOLF CREEK GENERATION STATION

Wolf Creek Generating Station was considered 99 percent complete by the end of 1984. The circulating water system operated extensively during start-up testing and extended into the 1984-1985 winter. "Hot Functional" testing was completed during the start-up activities. Construction activities that could affect the Neosho River were completed in 1980 and work on the plant site was limited primarily to site cleanup, much of which was completed in 1984.

The following milestones highlight activities during 1985, the year WCGS began operation:

- WCGS received its low power license on 11 March 1985 and immediately began fuel loading.

- Initial criticality was reached 22 May 1985 and the full power license was granted 4 June 1985.

- Power was first generated on 12 June 1985 with 100 percent power achieved on 8 August 1985.

- Commercial operation of WCGS was declared on 3 September 1985.

Start up/testing and operational activities during 1985 involved use of WCCL for cooling water and dissipation of waste heat. Heat rejection rates were greatest from August 1985, when 100 percent power was achieved, through December. WCGS operated throughout 1986 and most of 1987 except for maintenance and refueling outages. Outages in 1986 occurred in April (16.6 days) and from 16 October through 21 December (66.3 days) when refueling activities were completed. In 1987 outages occurred in January (4 days), April (1 day), June (1 day), July (5 days), early September (1 day), and from 28 September through 31 December (95 days).

1.4 DESCRIPTION OF STUDY AREA

1.4.1 Neosho River

The Neosho River is a relatively slow meandering stream that rarely exceeds a gradient of 1 m/km (Prophet 1966). The river was significantly altered in 1964 with the completion of John Redmond Dam. River flow in the study area is dependent upon discharge from John Redmond Reservoir (JRR) which is regulated by the U.S. Army Corps of Engineers. Substrates in the tailwaters of the JRR are layered limestone, shale, and sandstone bedrock. Flow is variable (Table 1-1) and entirely dependent upon reservoir releases. Pools, gravel bars, and riffles characterize the lower river near the confluence with Wolf Creek. Substrates in the riffle habitats are rock, rubble, and gravel, whereas the pools are characterized by bedrock overlaid by silt.

Four locations in the Neosho River were sampled (Figure 1-1). Location 1 was in the tailwaters of John Redmond Dam near the MUSH. The bottom substrate was bedrock, with rock riprap along the banks. Pools and riffles characterized Location 10 which was 0.7 kilometers upstream of the confluence with Wolf Creek. The riffles had substrates of rock, rubble, and gravel, whereas the pools were characterized by bedrock overlaid with silt. A riffle located approximately 0.5 kilometer below the confluence with Wolf Creek constituted Location 11. The riffle consisted of small rubble, gravel, sand, and silt. Location 4, 1.3 kilometers downstream of the confluence with Wolf Creek, was comprised of a deep pool and a shallow gravel bar. The substrate of the pool was silt and sand, whereas the gravel bar consisted of sand and gravel.

1.4.2 Cooling Lake

The WCCL was formed by one main earth-rolled dam across Wolf Creek and five perimeter saddle dams (Figure 1-1). The top of the main dam is at elevation 1,100 feet above mean sea level (msl) and each dam has a 3 to 1 slope on both the upstream and downstream faces. The upstream slope of each dam is riprapped for protection against wind-generated wave erosion while the downstream slope is seeded. Descriptions of the service and auxiliary spillways, low-level outlet works, and operation of the cooling lake are described in the operating license stage environmental report for WCGS (Kansas Gas and Electric 1981).

Filling of the WCCL began in October 1980 and continued through November 1981. Approximately 23 billion gallons of water were pumped through the makeup water screenhouse in 1981 with monthly pumping rates varying from nearly 49 million gallons in April to 3.4 billion gallons in October. Storage water was purchased from John Redmond Reservoir at the rate of 26.5 MGD (41 cfs) through a contract with the Kansas Water Resources Board. The cooling lake elevation rose from 1,050 to 1,079.5 msl during 1981 resulting in a surface area increase from 890 to 3,900 acres. Pumping continued in January, February, and March 1982 aided by surface water runoff which filled the cooling lake to normal operating level (1,087 msl) by June 1982. Storage elevations from 1983 through 1987 have been stable varying from 0.8 feet below to 2.0 feet above the normal water elevation of 1,087.0 msl (Table 1-2). Storage elevations were generally lowest during the winter (December-January) with peak elevations in May and June following spring runoff. Storage elevations during 1987 were generally above normal through summer and then declined to the annual minimum in late November. Makeup water from John Redmond Reservoir has only been required once (October 1987) since initial lake filling, but as discussed in Section 1.2, the auxiliary water pump(s) were used all but 16, 10, and 2 days in 1985, 1986, and 1987 respectively.

Stabilization of lake storage elevations has favored the development of submergent and emergent aquatic macrophytes. The small drainage area associated with the WCCL limits runoff into the WCCL which results in good water clarity, expanding the zone of submerged macrophyte colonization to depths up to 12 feet. Areas afforded wind protection by the baffle dikes and saddle dams, and along other protected shorelines have stands of Potamogeton and to a limited extent, Chara. Stands of cattails, Typha spp., also are continuing to develop. Establishment of aquatic macrophytes should benefit the cooling lake fishery by providing cover and shelter and could encourage production in the littoral zooplankton and macroinvertebrate communities.

Aquatic sampling locations were established upstream (Location 2) and downstream near the main dam (Location 6). Location 2, the location expected to be most affected by station discharges, was moved in 1982 from the old Wolf Creek channel near the makeup water discharge structure to an area adjacent to the creek channel, approximately 0.5 miles upstream of the 1981 location. This change was made to accommodate continued filling of the lake. Differences between these locations were typical of upstream and downstream reaches of reservoirs regarding depth and turbidity. Location 8, located east of Baffle Dike A (Figure 1-1) adjacent to the Ultimate Heat Sink, was added as an intake location for the 1984 study.

1.5 REFERENCES

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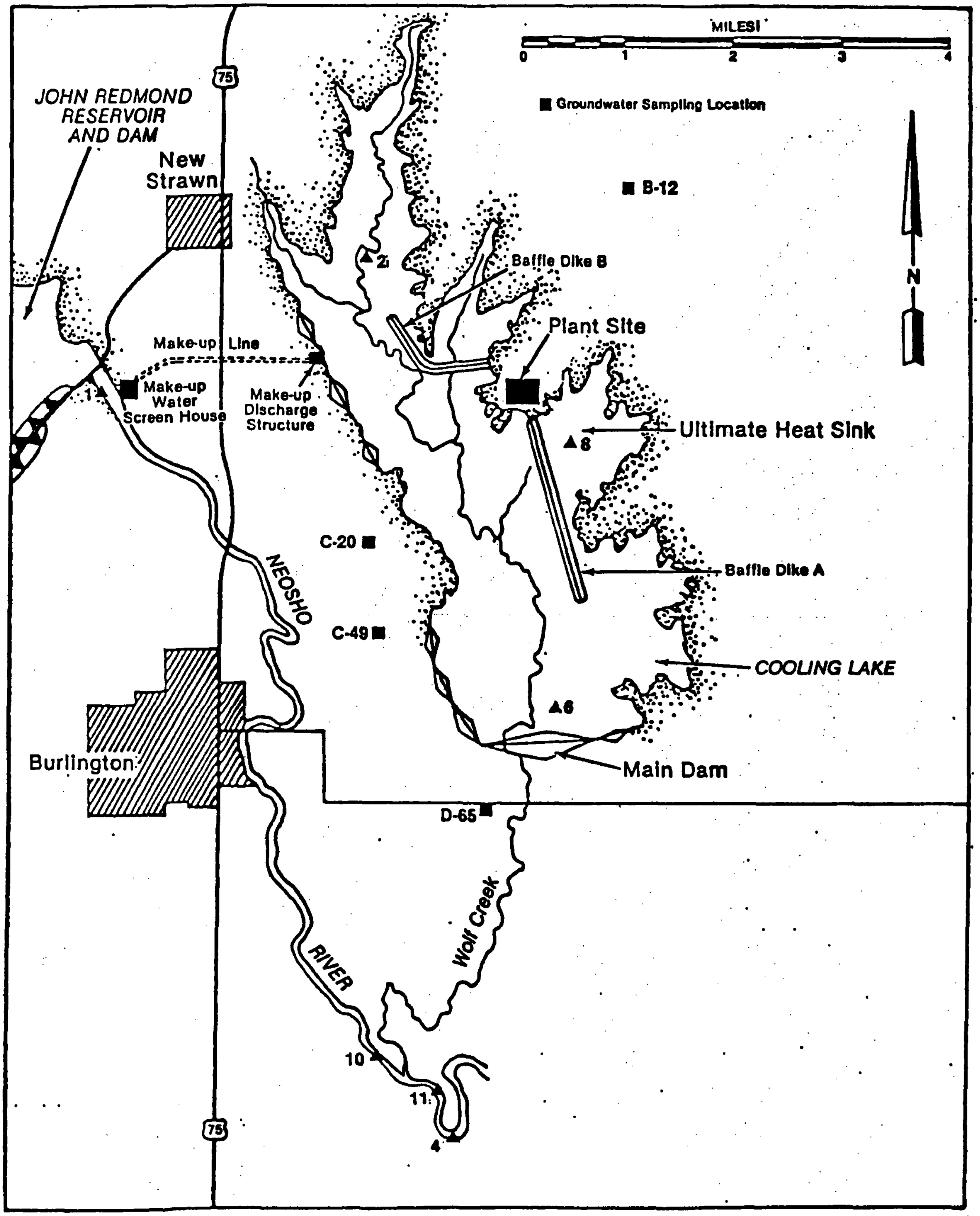

Figure 1-1. Aquatic sampling locations in the vicinity of Wolf Creek Generating Station.

TABLE 1-1 SUMMARY OF AVERAGE FLOWS (CFS) IN THE NEOSHO RIVER AT BURLINGTON, KANSAS, 1961-1987

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Mean
1961	-	-	-	-	-	-	2243	475	3627	1065	245	538	-
1962	2306	3521	2021	766	1414	4746	998	407	6599	1528	597	461	2090
1963	588	376	1154	378	318	664	686	69	31	50	87	82	374
1964	79	79	75	804	778	1639	135	99	32	32	1173	531	452
1965	318	360	1676	1321	324	9988	4211	151	4163	1065	245	538	2023
1966	493	547	418	1114	480	771	66	192	43	31	33	25	348
1967	21	23	25	514	65	2827	6944	557	1499	4583	966	635	1569
1968	544	340	211	1715	1162	2086	817	1917	115	1704	1741	997	1113
1969	1024	1231	2200	2603	6864	4066	7332	847	1189	1845	1085	1259	2645
1970	514	335	248	4402	2077	5156	424	75	724	1558	301	823	1381
1971	968	990	1771	235	1957	8449	4817	1263	42	78	1709	1428	1977
1972	487	332	103	454	4215	181	1604	188	154	45	235	941	753
1973	3578	5363	7637	7772	6203	3397	598	232	1342	11544	7543	3802	4913
1974	3039	1245	2368	2763	2759	3089	209	152	1330	413	2762	1390	1790
1975	1102	2444	2242	2723	771	6805	2342	186	345	124	93	653	1637
1976	228	60	50	359	3260	1363	1508	45	46	49	45	43	592
1977	45	46	47	48	1491	4862	6626	1114	1999	605	1923	484	1614
1978	300	812	2960	3484	1084	852	952	58	39	24	19	17	882
1979	18	437	3090	1493	558	2875	4085	587	129	68	983	575	1247
1980	355	904	1360	6308	499	171	150	53	58	36	18	26	819
1981	19	24	14	21	271	1786	3378	866	1032	537	4393	1801	1181
1982	513	4323	1330	610	4879	7385	1750	204	70	39	32	124	1748
1983	383	1092	736	6750	7741	5325	1344	70	39	31	268	735	2039
1984	436	847	3972	8191	4093	2813	1050	60	32	24	150	616	1852
1985	1105	695	5119	1191	3175	7187	1919	2537	3371	8510	6344	2807	3711
1986	785	2023	549	2083	2745	598	3343	1123	740	7931	2071	1631	2144
1987	860	2152	7581	3725	979	2294	1826	891	760	183	479	1965	1971

Note: Data from USGS gaging station except AUG-DEC 1987 data from WCGS water reports (JRR outflow).

TABLE 1-2 WEEKLY WOLF CREEK COOLING LAKE ELEVATIONS, 1982-1987

Month	Week	1982	1983	1984	1985[a]	1986[a]	1987[a]
JAN	1	1,079.5	1,087.0	1,087.0	1,086.6	1,088.2	1,087.6
	2	1,079.5	1,087.0	1,087.0	1,086.9	1,088.0	1,087.5
	3	1,079.5	1,087.0	1,087.0	1,087.0	1,087.8	1,087.6
	4	1,079.5	1,087.0	1,087.0	1,087.8	1,087.8	1,087.5
FEB	1	1,080.3	1,087.0	1,087.0	1,087.0	1,088.0	1,087.5
	2	1,080.3	1,087.3	1,087.0	1,087.0	1,088.0	1,087.5
	3	1,080.4	1,087.5	1,087.0	1,087.0	1,087.9	1,087.5
	4	1,079.5	1,087.8	1,087.0	1,087.3	1,087.5	1,087.5
MAR	1	1,080.4	1,087.8	–	1,088.0	1,087.5	1,088.0
	2	1,080.6	1,087.1	1,087.0	1,088.0	1,087.6	1,088.0
	3	1,080.8	1,087.5	1,087.0	1,088.0	1,087.5	1,088.0
	4	1,080.9	1,087.8	1,087.6	1,088.0	1,087.5	1,088.5
	5	–	1,087.8	1,087.0	1,088.1	1,087.4	1,088.0
APR	1	1,081.0	1,088.5	1,088.0	1,088.2	1,087.4	1,087.8
	2	1,081.3	1,088.4	1,088.0	1,088.2	1,087.5	1,088.0
	3	1,082.0	1,088.1	–	1,088.0	1,087.5	1,088.0
	4	1,082.4	1,088.3	1,088.4	1,088.0	1,087.5	1,088.0
	5	1,082.7	–	–	–	–	–
MAY	1	1,083.6	1,088.6	1,088.0	1,088.0	1,087.5	1,088.0
	2	1,084.8	1,088.2	1,088.0	1,088.0	1,087.5	1,087.5
	3	–	1,088.0	1,088.0	1,088.0	1,087.6	1,087.1
	4	1,086.5	1,088.4	1,088.0	1,088.1	1,087.6	1,088.0
JUN	1	1,087.5	1,088.5	1,088.0	1,088.2	1,087.7	1,089.0
	2	1,087.6	1,088.5	1,088.0	1,088.6	1,087.5	1,088.0
	3	1,087.6	1,088.5	1,088.6	1,088.7	1,087.2	1,088.0
	4	1,087.4	1,088.5	1,088.0	1,088.5	1,087.0	1,088.0
	5	–	–	1,088.0	1,088.2	1,087.0	1,087.5
JUL	1	1,087.5	1,088.2	1,088.0	1,088.1	1,087.0	1,087.5
	2	1,087.5	1,088.1	1,088.0	1,088.0	1,087.4	1,087.5
	3	1,088.0	1,087.4	1,087.7	1,088.0	1,087.5	1,087.5
	4	1,087.9	1,087.4	1,087.7	1,087.9	1,087.2	1,087.0
	5	1,087.8	–	–	–	–	–
AUG	1	1,087.8	1,087.4	1,087.5	1,087.6	1,087.0	1,087.1
	2	1,087.5	1,087.1	1,087.4	1,087.6	1,087.0	1,087.4
	3	1,087.5	1,087.3	1,087.3	1,087.5	1,087.0	1,087.3
	4	1,087.5	1,087.1	1,087.1	1,087.2	1,087.0	1,087.5
	5	–	–	1,087.0	1,088.0	1,086.9	1,087.4
SEP	1	1,087.5	1,087.0	–	1,088.0	1,086.6	1,087.2
	2	1,087.5	1,087.0	1,087.0	1,088.0	1,086.5	1,087.0
	3	1,087.5	1,086.6	1,087.0	1,087.8	1,086.5	1,087.0
	4	1,087.2	1,087.0	1,087.0	1,087.7	1,086.5	1,087.5
	5	1,087.2	1,087.0	1,086.5	–	–	–
OCT	1	1,087.0	1,086.5	1,086.5	1,087.5	1,087.1	1,086.5
	2	1,087.3	1,086.6	1,086.5	1,087.6	1,087.9	1,086.5
	3	1,087.0	1,086.6	1,086.5	1,088.4	1,087.4	1,086.4
	4	–	1,086.7	1,086.5	1,088.2	1,087.6	1,086.5
NOV	1	1,087.0	1,086.8	1,086.5	1,088.0	1,086.9	1,086.9
	2	1,087.1	1,086.6	1,086.5	1,088.1	1,087.5	1,086.5
	3	1,087.1	1,086.8	1,086.5	1,088.0	1,087.5	1,086.4
	4	1,087.0	1,087.0	1,086.5	1,087.9	1,087.5	1,086.2
	5	1,086.8	–	1,086.5	1,088.0	1,087.3	1,086.5
DEC	1	1,087.0	–	–	–	–	–
	2	1,086.8	1,086.1	1,086.3	1,088.0	1,087.4	1,086.6
	3	1,086.7	1,087.0	1,086.4	1,088.0	1,087.4	1,086.6
	4	1,087.0	1,086.5	1,086.4	1,088.0	1,087.6	1,087.2
	5	1,087.0	1,086.7	1,086.5	1,088.0	1,087.6	1,087.2

Note: Readings taken once per week.
(a) Weekly mean elevation.

2. WATER QUALITY

2.1 INTRODUCTION

Water quality studies have been conducted on the surface water and groundwater in the area of the WCGS since 1974. These studies were designed to provide a database reflecting existing water quality conditions which could be used as a comparison for conditions observed during construction and ultimately operation of the WCGS. Water quality parameters selected for analysis throughout the various study phases were chosen based on state water quality standards, drinking water standards and parameters predicted to change or be added to the system during operation as described in the operating license stage environmental report (ER-OLS) for this project.

2.2 METHODS

The selection of sampling locations for the study was modified over time as the scope of the study dictated (Table 2-1). Early years included sample collection in John Redmond Reservoir, the Neosho River and Wolf Creek. After January 1976 the John Redmond Reservoir location was dropped and samples were collected immediately below the dam in the tailwaters and at selected points downstream in the Neosho River. Samples were collected from the Wolf Creek watershed until 1981. Following closure of the cooling lake dam, Wolf Creek locations were changed to selected locations in the cooling lake. Two locations were sampled from 1981 through 1983 and three locations have been sampled from 1984 through 1987.

Groundwater samples for this study program have been collected from as many as 8 wells in a given study year. A total of twelve different wells have been used in the program. All wells sampled were existing, shallow aquifer wells that varied from hand dug and brick lined construction to drilled wells with steel or plastic casing. A list of the wells sampled each year is provided in Table 2-2. Starting in 1980 four wells were selected from the original group as the final set of groundwater monitoring wells for the project. These four wells B-12, C-20, C-49 and D-65 have been sampled each year since 1979. The parameters analyzed from groundwater samples were fairly consistent over the study period (Table 2-3).

Over the fourteen year period of this study as many as 41 individual analytical parameters have been determined for surface waters at one time or another. Table 2-4 provides a summary of the parameters and the number of samples of surface water analyzed each year of the study. In excess of 18,000 individual analyses were conducted on water samples, excluding quality control replicates and multiple dissolved oxygen and temperature data from surface to bottom profiles conducted in the cooling lake. Analytical methods used by laboratories conducting chemical analysis of water samples for these studies were generally the same throughout the study period. Methods used prior to 1979 were based primarily on Standard Methods for Water and Wastewater (APHA et al. 1971 and 1975). Beginning in 1979 methods also followed protocols established by the U.S. EPA (1979) in Methods for Chemical Analysis of Water and Wastes.

Starting with the 1980 study, bacteriological analyses were conducted using the delayed incubation method (APHA 1980). Water samples were filtered in an onsite laboratory, placed on holding media, and returned to EA's lab for incubation. During this same period the oil and grease solvent used for extraction was changed from hexane to freon to comply with U.S. EPA 1979 methods.

Selection of parameters for presentation in this summary report was first limited to those included in the ongoing studies at the WCGS. Next, parameters that were generally at or below analytical detection limits (e.g. oil and grease) were excluded. There were also a few parameters that exhibited a relatively narrow range of values (e.g. pH) or whose variability mimicked that of other parameters (e.g. specific conductance). Table 2-5 presents annual values for those parameters not selected for more detailed analysis. Graphical presentation of the remaining parameters consists of histograms and line drawings depicting annual mean concentrations of the river and lake and annual means by location. These data were evaluated for long term trends as well as comparisons of pre- and post-construction and preoperational and operation effects. In addition, data comparisons to state and federal water quality standards or criteria were conducted. Mean concentrations on each date for the combined location data from a given water body (Neosho River or Wolf Creek Cooling Lake) were plotted and are provided in Appendix A. These graphical representations provided a good understanding of the variability in analytic concentration over time and the expected seasonal changes in concentrations of parameters.

2.3 RESULTS AND DISCUSSION

2.3.1 Neosho River Surface Water

Throughout WCGS water quality studies, the general water quality in the Neosho River has been considered good. The major influences on solute concentrations as discussed in the past annual reports has been rainfall or snowmelt conditions and the volume of water released from the John Redmond Dam. Suspended matter in the water column as determined by total suspended solids often showed a direct relationship with levels of related solutes such as trace metals and nutrients. Annual mean concentrations of general water quality parameters such as color, manganese, chloride, potassium, pH, soluble silica, sodium, turbidity, soluble iron and specific conductance have shown very little variability throughout the study period (Table 2-5).

Water temperatures in the Neosho River showed expected seasonal variability (Appendix Table A-1). However, annual mean water temperatures varied little throughout the study and often reflected flow conditions (e.g. warmer temperatures were often observed during summer months with lower flow conditions than during summer months when flows were high).

Dissolved oxygen concentrations in the Neosho River varied seasonally as expected. Annual mean concentrations from 1974-1987 ranged from 9.1 to 11.2 mg/l. These concentrations are well above the minimum considered necessary to support aquatic life and meet applicable state and federal water quality criteria.

The data from the Neosho River do not reflect any direct construction or operational effects on water quality based on concentrations observed during these studies. A number of parameters exhibited a change in annual mean concentration after 1981. Although some of that change may be due to water system conditions, the changes more probably reflect the change in laboratories conducting the analysis. Interlaboratory difference is a known variable in all analytical situations and must be considered when evaluating the reported results.

Based on annual mean concentrations, total suspended solids (TSS), total alkalinity, calcium (Ca), magnesium (Mg), soluble orthophosphate ($O-PO_4$), total iron (Fe) and nitrate showed no consistent long term trend. TSS values were similar all years with the exception of 1981 and 1984 when annual mean concentrations were 2-3 fold higher than normal (Figure 2-1). The 1981 peak was the result of high values in April and October data at all river locations, while the 1984 peak appears to be the result of high values in February, particularly at Location 4. Spatially, there has been no indication of increased TSS values at Location 4 below Wolf Creek since VCGS operation began. Concentrations of Ca, Mg and $O-PO_4$ were lower in general after 1982 than earlier years (Figures 2-2, 2-3, 2-4). However, the concentrations do not show a distinct trend overall, and the lower values are probably related to the change in laboratories conducting the analysis following the 1981 study period. The actual differences in parameter concentrations before and after 1982 are generally not significant from a chemical standpoint. Orthophosphate levels generally rose from 1975 to 1981 in the river samples. However, the overall concentration levels of $O-PO_4$ in the river are low and the mean values presented in the figure represent values reported at or below the detection limit. The solute concentrations observed in the river are for the most part a reflection of the quality of water leaving the John Redmond Reservoir. Total iron levels were slightly higher in recent years in contrast to the solutes previously discussed (Figure 2-5). Total alkalinity (Figure 2-6) was higher than normal in 1987, but nitrate concentrations (Figure 2-7) have remained within the previously observed range of annual values. There have been no spatial differences in these parameters that suggest WCGS operation may be affecting water quality in the Neosho River.

Annual mean concentrations of total dissolved solids (TDS), sulfates, total organic nitrogen (TON), and total nickel (Ni) showed overall downward trends during the study period (Figures 2-8 to 2-11). TDS and sulfates concentration curves were most similar (Figures 2-8 and 2-9). Peak sulfate levels observed in 1976 and 1978 appeared to be due primarily to higher values in April and primarily February, respectively. Location 1 values were slightly higher than downstream locations. However, little spatial variability of sulfate has been noted overall during the study period (Figure 2-9). Total organic nitrogen (TON) levels peaked in 1984 and 1986 to levels about twice that normally observed in the river. The 1984 peak appeared to be caused by higher levels observed in April and August samples, while in 1986 higher than normal values were observed all year. During 1984, TON values were higher at Location 1 than downstream locations, while the levels observed at Locations 10 and 4 were higher in 1986 (Figure 2-10). For the most part, little or no spatial difference has been observed between Locations 10 and 4 for any of these parameters, indicating the construction and operation of VCGS has not altered water quality in the Neosho River.

Total nickel data is available only for the period 1983-1987. Concentrations rose from 1983 to 1985, then dropped dramatically in 1986, and 1987 levels were slightly below the 1986 values (Figure 2-11). The high 1985 values may reflect the higher than normal flow conditions observed during much of the 1985 study period. As was observed for most parameters, releases from JRR (Location 1) appeared to control nickel concentrations in this segment of the river, and there were no major spatial differences between Locations 10 and 4, above and below Wolf Creek respectively.

Annual mean concentrations of ammonia have varied throughout the study period in a somewhat cyclic manner (Figure 2-12). Overall there was a slight upward trend in the data; however, the ammonia concentrations observed were low. Peak levels were observed in 1979 and reflect higher values at all locations, particularly in February of that year when discharge from John Redmond Dam was less than 1 cfs. Chemical oxygen demand (COD) and biochemical oxygen demand (BOD) levels followed the same trend of generally increasing values through 1984 then dropped off to near pre-1980 levels in 1985 (Figures 2-13, 2-14). Both parameters showed less variability in annual mean values in the 1974-1979 period. Both parameters peaked in 1984, and this peak appeared to be due primarily to higher values at Location 1 (particularly for COD) during February of that year. Overall the levels of BOD and COD observed in the Neosho River are low and are not indicative of heavy organic loading. The oxygen demand values observed after 1981 may also partially reflect the change in the laboratory conducting the analysis.

Copper (Cu) data is available from 1974 through 1987, while chromium (Cr) data is available for the 1983-1987 period only (Figures 2-15, 2-16). Both of these parameters were analyzed as total metals and therefore reflect the concentrations in the sample due to dissolved metals in the water as well as any metals in sediment or residue contained in the water column at the time of sampling. Copper showed little variation in annual mean concentrations from 1974-1981 then began to rise through 1984 (Figure 2-15). Overall the levels of Cu have shown a slightly increasing trend throughout the study. The observed concentration was higher following the 1981 study period and may reflect the change in analytical laboratories. Chromium concentrations peaked in 1985 at all three river locations.

2.3.2 Cooling Lake Water Quality

Water quality sampling in the WCCL began in February 1981 at Locations 2 and 6. Sampling at a third location (Location 8) began in February 1984. Since that time all three locations have been sampled. Water quality of the WCCL during the 1981 sample year reflected primarily the quality of water pumped into the lake from the Neosho River. In addition the concentrations of solutes that were associated with sediment and soils were higher in the lake due to the scouring effects of the pumped water flowing into the lake. As with the water quality in the Neosho River only selected parameters are discussed in the text of this report. Table 2-5 provides a summary of annual mean concentrations of parameters that due to either the consistency of the data, low concentrations, or the fact that they may have been sampled for only a short period of time are not discussed in detail elsewhere in this report.

Review of the data in Table 2-5 indicated that for the parameters presented the concentrations of these analyses in the WCCL have changed very little during the 1981-1987 period. One exception to that observation is the turbidity levels in the lake. As expected during the 1981 lake filling stage, turbidity levels were 2-3 fold higher than following years due to the disturbance of soils during pumping and also the use of river water to fill the lake.

During the 1981 lake filling phase a number of parameters were much higher than subsequent years. Total suspended solids, TDS, sulfates, calcium, total iron, orthophosphate and nitrate levels were all relatively high in 1981 (particularly at Location 2). This 1981 peak reflected concentrations of these parameters in the Neosho River water used to fill the WCCL.

Following the 1981 lake filling a number of parameters have shown little change in concentration in the lake over the seven year study period. Total alkalinity (Figure 2-6), magnesium (Figure 2-3) and ammonia (Figure 2-12) levels were not substantially higher in 1981 but rather have maintained a generally constant level in the WCCL. Alkalinity increased in 1987 as did ammonia levels; however, the change in actual concentrations was small. Nitrate levels after the 1981 peak dropped to an annual mean level of 0.1 to 0.2 mg/l and have stayed in that range throughout the study (Figure 2-7).

Annual mean concentration of total suspended solids (Figure 2-1) and total dissolved solids (Figure 2-8) declined significantly after the 1981 lake filling phase and have continued to decline slightly over the 1982-1987 study period. Calcium levels have declined more gradually over the 1981-1987 period (Figure 2-2). BOD and COD also have shown a declining trend (except COD in 1987). Levels of these two indicator parameters have been generally low throughout the study period (Figures 2-13 and 2-14). COD concentrations have been less consistent than BOD as was the case in the Neosho River data. This may reflect analytical precision more than it does actual water body differences in COD levels. COD values reported from four eastern Nebraska reservoirs ranged from 2.9 to 104 mg/l but usually were in the 15 to 20 mg/l range (Ukpaka 1971). At Sutherland Reservoir in western Nebraska, BOD and COD seasonal values respectively ranged from 2.0 to 3.5 mg/l and from 0.7 to 6.5 for the period 1972 through 1984 (EA 1985).

Analysis of water samples for nickel began in 1983 in the WCCL. The concentration in 1983 was the highest observed in the lake to date. Subsequently the observed values have tended to be lower each year (Figure 2-11). An exception to that trend occurred in 1985 when the higher values appeared to be due to samples collected in December of that year. The overall difference in solute concentration observed in nickel and other trace metals was small because the data is presented in µg/l levels or parts per billion. Very minor matrix differences in samples can cause seemingly large differences in concentrations for these parameters. In addition, these data are for total metals and therefore reflect both dissolved material in the water as well as metals that were adsorbed to residue in the water sample and are therefore not immediately available as a solute in the water matrix.

Annual mean concentrations of total iron and sulfates (Figures 2-5 and 2-9) peaked in 1981, dropped significantly in 1982 and have since shown very slight increases in concentration over time. The observed differences in concentration were very low as with most solutes studied in the lake. Soluble orthophosphate levels also dropped from a 1981 peak. However, the concentrations continued to drop slightly through 1984 and have since shown a slightly increasing trend (Figure 2-5). The high values observed in 1986 were the result of higher values in August, primarily at Location 2. Orthophosphate levels also reflected higher than actual concentrations, because concentrations reported as less than the analytical detection limit were plotted assuming that value.

With two exceptions annual mean levels of total organic nitrogen (TON) have been very stable (Figure 2-10). TON levels in the WCCL increased in 1982 and 1986 by 2-3 fold the usual level. Both of these peaks were observed during the March/April period and probably reflect resuspension of nitrogen-containing materials during spring turnover.

Two trace metals exhibiting increased annual mean concentrations in WCCL were copper and chromium. Annual mean copper values have generally increased steadily since lake filling (Figure 2-15). Copper levels increased considerably in 1985 and, though lower in 1987, were still higher than previously observed. The higher values for 1986 were observed throughout the year and were observed at all locations, although Location 2 levels were higher than those at 6 and 8 in both years (Figure 2-15). Total chromium levels increased by 10 fold in 1985 within WCCL. The annual mean levels observed in the lake were high at all three locations, and the highest values were recorded in December of 1985 when replicate values were in excess of 100 μg/l. Unusually high chromium values were also observed in the Neosho River for the same period (Figure 2-16) and the data were considered suspect. If the December 1985 data were eliminated from the calculation of annual means, the peak in 1985 would be in the range of 3.8 μg/l rather than 22 μg/l as plotted. As with orthophosphate values, plotted data for copper and chromium reflect data points that were recorded at less than the analytical detection limits, but for calculation purposes were assumed to be observed at the detection limit concentration.

Average lake surface water temperatures were higher during preoperational and operational periods than during lake filling (Figure 2-17). The only exception to that trend was in April sampling at Locations 2 and 6 during 1981, when higher temperatures probably resulted from shallow water depth and the influence of pumped water from the Neosho River. On the average, lake surface has been 1.0 to 5.5 degrees C warmer during plant operation than in the preoperational period. Spatially, temperatures at Location 2 have increased the greatest (3.5 to 7.8 C); Location 6 temperatures have increased by 0.5 to 5.8 C, and Location 8 by 1.5 to 3.5 C. The greatest temperature increases were observed in April. Winter operational temperatures were similar to preoperational temperatures. A scheduled WCGS outage generally occurs during this period and heat loading to the lake is thus reduced.

Depth profiles in WCCL indicated that water temperatures generally decreased with depth. Location 6, being the deepest location, best illustrated temperature changes with depth (Figure 2-18). Temperature differentials in most months were very small, but summer temperatures at Location 6 varied by as much as 9.5 C between surface and bottom (June 1987).

Dissolved oxygen profile data collected from 1985 through 1987 indicated that D.O. also generally declined with depth (Figure 2-19). Review of the profiles at Location 6 indicated that the greatest decline in D.O. occurred during summer months. Dissolved oxygen was generally well above the levels necessary for the protection of aquatic species in the upper level of the VCCL. However, at depths below 10 meters, D.O. was at or near zero mg/l in July of 1985 and 1986 and in June 1986 and 1987. In all years concentrations rose to above 5 mg/l by the August sampling period. The decline in dissolved oxygen during the summer period reflected the effects of warm summer water temperatures and static deep water conditions, a combination of factors that often is conducive to D.O. depletion.

2.3.3 Groundwater Quality

Mean concentrations of water quality parameters in groundwater samples collected in 1987 were within the range of concentrations observed in previous years with few exceptions. Concentrations of hardness, chloride and magnesium were lower in well D-65 than in any previous year as were sulfate concentrations in B-12 and C-49 (Table 2-6). Total iron in well C-49 and specific conductance in wells C-20 and D-65 were also lower than previously observed. Nitrates and soluble iron concentrations were higher in wells D-12 and C-49, respectively, than in previous years. As in previous years, well D-65 generally had the highest levels of dissolved constituents and well C-49 the lowest. The water quality in wells B-12 and C-20 was generally similar. Groundwater quality with the possible exception of well C-49, reflected the age and condition of the wells and the influence of surface water inflows during wet periods.

National Primary Drinking Water Criteria for nitrates (10 mg/l) has been exceeded in all four wells at various times during the 11 year study period. The National Secondary Drinking Water Standard for TDS (500 mg/l) was exceeded during all sample periods in all wells. The chloride criteria (250 mg/l) was exceeded in well D-65 in all years except 1987 and in one or more years in all other wells. The total iron criteria (0.3 mg/l) was exceeded most years in all wells except C-49. Well water collected for this study has consistently been very hard with high levels of dissolved constituents. These observations have not changed since WCCL was filled or since WCGS began operation. Thus to date there appear to be no effects on groundwater quality due to WCGS in the areas covered by these four groundwater monitoring wells.

2.4 SUMMARY AND CONCLUSIONS

2.4.1 Neosho River Water Quality Studies

Water quality studies in the Neosho River near the WCCL have been conducted since 1973. Seasonal mean concentrations of water quality parameters during 1987 were within previously established ranges for the study area. Water quality among river locations was similar though slight natural differences between the John Redmond Reservoir tailwaters (Location 1) and the lower river (Locations 4 and 10) were apparent. Seasonal differences observed during 1987 and previous years reflect changes in discharge rates from John Redmond Dam and runoff due to local precipitation and snowmelt events. Since filling of the WCCL began in 1981, flows from Wolf Creek into the Neosho River have been limited to seepage, releases for testing of blowdown procedures, and runoff events. There have been no apparent deleterious effects to water quality in the Neosho River due to operation of WCGS based on available water quality monitoring data.

2.4.2 VCCL Water Quality Studies

Water quality studies of the VCCL began when the lake was initially filled during 1981. Water quality was greatly influenced by makeup water being pumped from the Neosho River during that year. Since 1981 makeup water has generally been added during routine use of the auxiliary raw water pumps and quarterly testing of the makeup water pumps. Therefore, the VCCL water quality has been generally independent from influence of the Neosho River. Concentrations of water quality parameters are very similar among locations in the cooling lake, with the shallow upstream site (Location 2) slightly different in water quality than near the main dam (Location 6) and the station intake (Location 8). Concentrations of dissolved and suspended constituents continued to show declining trends since operation of the VCCL began, indicating an improvement in overall water quality. Surface water temperature in the cooling lake during spring and summer periods has been warmer than in preoperation years (particularly Location 2) as is expected due to plant operation. There appears to be a slight trend of increasing concentrations of iron, chromium, copper and sulfate in the cooling lake; however, this trend does not appear to indicate adverse impact from plant operations but rather natural changes in impounded water.

2.4.3 Groundwater Studies

Groundwater data collected near WCGS since 1973 have shown that quality of well water varied widely among wells. Data collected during 1987 indicated water quality parameters from the monitoring wells were within concentration ranges observed in previous studies with few exceptions; some dissolved constituents

(Cl, Mg, and Fe) were lower in one or more wells in 1987 than in previous years. Well water at the monitoring sites has typically been very hard with high levels of dissolved constituents. Water quality in the wells tends to reflect shallow perched water resulting from precipitation and runoff. These observations have not changed since dam closure for the VCCL or after VCGS began operation.

2.5 REFERENCES

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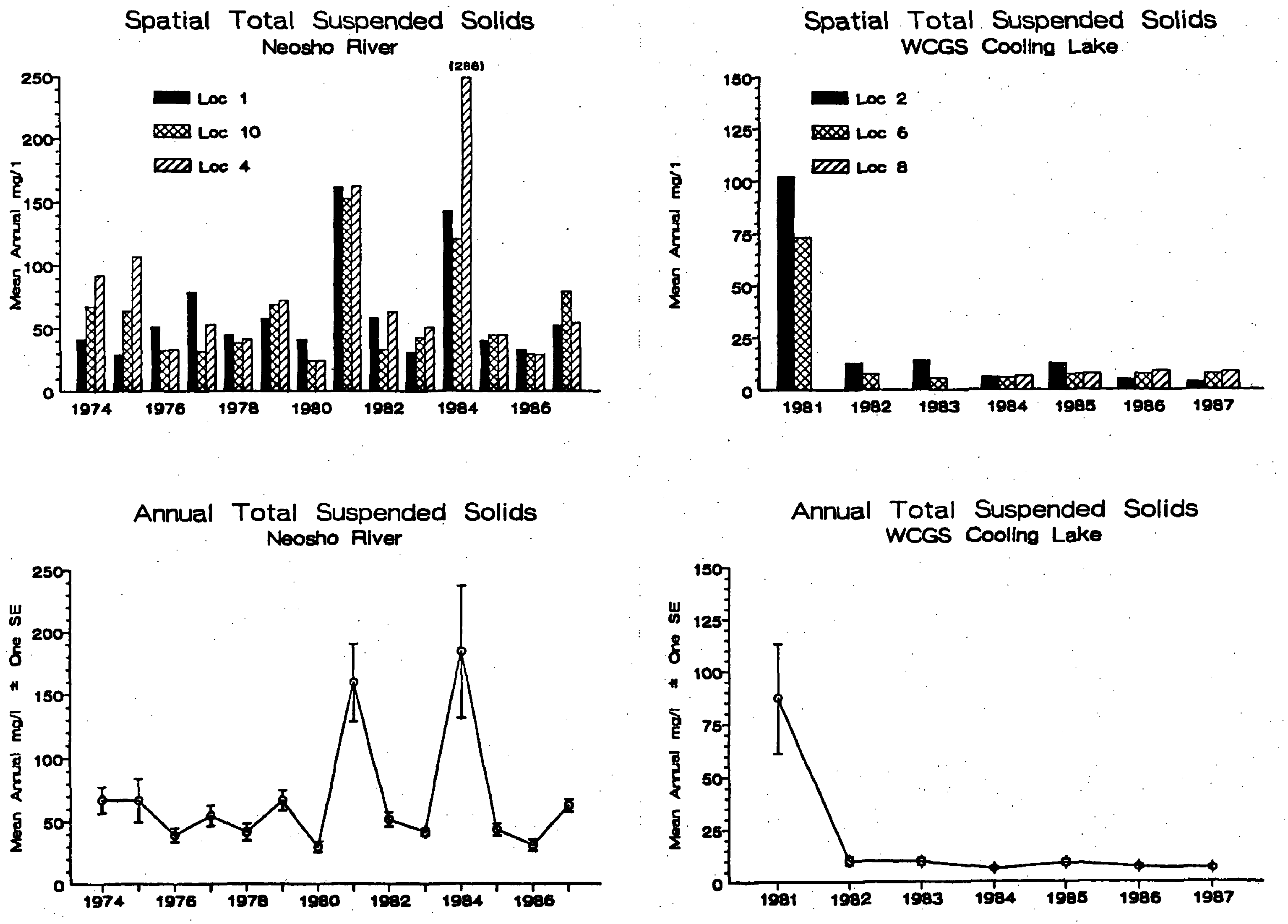


Figure 2-1. Total suspended solids in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

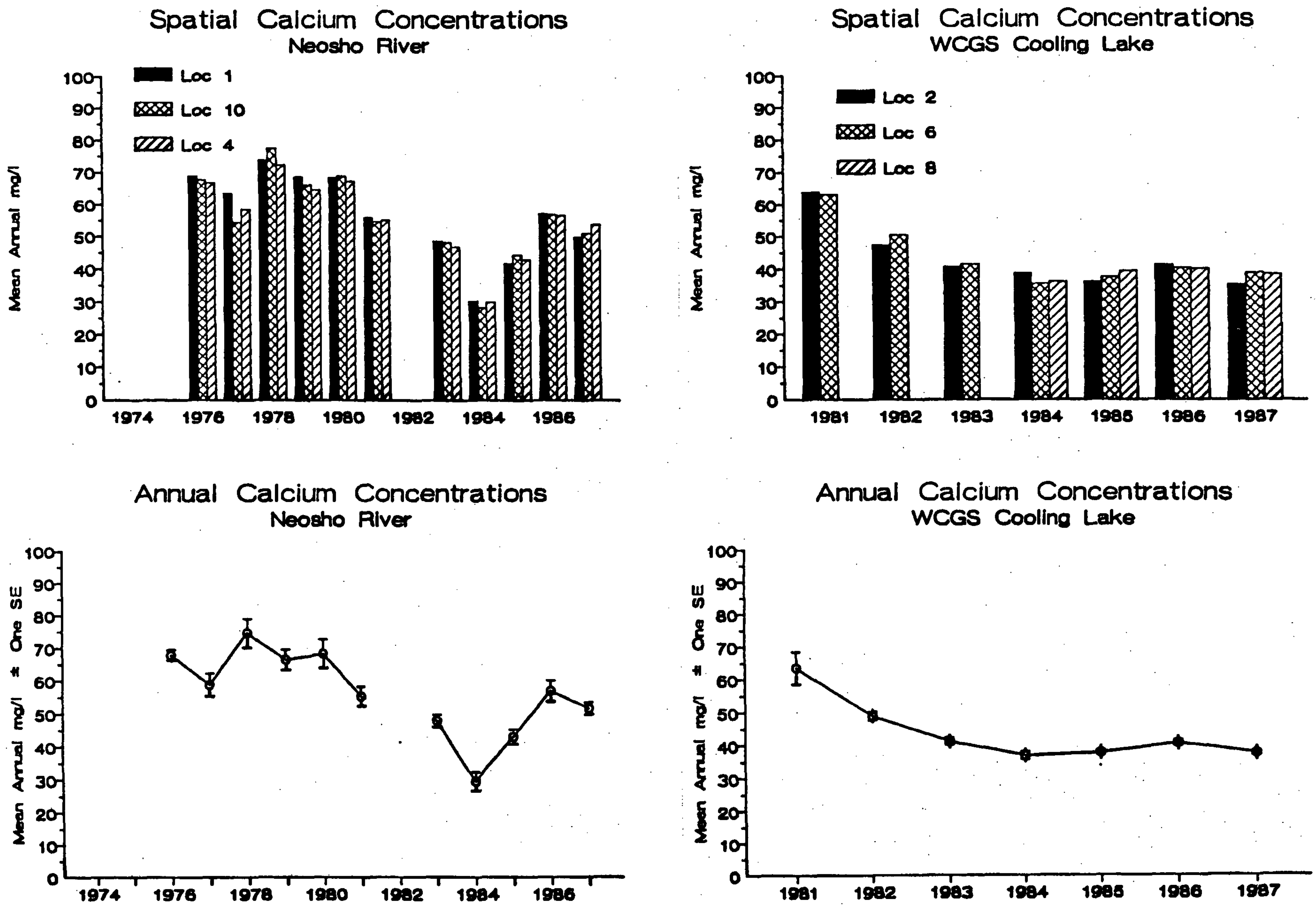


Figure 2-2. Calcium concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

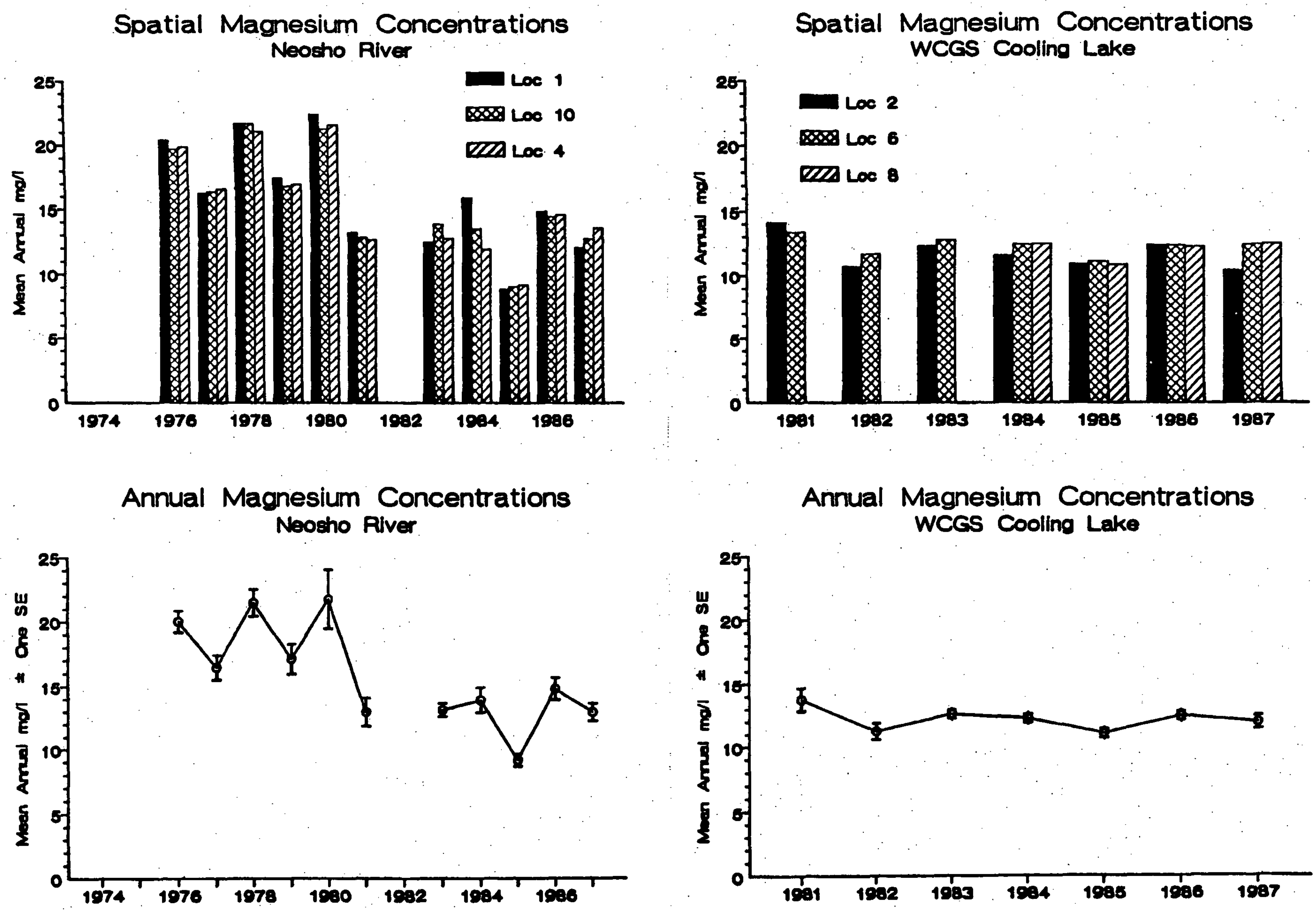


Figure 2-3. Magnesium concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

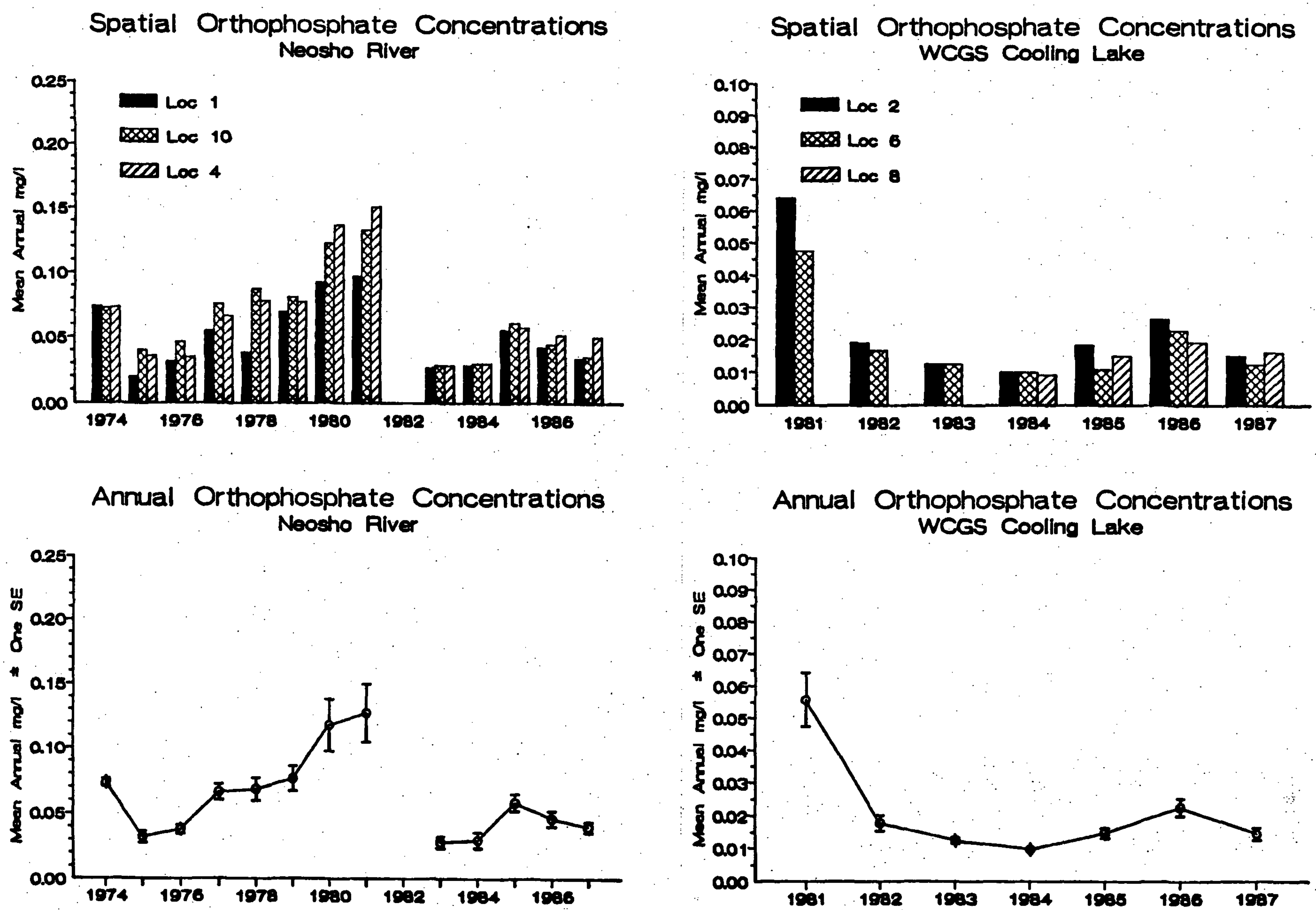


Figure 2-4. Soluble orthophosphate concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

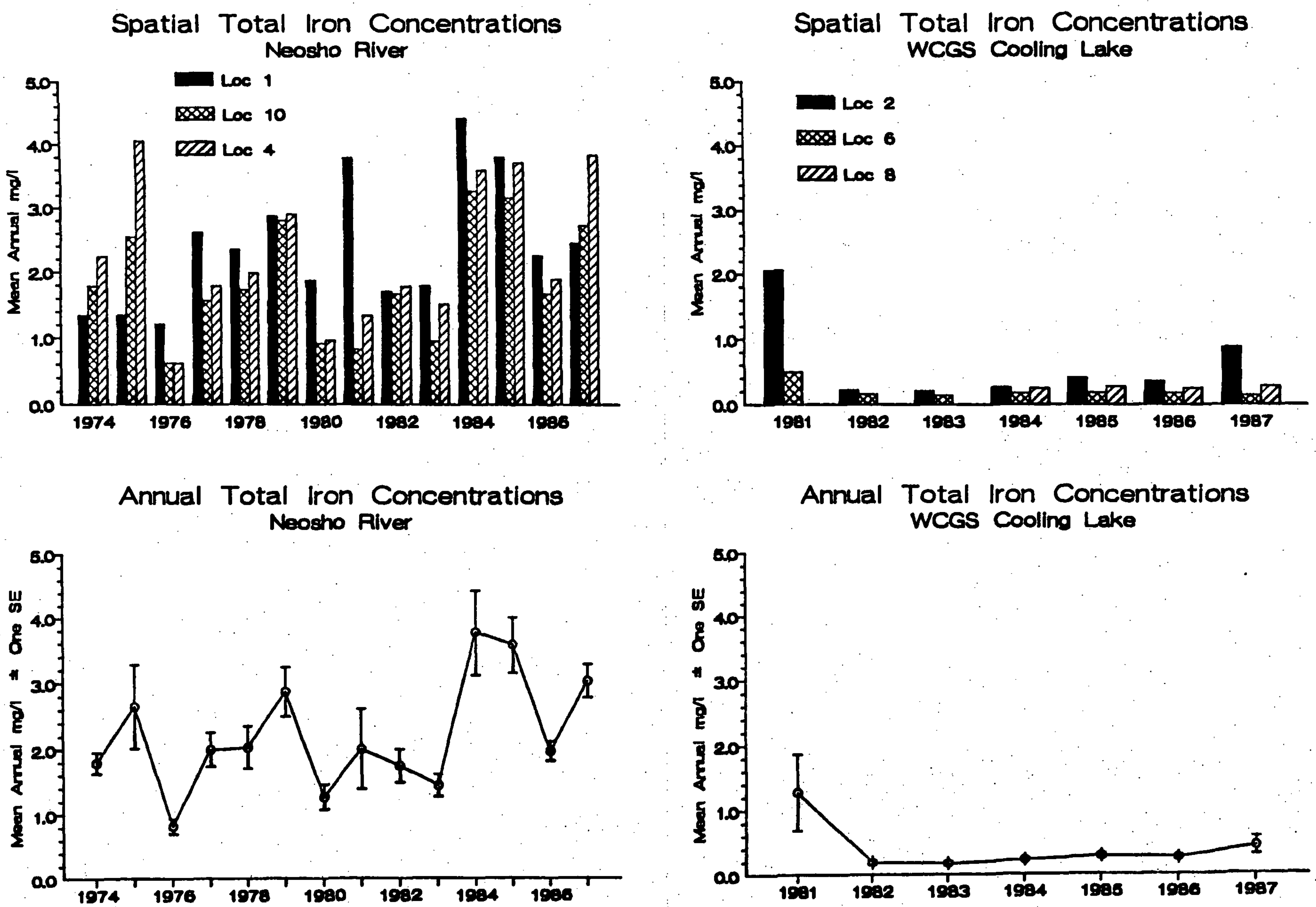


Figure 2-5. Total iron concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

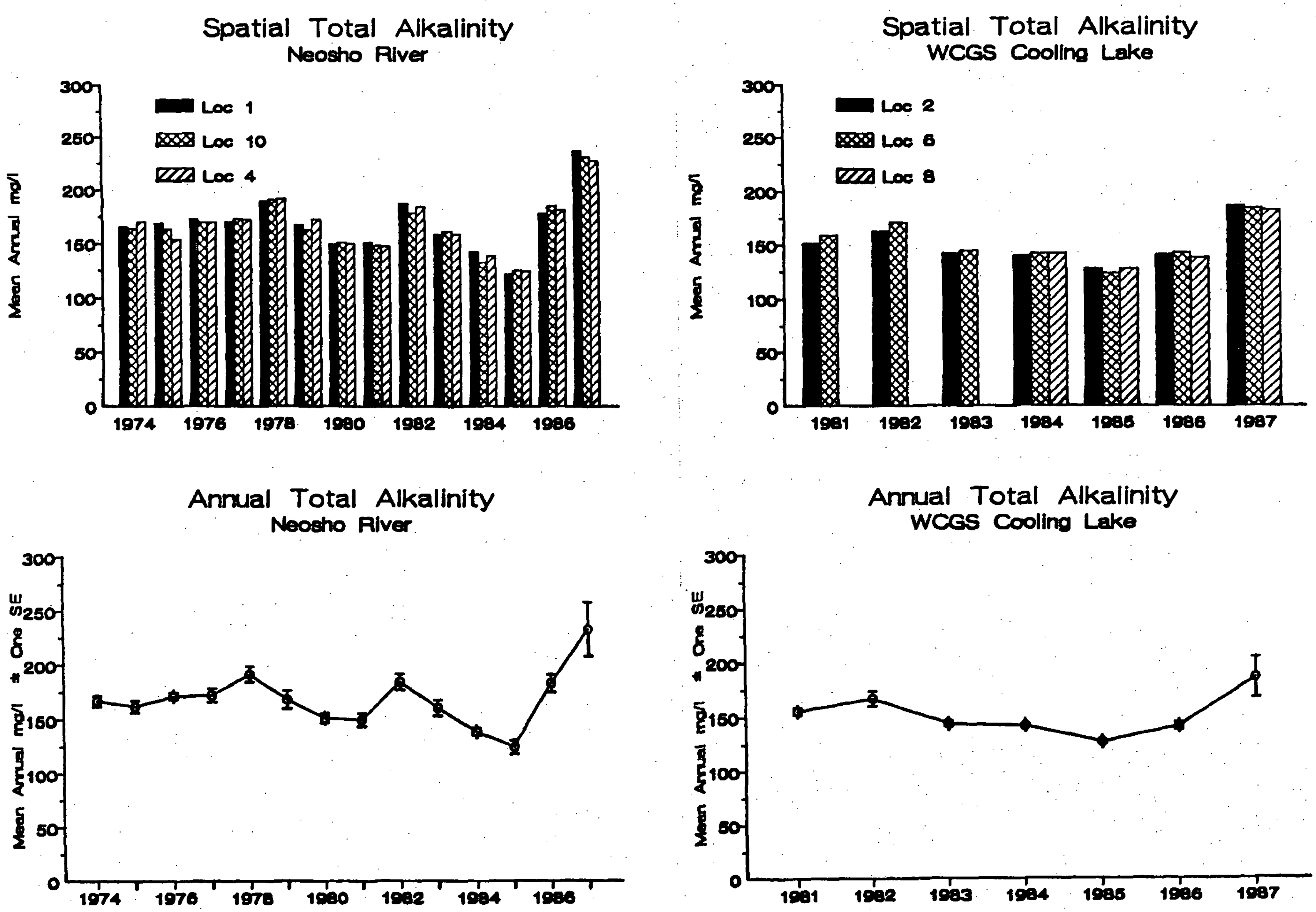


Figure 2-6. Total alkalinity concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

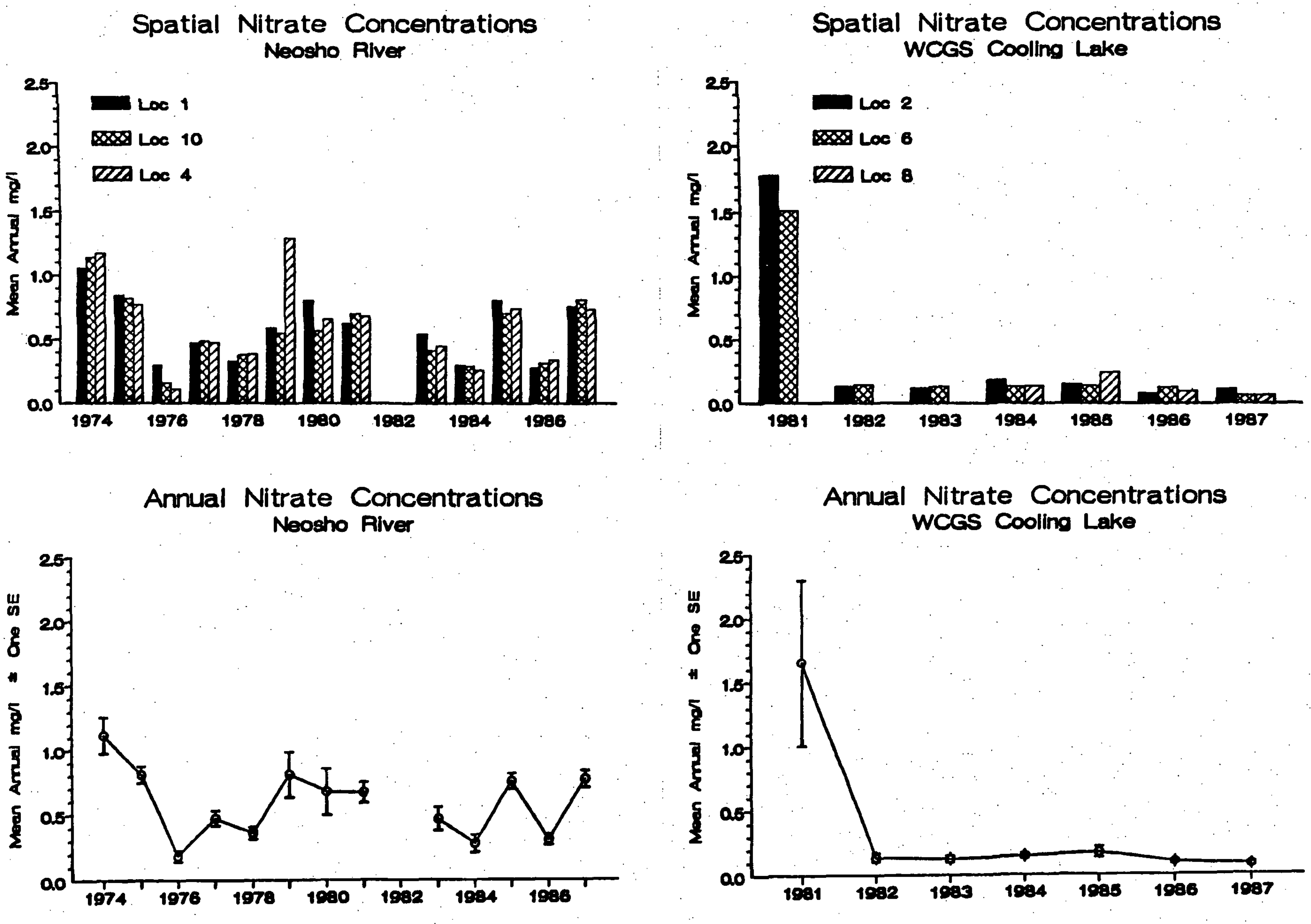


Figure 2-7. Nitrate concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

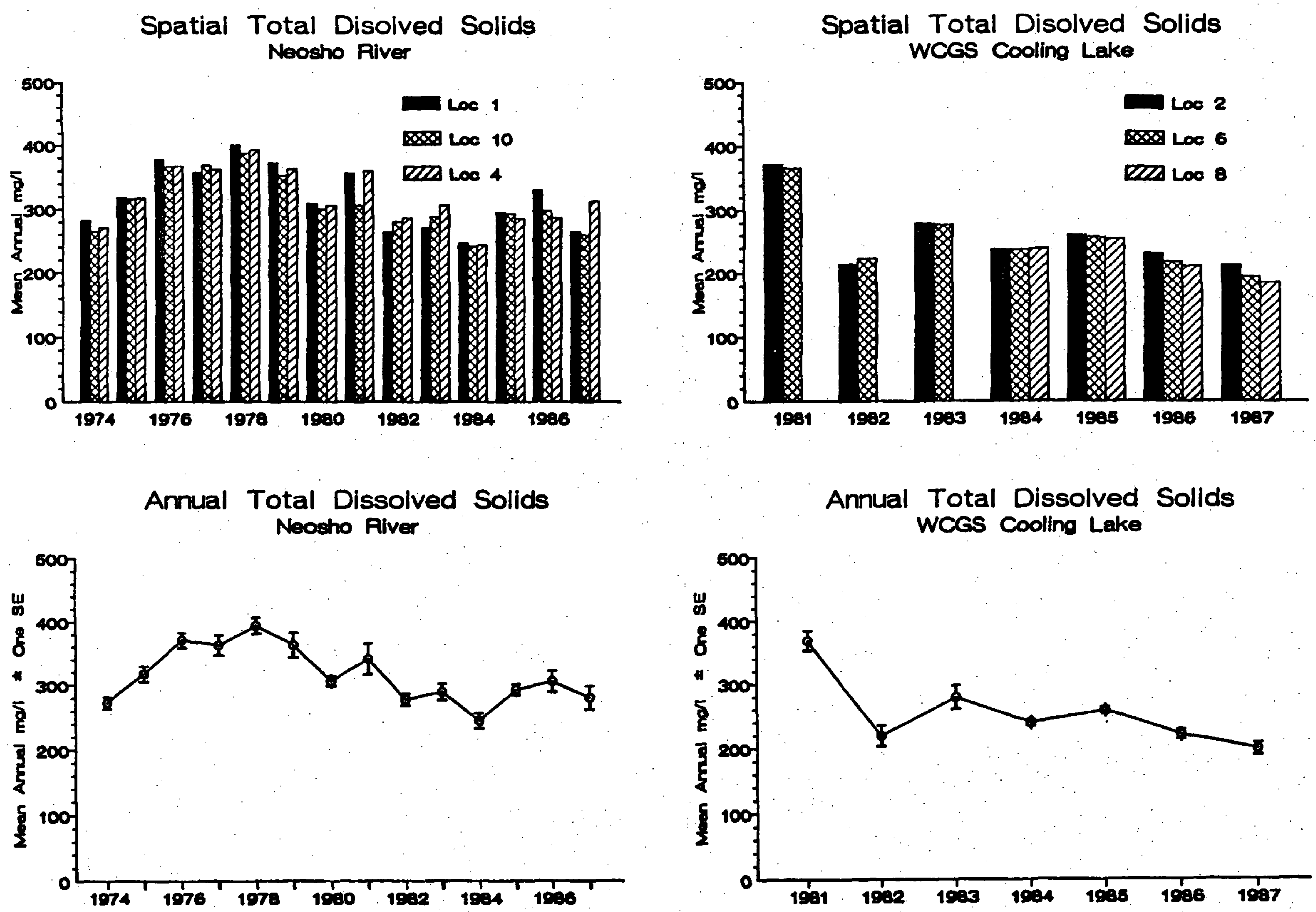


Figure 2-8. Total dissolved solids in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

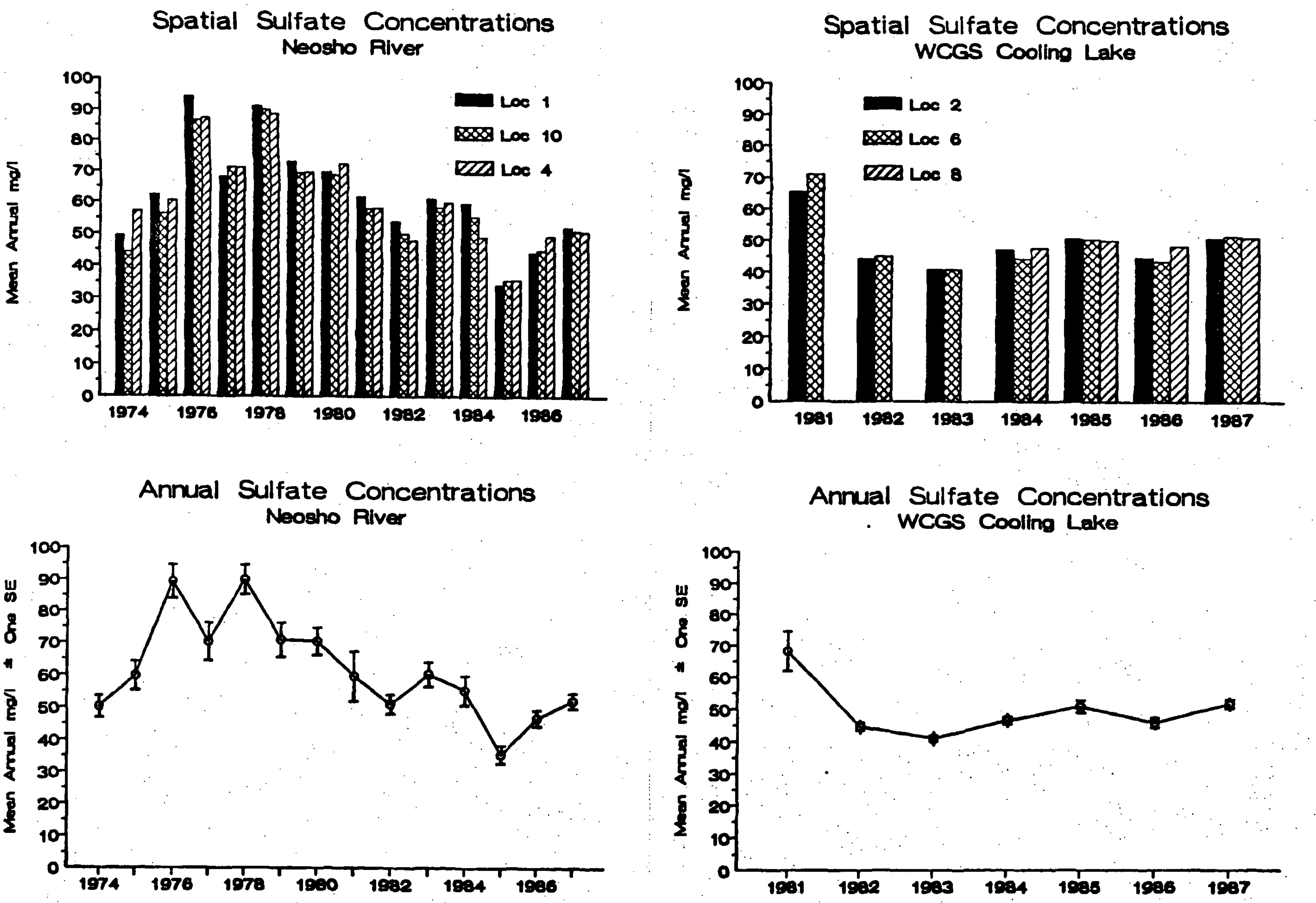


Figure 2-9. Sulfate concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

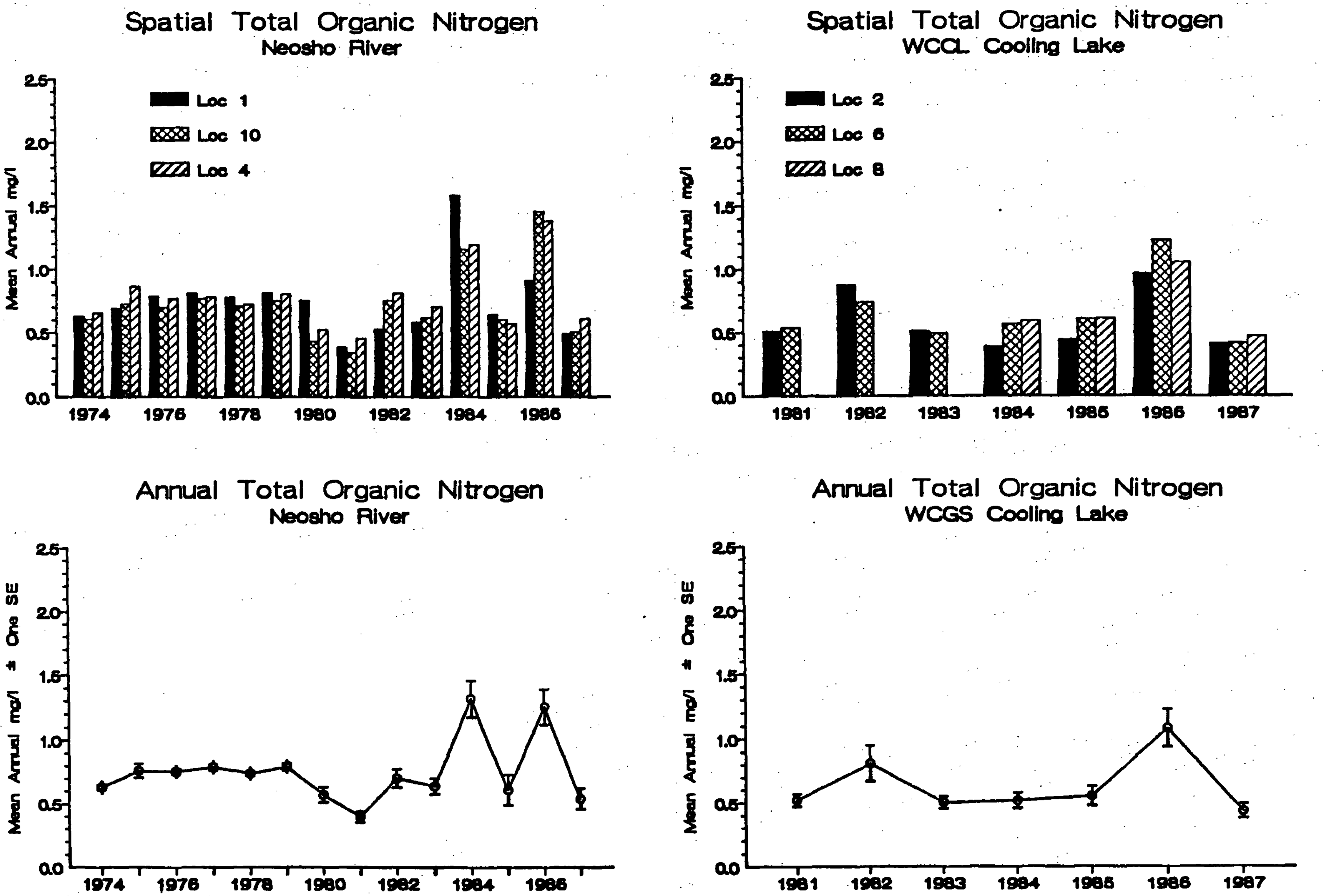


Figure 2-10. Total organic nitrogen concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

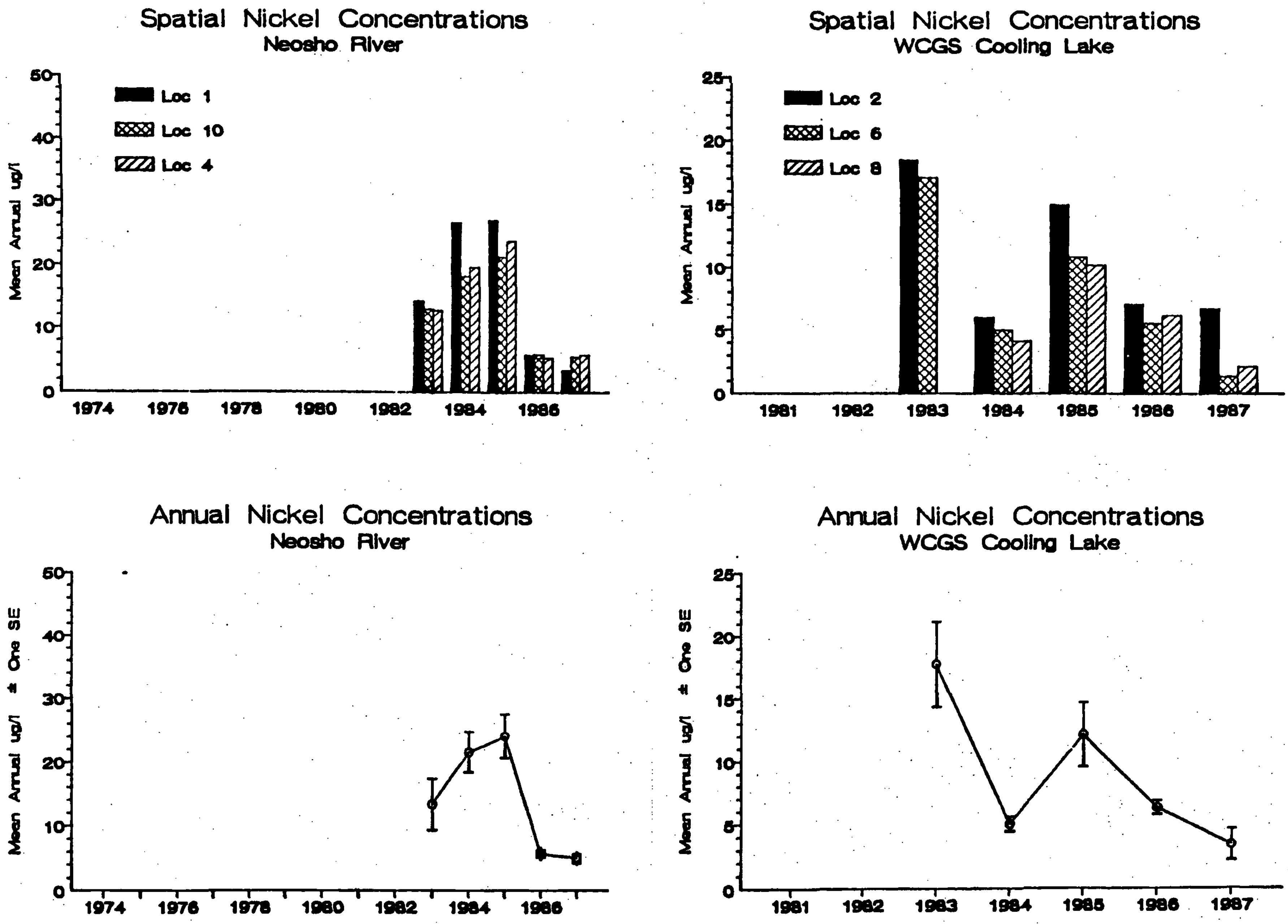


Figure 2–11. Nickel concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

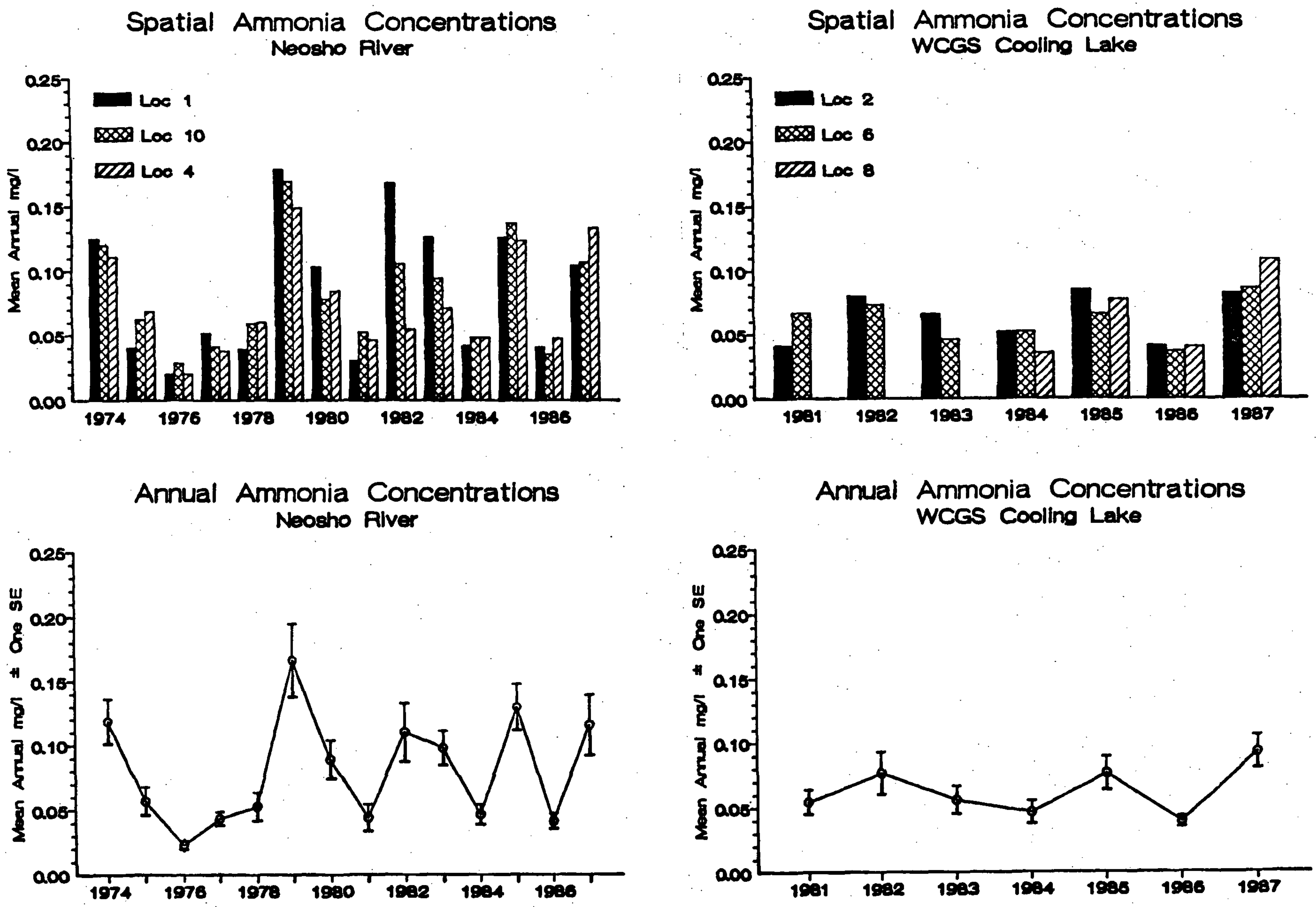


Figure 2-12. Ammonia concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

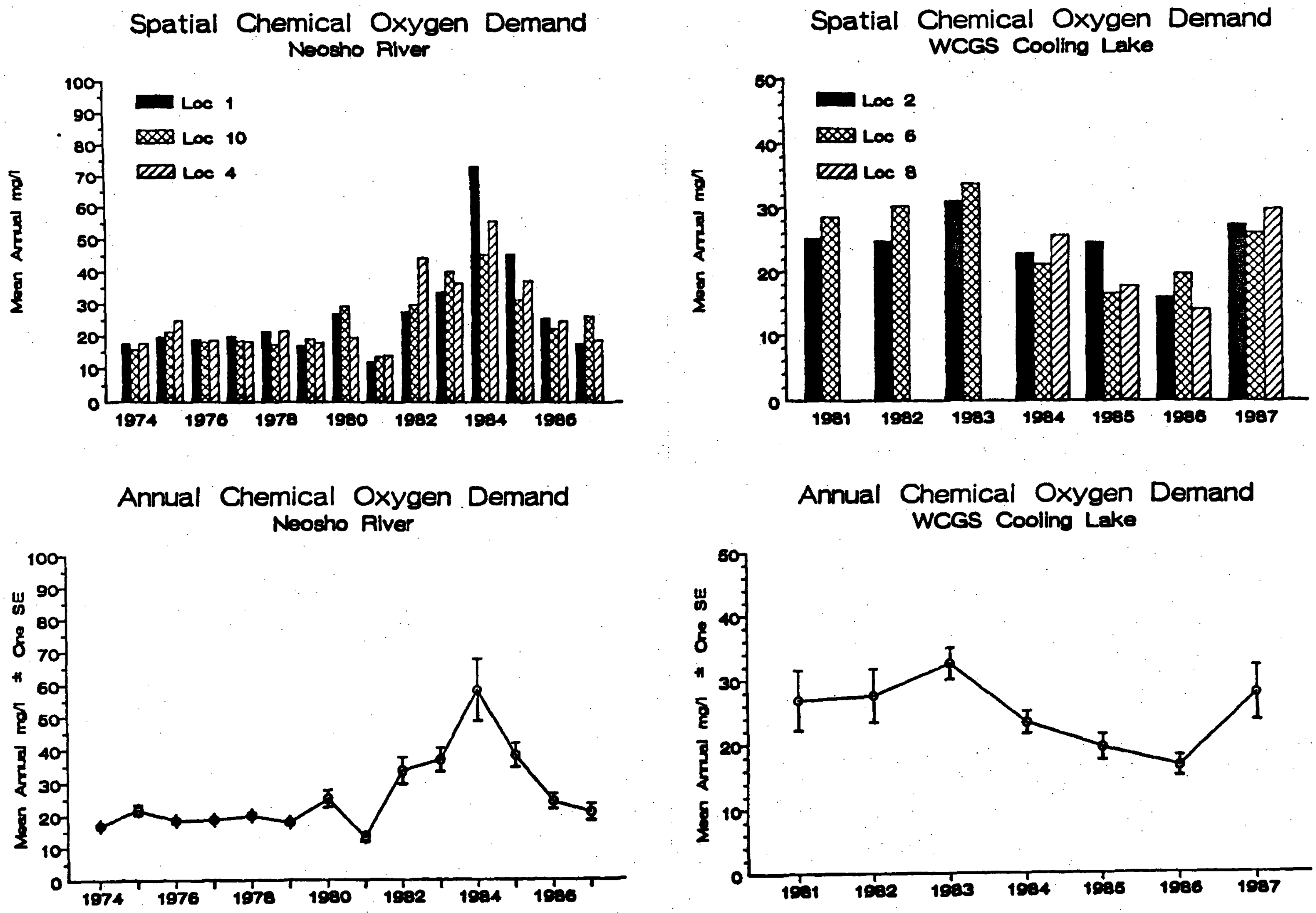


Figure 2-13. Chemical oxygen demand in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

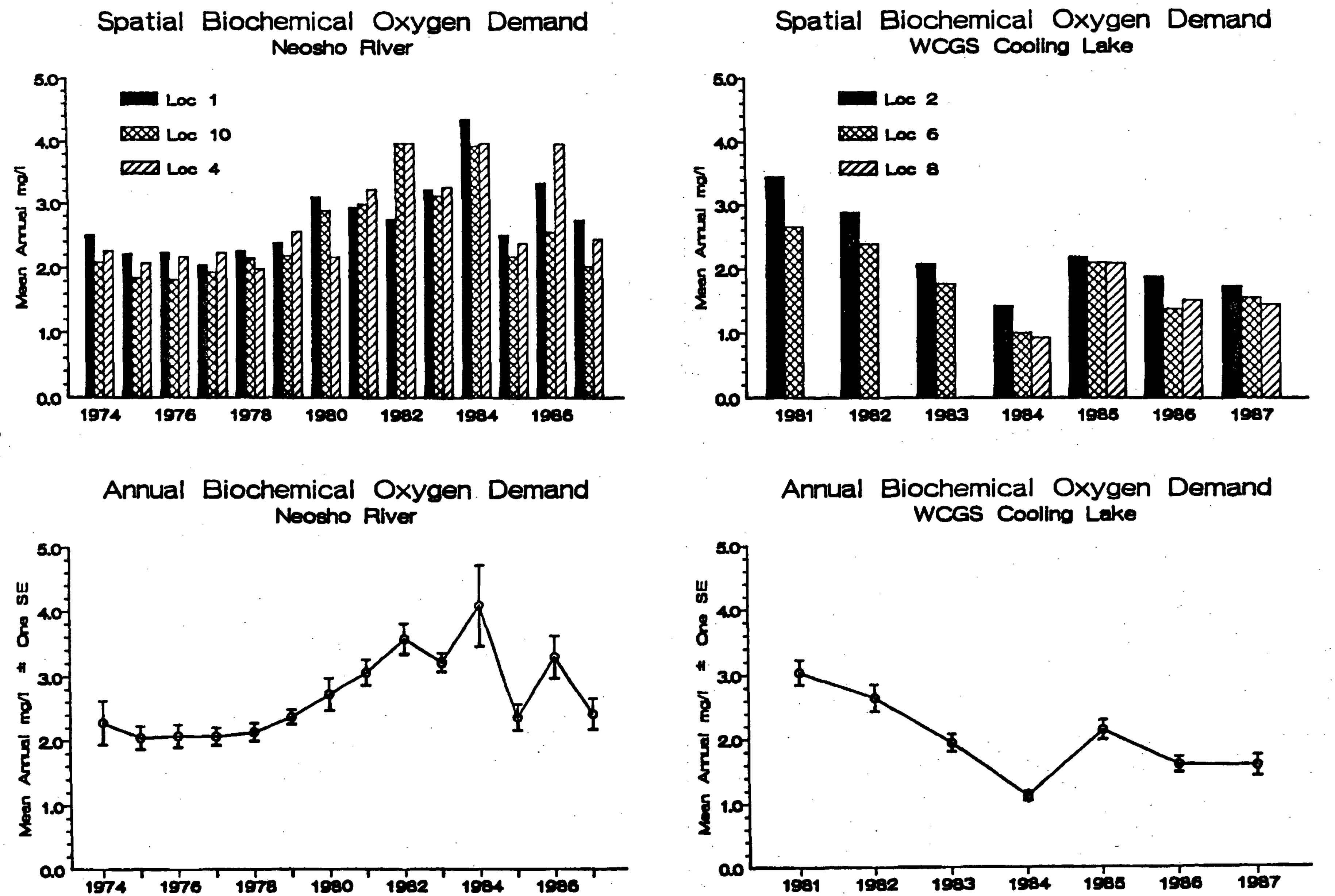


Figure 2–14. Biochemical oxygen demand in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

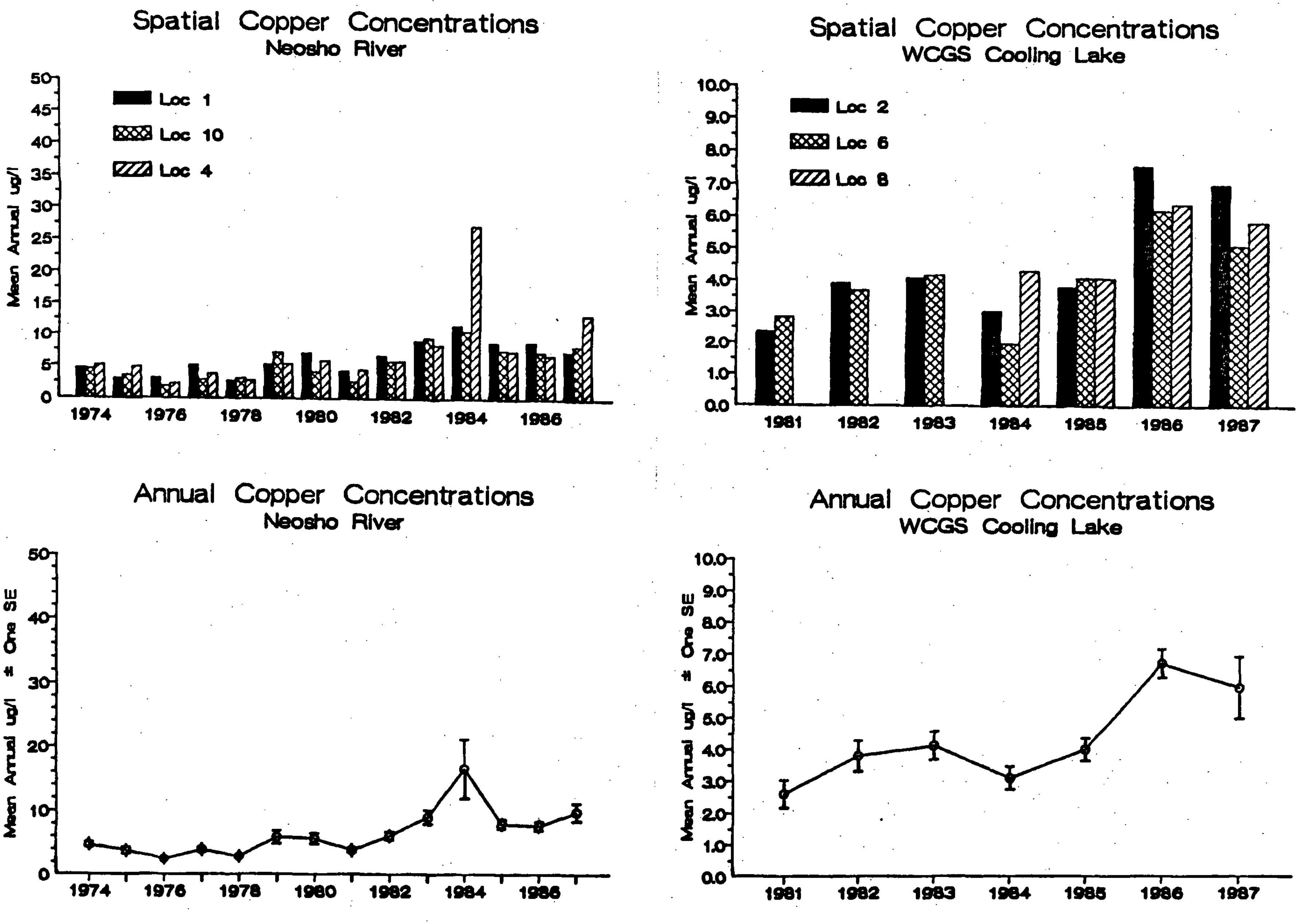


Figure 2-15. Copper concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

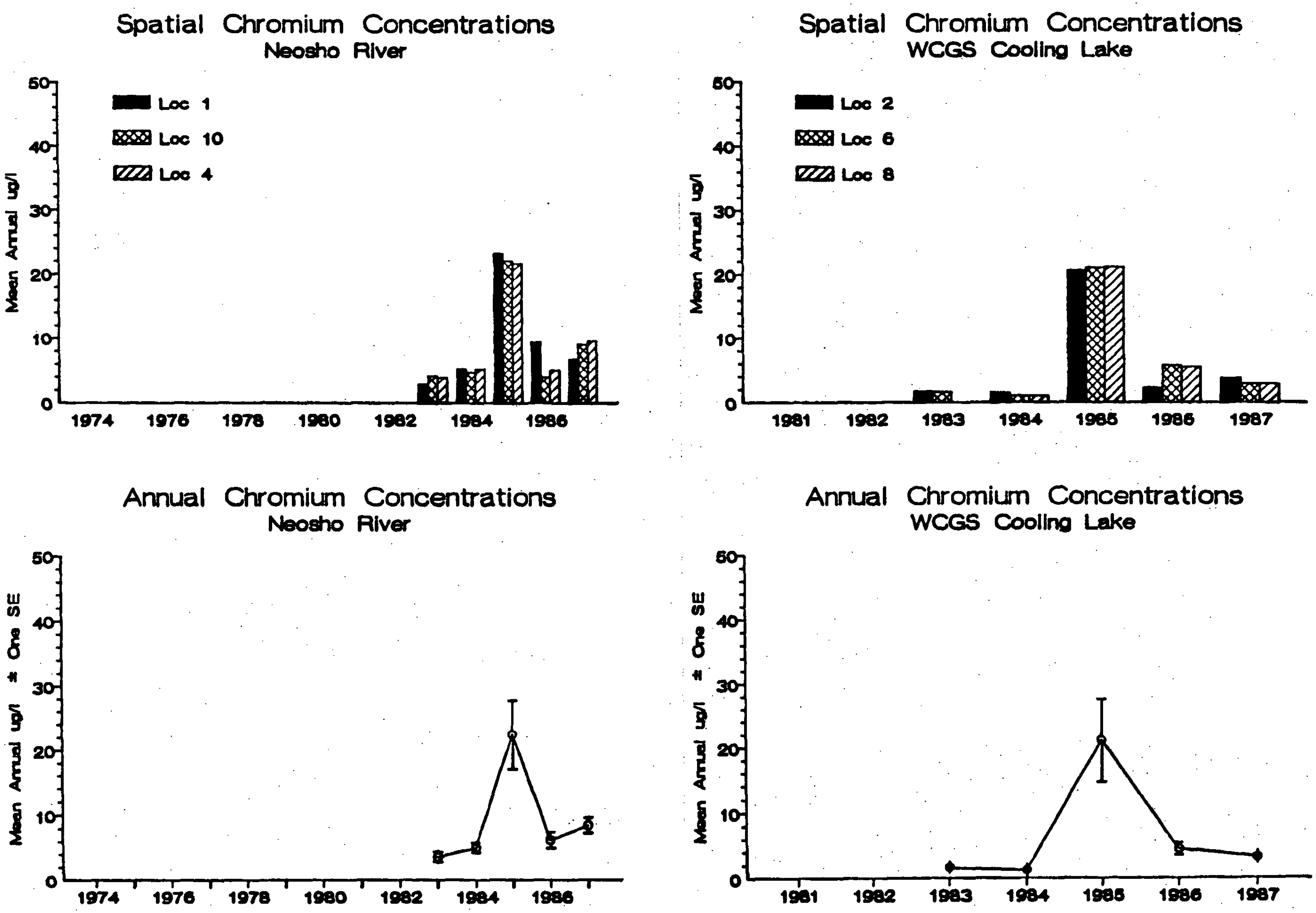


Figure 2-16. Chromium concentrations in the Neosho River and WCGS Cooling Lake near Wolf Creek Generating Station.

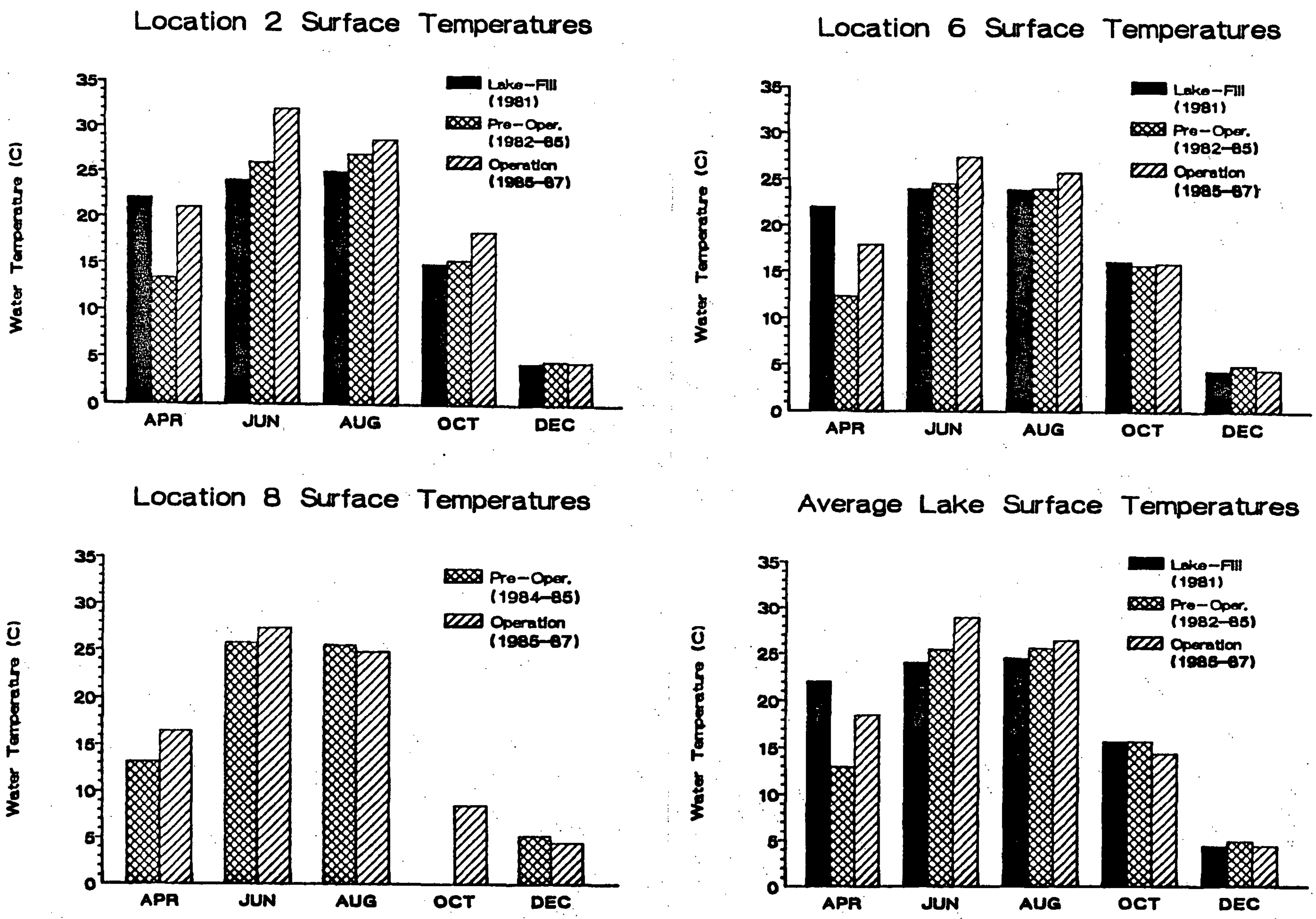
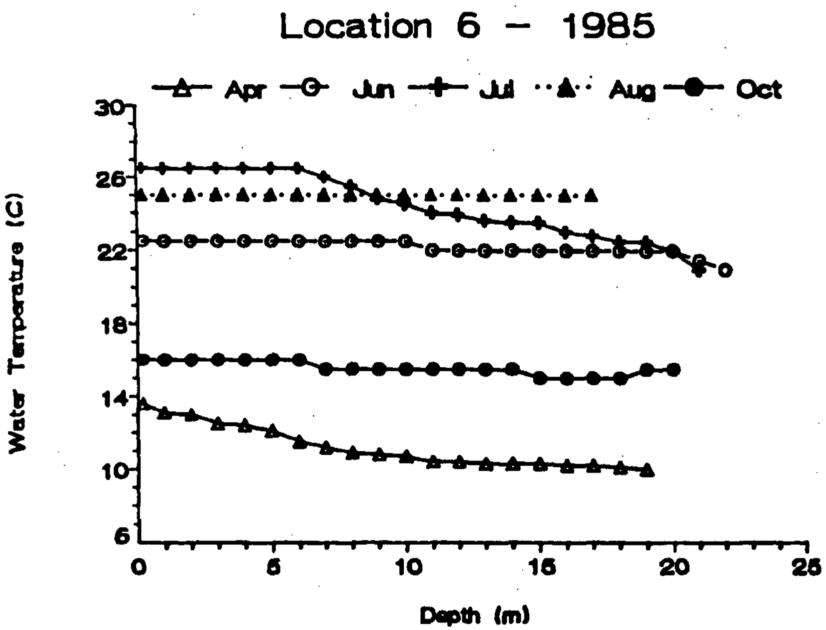
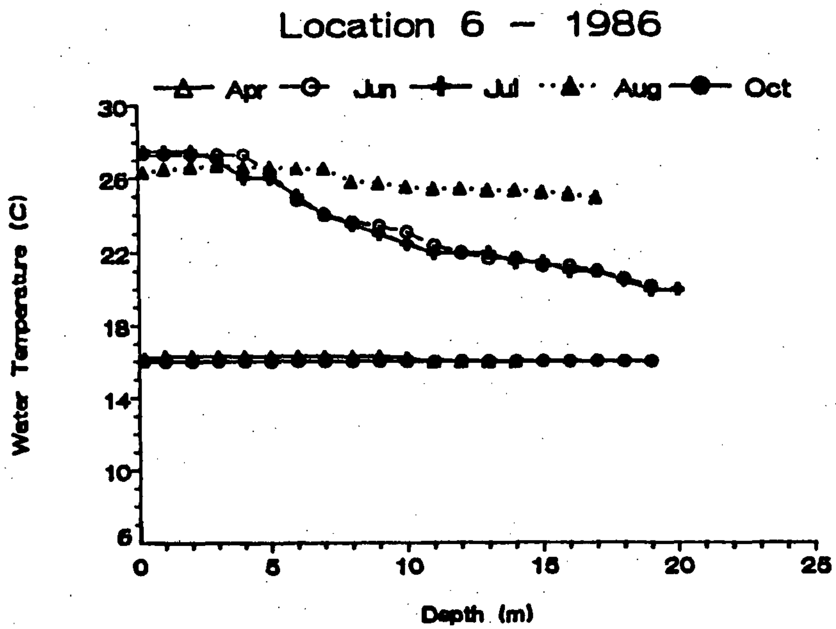


Figure 2-17. Surface water temperatures in WCGS Cooling Lake near Wolf Creek Generating Station.





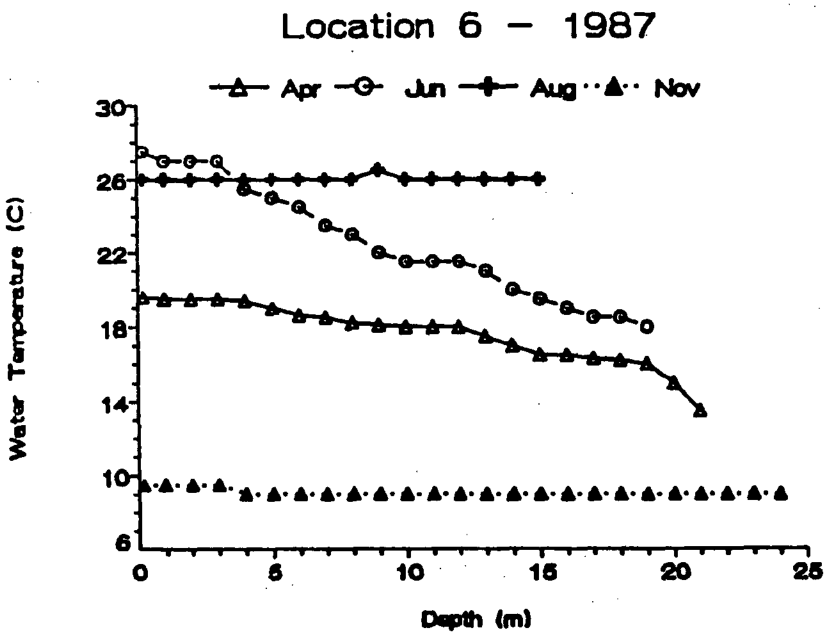
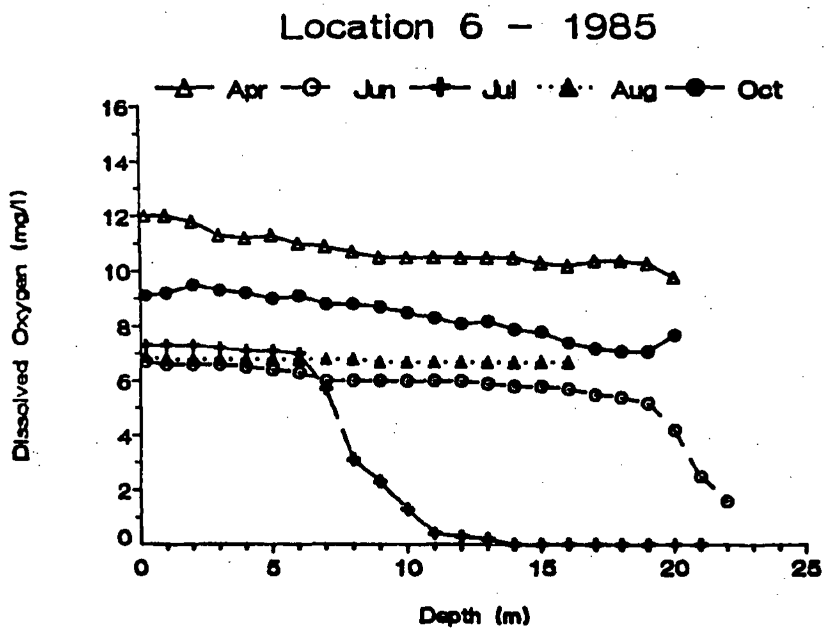
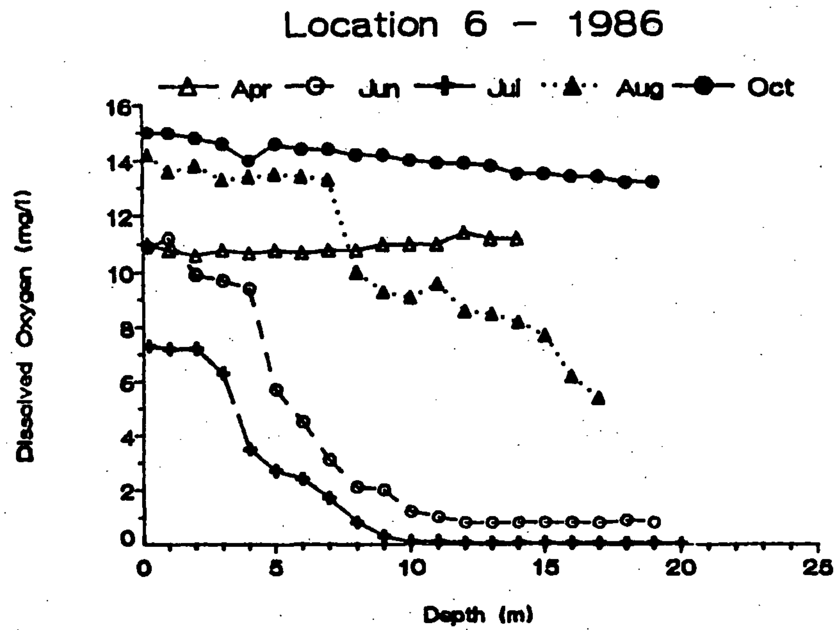


Figure 2-18. Depth profiles of water temperature at Location 6 in WCGS Cooling Lake near Wolf Creek Generating Station, 1985-1987.





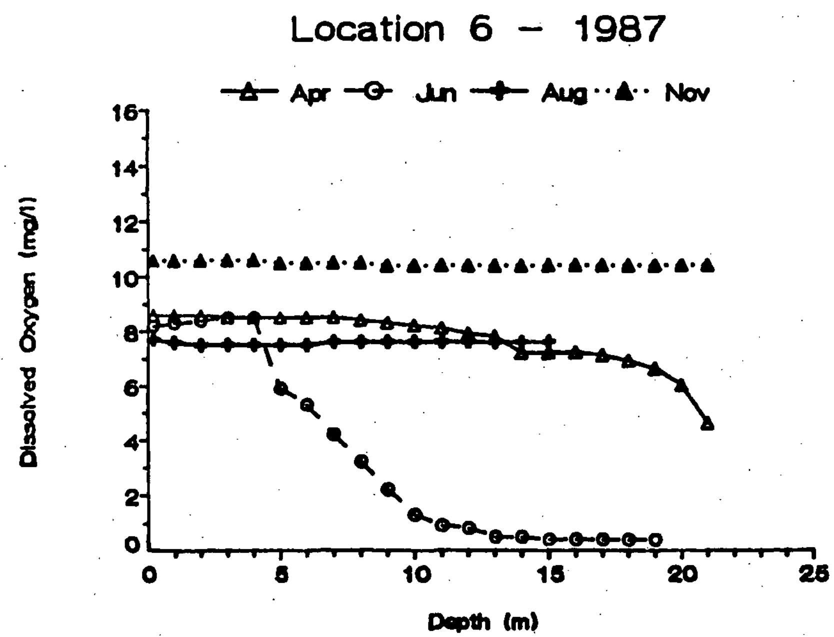


Figure 2-19. Depth profiles of dissolved oxygen at Location 6 in WCGS Cooling Lake near Wolf Creek Generating Station, 1985-1987.

TABLE 2-1 SUMMARY OF LOCATIONS SAMPLED AT WOLF CREEK GENERATING STATION, 1974-1987

Year	River and Creek Locations 1[a]	3	4	5	7	10	Lake Locations 2[a]	6	8
1974	X	X	X	X	-	X	X	-	-
1975	X	X	X	X	X	X	X	-	-
1976	X	X	X	X	X	X	X	-	-
1977	X	X	X	X	X	X	X	-	-
1978	X	X	X	X	X	X	-	-	-
1979	X	X	X	X	X	X	-	-	-
1980	X	X	X	-	X	X	-	-	-
1981	X	-	X	-	-	X	X	X	-
1982	X	-	X	-	-	X	X	X	-
1983	X	-	X	-	-	X	X	X	-
1984	X	-	X	-	-	X	X	X	X
1985	X	-	X	-	-	X	X	X	X
1986	X	-	X	-	-	X	X	X	X
1987	X	-	X	-	-	X	X	X	X

(a) Location 1 - Above John Redmond Dam 1974-1975.
Location 2 - Upper Wolf Creek before dam closure - in upper lake 1981 to present.

TABLE 2-2 WELLS SAMPLED AS PART OF GROUNDWATER PROGRAM NEAR WOLF CREEK GENERATING STATION, 1974-1987

Well #	74	75	76	77	78	79	80	81	82	83	84	85	86	87
B-12	-	X	X	X	X	X	X	X	X	X	X	X	X	X
C-6	-	X	-	-	-	-	-	-	-	-	-	-	-	-
C-10	-	-	-	-	-	X	-	-	-	-	-	-	-	-
C-20	-	X	-	X	X	X	X	X	X	X	X	X	X	X
C-49	-	-	-	-	-	X	X	X	X	X	X	X	X	X
C-50	-	X	X	X	X	-	-	-	-	-	-	-	-	-
D-24	-	-	-	-	-	X	-	-	-	-	-	-	-	-
D-26	X	-	-	-	-	-	-	-	-	-	-	-	-	-
D-28	X	X	X	X	X	-	-	-	-	-	-	-	-	-
D-42	-	X	X	X	X	X	-	-	-	-	-	-	-	-
D-55	-	X	X	X	X	X	-	-	-	-	-	-	-	-
D-65	-	X	X	X	X	X	X	X	X	X	X	X	X	X

Note: X indicates well was sampled during the year.

TABLE 2-3 SUMMARY OF PARAMETERS ANALYZED IN GROUNDWATER SAMPLES FROM WELLS NEAR WOLF CREEK GENERATING STATION, 1974-1987

Parameter	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Alkalinity	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Calcium	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Magnesium	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Potassium	X	X	X	X	X	X	X	X	X	-	-	-	-	-
Sodium	X	X	X	X	X	X	X	X	X	-	-	-	-	-
Chloride	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TDS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Conductance	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nitrate	X	X	X	X	X	X	-	X	X	X	X	X	X	X
Phosphorus	X	X	X	X	X	X	X	X	X	-	-	-	-	-
Silica	X	X	X	X	X	X	X	X	X	-	-	-	-	-
Iron (Total)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Iron (Soluble)	-	X	X	X	X	X	X	X	X	X	X	X	X	X
Manganese	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Manganese	-	X	-	-	-	-	-	-	-	-	-	-	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hardness	-	-	-	-	-	-	X	-	X	X	X	X	X	X
Selenium	-	-	X	X	X	X	X	X	X	-	-	-	-	-

TABLE 2-4 NUMBER OF ANALYSES CONDUCTED ON SURFACE WATER QUALITY SAMPLES COLLECTED NEAR WOLF CREEK GENERATING STATION, 1974-1987

Parameters	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Oil and grease	-	-	-	-	-	-	-	-	24	48	60	71	72	47
Water temp	22	24	20	20	16	16	12	24	26	48	60	36	33	22
Dissolved oxygen	24	24	36	39	32	35	23	48	47	48	56	51	57	36
Oxygen saturation	22	24	36	39	28	31	-	34	-	48	56	63	33	22
pH	24	24	36	36	36	36	24	48	48	48	60	72	72	48
Alkalinity	24	24	36	36	36	-	24	46	48	48	60	72	72	48
Sulfate	24	24	36	36	36	36	24	48	48	48	60	72	72	48
TDS	24	24	36	36	36	36	24	46	48	48	60	72	71	48
Specific Cond.	24	24	36	36	36	36	18	46	48	48	54	72	72	48
TSS	24	24	36	36	36	36	24	47	48	48	60	72	71	48
Turbidity	24	24	36	36	36	36	24	48	48	48	60	72	72	48
Color, True	24	24	36	36	36	36	18	48	48	-	-	-	-	-
Ammonia	24	24	36	36	36	36	24	45	48	48	60	72	72	48
Nitrate	22	24	36	36	36	36	24	48	24	48	60	72	72	48
Nitrite	24	24	36	36	36	36	24	48	24	48	60	72	72	48
Organic Nitrogen	24	24	36	36	36	36	24	48	48	48	60	72	72	48
Orthophosphate Sol.	24	24	36	36	36	36	24	48	24	48	59	72	66	48
Phosphorus	24	24	36	36	36	36	24	48	48	-	-	-	-	-
Silica	24	24	36	36	36	36	24	47	30	-	-	-	-	-
Bact. Fecal Colif.	20	22	36	34	35	35	24	48	-	48	60	72	72	48
BOD	24	24	36	36	36	35	24	48	48	47	59	72	72	48
COD	24	24	36	36	36	36	24	48	48	48	60	72	64	48
Organic Carbon	24	24	36	36	36	36	24	48	48	-	-	-	-	-
Hexane Sol.	24	20	35	31	34	33	21	44	-	-	-	-	-	-
Copper, Total	24	24	36	36	36	36	24	48	48	38	60	72	72	48
Iron, Total	24	24	36	36	36	36	24	48	48	48	60	72	72	48
Lead, Total	24	24	36	30	36	36	18	48	48	-	-	-	-	-
Manganese, Total	24	24	36	36	36	36	24	48	24	48	60	-	-	-
Mercury, Total	24	24	30	36	36	36	24	48	-	-	-	-	-	-
Zinc	24	24	36	36	36	35	24	48	48	-	-	-	-	-
Calcium	-	-	36	36	36	36	24	48	24	48	60	72	72	46
Chloride	-	-	36	36	36	36	24	48	48	48	60	72	72	48
Magnesium	-	-	36	36	36	36	24	48	24	48	60	72	72	48
Potassium	-	-	36	36	36	36	24	48	24	-	-	-	-	-
Sodium	-	-	36	36	36	36	24	48	24	-	-	-	-	-
Iron (sol.)	-	-	36	36	36	36	24	48	24	48	60	71	72	48
Bact. Fecal Strep.	-	-	24	33	36	35	24	23	-	-	-	-	-	-
Selenium	-	-	36	36	36	36	18	48	-	-	-	-	-	-
Hardness	-	-	-	-	-	-	-	-	48	-	-	-	-	-
Chromium, Total	-	-	-	-	-	-	-	-	-	48	60	72	72	48
Nickel	-	-	-	-	-	-	-	-	-	48	60	72	72	48

Note: Total analyses scheduled for collections from Neosho River, Wolf Creek, and WCCL.

TABLE 2-5 ANNUAL MEAN CONCENTRATIONS OF SELECTED WATER QUALITY PARAMETERS FOR THE NEOSHO RIVER AND WOLF CREEK COOLING LAKE (WCCL) NEAR WOLF-CREEK GENERATING STATION, 1974-1987

Parameter	Neosho River 1974	75	76	77	78	79	80	81	82	83	84	85	86	87
Bacteria-Fecal coliform	610	148	146	100	194	602	278	32	-	>200*	44	>68	19	45
Bacteria-Fecal streptococcus	-	-	104	53	43	160	80	343	-	-	-	-	-	-
Chloride	-	-	26	34	31	23	22	29	13	18	13	9	11	11
Color	16	19	11	22	12	15	21	8	-	-	-	-	-	-
Dissolved oxygen	11.1	9.1	9.3	9.8	10.0	9.9	10.6	9.6	9.9	10.6	10.5	9.5	11.2	9.7
Iron-soluble	-	-	0.10	0.09	0.06	0.06	0.16	0.27	0.15	<0.12	<0.86	<0.13	0.08	0.05
Lead	7	<3	<2	<3.7	9.4	<3	<2.0	<4.3	<3.9	-	-	-	-	-
Manganese	0.08	.09	0.12	0.12	0.09	0.09	0.11	0.11	0.06	0.11	0.17	-	-	-
Mercury	0.1	2.0	<6.5	<1.1	1.1	0.65	<1.9	<4.8	-	-	-	-	-	-
Nitrite	0.03	0.02	0.02	0.02	0.02	0.02	0.02	<.02	0.03	<0.02	0.05	0.06	<0.03	0.05
Oil and Grease	0.6	1.4	0.48	<3	2.5	<3	51	<19	-	<3.2	<3	<3	<3	<3
pH	7.9	7.7	8.1	8.0	8.1	8.1	7.8	7.9	7.9	7.9	7.8	7.5	7.6	7.7
Phosphate-Total	0.14	0.15	0.21	0.17	0.13	0.15	0.17	0.33	-	-	-	-	-	-
Potassium	-	-	4.2	4.9	4.9	5.3	4.8	4.4	3.9	-	-	-	-	-
Selenium	-	-	3.8	<2	2.8	21	<1.7	<0.7	-	-	-	-	-	-
Silica	6.6	4.4	3.0	6.9	3.7	4.5	1.4	<7.3	-	-	-	-	-	-
Sodium	-	-	22	21	25	19	20	20	-	-	-	-	-	-
Specific Conductance	456	468	592	552	620	501	477	399	437	478	413	361	396	417
Total Organic Carbon	13	18	7.6	8.2	8.0	8.6	8.0	6.4	7.8	-	-	-	-	-
Turbidity	35	64	27	43	27	35	29	30	35	27	54	56	33	44
Water Temperature	12.4	14.7	15.2	14.3	11.9	13.2	11.2	15.6	15.1	12.1	11.0	14.7	14.0	20
Zinc	21.5	15.2	8.7	17.5	16	23	<50	<11.1	<21.3	-	-	-	-	-

Parameter	WCCL 1981	82	83	84	85	86	87
Bacteria-Fecal Coliform	3	-	12	5	2	1	4
Bacteria-Fecal Steptecoccus	80	-	-	-	-	-	-
Chloride	26	15	15	14	13	12	16
Color	4.8	4.6	-	-	-	-	-
Dissolved oxygen	9.4	9.4	8.9	8.7	9.7	12.8	8.9
Iron-soluble	0.30	<0.15	<0.5	<0.005	<0.08	<0.09	<0.1
Lead	<2.7	-	-	-	-	-	-
Manganese	0.08	-	0.07	0.07	-	-	-
Mercury	<2.1	-	-	-	-	-	-
Nitrite	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01
Oil and Grease	<10.3	<1.1	<3.1	<3.0	<3.1	<3.0	<3
pH	7.9	7.8	7.9	7.8	7.6	7.7	8.0
Phosphate-Total	<0.15	<0.26	-	-	-	-	-
Potasium	4.2	4.1	-	-	-	-	-
Selenium	<0.5	-	-	-	-	-	-
Silica	1.8	2.4	-	-	-	-	-
Sodium	19	11	-	-	-	-	-
Specific Conductance	436	407	376	367	367	319	353
Total Organic Carbon	6.0	6.9	-	-	-	-	-
Turbidity	13.5	5.3	6.0	4.2	5.8	4.2	5.2
Water Temperature	15.9	14.7	14.7	15.1	16.5	15.7	22.2
Zinc	<16.4	<28.8	-	-	-	-	-

Note: Dash (-) indicates the parameter was not scheduled for determination.

TABLE 2-6 MEAN CONCENTRATIONS OF WATER QUALITY PARAMETERS FOR WELLS SAMPLED NEAR WOLF CREEK GENERATING STATION, 1977-1987

Well B-12

	Units	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
pH	units	7.3	7.6	7.6	7.3	6.8	7.6	8.2	7.6	8.3	8.2	7.5
Alkalinity	mg/l	365	390	290	259	401	572	451	491	486	774	522
Specific conductance	µmhos/cm	1,155	1,200	1,100	635	2,140	3,196	2,850	1,770	1,615	985	2,100
Hardness	mg/l	-	-	-	909	-	1,301	883	642	386	400	677
Total dissolved solids	mg/l	759	793	757	690	2,283	2,415	2,113	970	1,212	1,003	1,479
Calcium	mg/l	107	116	115	260	398	262	232	62	108	111	196
Chloride	mg/l	60	81	97	57	372	269	238	194	126	75	342
Magnesium	mg/l	22.6	21.3	22	65	94	25.9	73.8	131	39.6	38.6	45.6
Sulfate	mg/l	117	170	220	387	450	620	484	413	227	120	48
Nitrate	mg/l	10	-	4	-	4.2	54.6	81	21.5	2.2	<.05	114
Iron, total	mg/l	1.8	3.6	1.5	16.4	32	20	20.4	20.0	28.4	56.3	5.4
Iron, soluble	mg/l	0.26	0.08	0.01	0.80	0.03	0.15	0.87	16.5	0.14	0.24	0.12

Well C-20

	Units	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
pH	units	7.1	7.5	7.1	6.8	-	7.0	7.4	7.6	7.3	7.1	7.3
Alkalinity	mg/l	262	249	186	224	-	292	258	312	273	295	579
Specific conductance	µmhos/cm	1,370	1,600	1,400	1,300	-	1,295	1,665	1,152	1,572	1,169	1,100
Hardness	mg/l	-	-	-	702	-	788	790	650	655	545	653
Total dissolved solids	mg/l	1,090	1,192	1,140	654	-	952	1,126	556	1,091	1,084	985
Calcium	mg/l	200	217	220	250	-	300	280	102	224	241	222
Chloride	mg/l	170	147	130	150	-	128	188	121	284	135	243
Magnesium	mg/l	21	20	22	19	-	14.2	22.6	20.5	24.2	15.0	23.9
Sulfate	mg/l	45	32	60	-	-	53	49	68	166	50	53
Nitrate	mg/l	61	-	86	-	-	29.9	78	31.4	42.2	50.3	50.1
Iron, total	mg/l	1.8	0.9	1.6	5.8	-	15.1	1.5	3.5	7.0	<1.6	2.4
Iron, soluble	mg/l	0.12	0.03	0.08	0.05	-	1.4	0.12	3.4	0.18	<0.03	0.07

Well D-65

	Units	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
pH	units	6.9	7.3	7.5	6.5	7.5	6.8	6.8	7.0	7.2	6.9	7.1
Alkalinity	mg/l	161	130	158	110	190	167	138	164	150	153	320
Specific conductance	µmhos/cm	5,093	5,530	5,700	4,700	3,040	4,399	4,031	3,040	3,625	2,592	2,000
Hardness	mg/l	-	-	-	2,070	-	1,634	1,379	1,294	1,412	1,250	868
Total dissolved solids	mg/l	3,858	4,690	4,565	1,162	2,914	3,146	4,342	1,774	2,954	2,747	2,229
Calcium	mg/l	499	596	750	690	501	498	394	184	416	380	270
Chloride	mg/l	497	510	610	6,045	576	578	352	459	386	312	142
Magnesium	mg/l	120	133	150	114	96	74	96	65	77	90	47
Sulfate	mg/l	20	<1	180	30	44	62	74	60	58	68	59
Nitrate	mg/l	0.45	-	0.70	-	1.4	310	372	178	231	173	171
Iron, total	mg/l	10.9	7.8	6.1	4.3	4.6	31.5	26.9	65	12.0	6.7	9.0
Iron, soluble	mg/l	0.027	0.033	0.011	0.12	2.66	5.57	0.45	17.5	0.29	<0.05	0.06

TABLE 2-6 Cont.

		Well C-49							
	Units	1980	1981	1982	1983	1984	1985	1986	1987
pH	units	7.0	7.1	7.0	7.2	7.0	7.4	7.3	7.1
Alkalinity	mg/l	265	348	431	368	356	348	376	541
Specific conductance	μmhos/cm	1,100	860	1,160	1,348	1,314	1,191	1,026	1,000
Hardness	mg/l	499	-	530	518	633	515	461	477
Total dissolved solids	mg/l	742	781	785	1,418	730	800	792	841
Calcium	mg/l	140	126	126	143	64	141	206	125
Chloride	mg/l	3,066	84	48	72	44	74	47	52
Magnesium	mg/l	37	31	405	39	36	36	34	40
Sulfate	mg/l	151	188	206	258	278	143	114	46
Nitrate	mg/l	-	3.4	11.5	186	8	6.6	63.7	4.4
Iron, total	mg/l	-	0.24	0.10	0.09	0.18	0.09	3.8	0.07
Iron, soluble	mg/l	0.068	0.23	0.14	0.06	<0.1	0.08	<0.03	0.32

3. PLANKTON PRODUCTIVITY

3.1 INTRODUCTION

The plankton of freshwater lakes and rivers is composed of small plants and animals. Their position both vertically and horizontally in the water column is for the most part not self-controlled but rather is determined by physical factors such as currents, eddies, and turbulence. Phytoplankton consists of various types of algae, microscopic plants, which are suspended in the water column. While some algal taxa normally occur in suspension, others are washed free from substrates to which they were attached. Phytoplankton is given consideration in aquatic studies because it forms the primary trophic level of the aquatic food chain. Several species of zooplankton and macroinvertebrates feed on phytoplankton (Jonasson 1969, Saunders 1969), as do some fish species such as gizzard shad (Cramer and Marzolf 1970). There are also aesthetic considerations which may affect recreational use of lakes and reservoirs. Large algal blooms may occur sporadically during warm weather, cloud the water, and make recreational activities such as fishing, swimming, and boating less enjoyable.

Zooplankton are generally considered the second link (primary consumers) in aquatic food chains, although certain common limnetic taxa such as *Cyclops* species prey upon other zooplankters and thus are regarded as secondary consumers (Fryer 1957, McQueen 1969). Zooplankton that are primary consumers feed on phytoplankton, bacteria, protozoa, and organic detritus and are in turn utilized by aquatic macroinvertebrates and fish (secondary and tertiary consumers). Most fish species at some stage of development depend primarily on zooplankton as a food source. Availability of sufficient quantities of zooplankton at critical periods may affect survival of the fry and fingerling stages of fish species that are of commercial or recreational value (Siefert 1972, Clady 1977). Gizzard shad, the primary species of forage fish in the diets of walleye, white bass, and largemouth bass in several midwestern reservoirs, relies exclusively on zooplankton during a portion of its early life history (Kutkuhn 1957, Cramer and Marzolf 1970).

Plankton studies at WCGS began on the Neosho River in 1973 and on the Wolf Creek Cooling Lake (WCCL) in 1981. Although these studies at one time included determinations of phytoplankton and zooplankton composition and abundance, for several years emphasis has been placed on standing crop and productivity estimates for WCCL. These include phytoplankton chlorophyll a concentrations, phytoplankton carbon fixation rates, zooplankton dry weight biomass, and zooplankton ash-free dry weight biomass. Although plankton studies in the river were discontinued in 1982, phytoplankton studies resumed the next year, and measurements of chlorophyll a concentrations continue. The primary purpose of the present study is to examine spatial and temporal trends in the plankton data for effects of WCGS operation, which began in August 1985.

3.2 METHODS

Phytoplankton samples were collected from the Neosho River either quarterly or bimonthly from 1973 through 1987, except in 1982 when sampling was not conducted. In all years sampling occurred at Location 1 either in John Redmond Reservoir or its tailwaters, at Location 10 upstream of the confluence with Wolf Creek, and at Location 4 downstream of Wolf Creek (Figure 1-1). At each location whole water was collected for six replicate determinations of chlorophyll a concentration and carbon fixation rate. Bimonthly plankton sampling in WCCL began in 1981 at Location 2 near the WCGS discharge and Location 6 near the dam. Location 8 near the WCGS intake was added to the program in 1984. As in the river, phytoplankton collections consisted of surface sampling of whole water for six replicates at each location. Zooplankton biomass sampling consisted of four replicate vertical tows (bottom to surface) with a 30-cm diameter, No. 10 (153 μm) mesh conical plankton net.

Analytical methods for the plankton standing crop and productivity measurements are described in detail in recent WCGS annual reports. For phytoplankton, chlorophyll a concentrations (corrected for phaeophytin) were determined fluorometrically from acetone extracts (Lorenzen 1966; Strickland and Parsons 1972; APHA 1981) and were reported per cubic meter of water (mg/m^3). The rate of carbon fixation was estimated with the light bottle/dark bottle C-14 method (Wetzel 1964; Parkos et al. 1969; Strickland and Parsons 1972), and primary productivity was expressed as carbon fixed per cubic meter per hour ($mg/m^3/hr$). Zooplankton biomass was determined gravimetrically after drying at 60 C for dry weights (Lovegrove 1962) and after incineration at 500 C for ash-free dry weights (APHA 1981). Both zooplankton biomass parameters were reported per cubic meter of water (mg/m^3).

Overall spatial trends in the data were examined by plotting average annual values for each location in each year of sampling. Three approaches were used to evaluate temporal trends. First, average values for either the river or lake were calculated for each sampling date. The resulting plots permitted detailed examination of temporal cycles within each year. Secondly, average bimonthly (seasonal) values were calculated for each of three time periods. For the river these periods were prior to lake-construction and dam closure on Wolf Creek (Pre-Lake, 1973-1979), Pre-Operational (1980-AUG 1985), and WCGS operational (OCT 1985-1987). For the cooling lake, the Pre-Lake period was replaced by Lake Filling (1981). This approach allowed conditions during station operation to be compared with those of earlier periods. Finally, annual means and standard errors were calculated to examine overall year-to-year trends in the data.

3.3 RESULTS AND DISCUSSION

3.3.1 Neosho River Phytoplankton

Chlorophyll a concentrations in the Neosho River ranged from <1 to nearly 144 mg/m^3 (Tables 3-1, 3-2). Spatially, annual phytoplankton standing crop was often greatest at Location 1 and usually very similar at Locations 10 and 4 (Figure 3-1). The phytoplankton of the river is strongly influenced by releases from John Redmond Reservoir, which constitute nearly all of the flow in this section of the river. During moderate to high flows, chlorophyll concentrations immediately upstream and downstream of the confluence with Wolf Creek were very similar to those observed in the tailwaters. During low flow conditions, values at Location 10 immediately upstream of Wolf Creek were often different (usually but not always higher) than those observed at the other locations.

Temporally, no consistent pattern was noted in standing crop for the individual sampling dates (Figure 3-1). Unusually high values (>100 mg/m^3) occurred in

February 1984 and March 1986. On a seasonal basis, little variability was noted in chlorophyll for the period 1973 through 1979. Although there was a tendency for slightly lower values in June and higher values in late summer, average chlorophyll fell within a relatively narrow range ($\simeq$ 10-20 mg/m^3). During the 1980 to 1985 preoperational period, standing crop was distinctly higher in late winter with a minor peak evident in late summer. The late winter peak persisted during the operational period when spring and early summer values were higher than in earlier periods. A late summer minimum was also noted during the operational period. On an annual basis, chlorophyll values in the river displayed a moderate increase from 1973 through 1983 and then rose to a maximum in 1984. Since then, annual values have been declining toward earlier levels, except in 1985 when heavy precipitation in the watershed and unusually high river flows resulted in the lowest phytoplankton standing crop observed in the Neosho River.

Carbon-fixation rates ranged from 0 to 226 mg C/m^3/hr (Tables 3-1, 3-2). There were no consistent spatial differences in annual productivity, and in most years values were similar at all three river locations (Figure 3-2). There were no apparent seasonal cycles from the temporal results for individual sampling dates, but these data did show that the four greatest productivities all occurred during 1986. These high values caused seasonal means for four of the six seasons during the operational period to be substantially higher than respective values for earlier periods. Not surprising the annual mean productivity was much higher in 1986 than in any other year. However, carbon fixation rate in 1987 was within the range of annual values observed prior to 1986.

The absence of major spatial differences between Locations 10 and 4 in recent years indicated that neither phytoplankton standing crop nor productivity in the Neosho River was affected by WCGS operation. The general absence of spatial differences prior to WCGS operation suggested that Wolf Creek, which was an intermittent stream, seldom affected river phytoplankton historically. Instead phytoplankton standing crop primarily reflects releases from John Redmond Reservoir (JRR), with some downstream declines typical for lake plankton subjected to the lotic conditions of a river. Carbon fixation rates in turn are strongly influenced by phytoplankton standing crop as well as natural variations in ambient conditions such as temperature and turbidity. Thus, temporal patterns for phytoplankton productivity may be modified from those observed for standing crop. The potential for WCGS to impact the Neosho River phytoplankton community has been minimal based on low diversion rates from the JRR tailwaters and the absence of substantial discharges from the cooling lake. When these discharges do occur, any effects on the river phytoplankton would probably be additions to or dilutions of the community that originated in JRR. These effects would be very temporary and only persist for a short time after the discharge was discontinued.

3.3.2 Cooling Lake Phytoplankton

Chlorophyll a concentrations in the Wolf Creek Cooling Lake (WCCL) ranged from 1.8 to 25.7 mg/m^3 (Table 3-3). Spatially, standing crop was distinctly greater at Location 2 than at Location 6 through 1984 (Figure 3-3). Since then spatial differences have been less pronounced, probably because WCGS operation has increased the circulation and mixing of waters throughout WCCL. Temporally chlorophyll values tended to be at or near annual maxima in autumn and at annual minima in winter or early spring. There has been little evidence of a major spring pulse that is typical of most midwestern lakes and reservoirs. Unusually high phytoplankton standing crops occurred in October and December 1985 and April 1986, soon after WCGS operation began. Similar peaks did not occur in the JRR tailwaters (Table 3-2), suggesting that factors peculiar to WCCL rather than local climatic factors were responsible. It is conceivable that increased lake mixing and the onset of thermal discharges associated with WCGS start up caused a temporary stimulation of phytoplankton standing crop. However, chlorophyll values had returned to normal levels by the summer of 1986. The absence of fall peak in 1987 probably resulted because sampling was postponed from October to November.

On a seasonal basis, phytoplankton standing crop was consistently highest during lake filling in 1981 (Figure 3-3). This result was not unexpected as the tailwaters of John Redmond Reservoir, a relatively shallow eutrophic reservoir, were the primary source of water for lake filling. Also, the newly flooded soil and vegetation in WCCL would serve as an added source of nutrients stimulating phytoplankton standing crop. More uniform seasonal values were observed during the preoperational period although a fall maximum remained evident. The prominence of the fall maximum continued to decline during WCGS operation. Other seasons exhibiting progressive declines from lake filling through operation included spring (April) and early winter (December). On an annual basis, chlorophyll values appeared to stabilize soon after the lake-filling maximum, increased to near lake-fill values in 1985-86, and declined to a 1987 minimum. Most of the annual increases observed for 1985 and 1986 were related to the previously discussed high standing crops recorded soon after WCGS start up. The absence of October sampling in 1987 was a factor which reduced that annual mean. Overall annual trends were considered representative of a new lake that was initially filled with eutrophic water and then gradually assumed its own character, with a possible temporary stimulation associated with VCGS start up. Based on average annual chlorophyll a concentrations, the VCGS cooling lake can be classified in the mesotrophic range (Wetzel, 1975).

Phytoplankton carbon fixation rates ranged from 0.0 to 115.8 mg $C/m^3/hr$ (Table 3-3). Spatial differences were less pronounced than those observed for chlorophyll a concentrations, but productivity was often greatest at Location 2 (Figure 3-4). Temporally, there were no consistent trends in the timing of annual minima and maxima. Unusually high fixation rates occurred in February 1981, April and October 1982, and April through December 1986. The high productivity in 1986 caused all seasonal values except those in cold months to be higher during the operational period than during earlier periods. However, carbon fixation rates were also unusually high in the JRR tailwaters during 1986, indicating that the cause was not unique to VCCL and not related to VCGS operation.

Different seasonal patterns were evident for each of the three periods examined. During lake filling in 1981, maximum fixation rates were restricted to cold months (Figure 3-4). In the preoperational period, a bimodal pattern with peaks in April and October was observed. During VCGS operation, the April peak became dominant and resulted in a unimodal pattern. On an annual basis, phytoplankton productivity has varied between 9 and 17 mg $C/m^3/hr$ since 1982, except for the unusually high value (65 mg $C/m^3/hr$) in 1986. Carbon fixation rates have been strongly influenced by phytoplankton standing crop as well as natural variations in ambient conditions (e.g. temperature), and as a result fixation rates have revealed few consistent spatial or temporal trends.

Phytoplankton standing crop in WCCL was less than that observed in other regional lakes that are thermally influenced (Table 3-4). Chlorophyll a concentrations in WCCL averaged less than 10 mg/m^3 for 1981-87, whereas most other lakes have recorded overall means of 20 mg/m^3 or greater. Turtle Creek Reservoir, a 1,550-acre Indiana lake, exhibited substantially increased standing crop under two-unit operation but not under one-unit. Chlorophyll a values in Sutherland Reservoir, a 3,050-acre lake in western Nebraska, peaked during one-unit operation in 1981 and stabilized at somewhat lower values during two-unit operation. Standing crop in 660-acre Nelson Lake, located in western North Dakota, was similar to that observed in Sutherland Reservoir. Only Clinton Lake, a 4,890-acre Illinois impoundment, exhibited standing crops considered similar to WCCL, but those values were prior to the onset of thermal enrichment. Unlike many lakes in midwestern and plains states, the WCCL is deep and does not have a major source of nutrient inputs. These factors may be adequate to prevent eutrophic conditions from developing at WCCL.

3.3.3 Cooling Lake Zooplankton

Zooplankton biomass in WCCL ranged from 17 to 1,052 mg/m^3 for dry weights and from 14 to 338 mg/m^3 for ash-free dry weights (Table 3-5). Spatial differences in dry weight were minor except in 1985 and 1987 when standing crop was highest at Location 2 and lowest at Location 6 (Figure 3-5). No consistent temporal patterns were evident, but there was a tendency for high dry weights in April and low dry weights in June or August. Unusually high values occurred in

April, June, and October 1985 and in December 1986. On a seasonal basis, there has been a shift in the occurrence of maximum dry weight from spring in the preoperational period to autumn during WCGS operation. Based on annual values, zooplankton dry weights declined from 1981 through 1983, stabilized briefly before sharply rising to a 1985 maximum, and then returned to levels similar to the first two years of study. Most of the 1985 maximum was attributable to high standing crops that occurred before WCGS began operation.

Because zooplankton biomass samples sometimes contained sand, silt, and other suspended solids, ash-free dry weights (AFDW) was considered more representative of standing crop. Although AFDW was greater at Location 6 than at Location 2 from 1981 through 1983, there have been no consistent spatial trends in recent years (Figure 3-6). Neither has there been a consistent timing of yearly minima and maxima. Seasonally, standing crop from late winter through summer was greater during lake-filling than in later periods. With the exception of early winter, seasonal zooplankton standing crops were similar in preoperational and operational periods. Annually, AFDW declined through 1984, increased through 1986, and again declined in 1987. These annual trends were similar to those observed for dry weights, with the exception of 1985. The nature of differences between dry weight and AFDW in 1985 suggested that dry weights in that year were strongly influenced by non-organic materials (e.g. sand, etc.). The absence of consistent spatial differences in recent years, the similarity in seasonal values for preoperational and operational periods, and the absence of sustained high biomass after WCGS start-up all indicated that WCGS operation was not adversely affecting AFDW standing crop in the cooling lake.

Zooplankton AFDW in the cooling lake has been similar to that observed for lakes Sangchris and Shelbyville in Illinois, but substantially less than that recorded for Nelson Lake, North Dakota (Table 3-4). In WCCL similar annual trends were observed for phytoplankton and zooplankton standing crop (Figure 3-7). However, for both zooplankton parameters there were declines between 1982 and 1983 while chlorophyll *a* concentrations remained stable. This difference was related to differential declines in plankton production after WCCL was filled and major inputs from John Redmond were discontinued. Apparently for phytoplankton the decline occurred very soon after lake filling, but for zooplankton it did not occur until June 1982. Because crustacean zooplankters have much longer life cycles than planktonic algae, the degree and extent of these annual zooplankton declines probably reflected relatively slow natural attrition of zooplankton introduced from JRR as well as a response to the declining phytoplankton production.

Other differences between phytoplankton and zooplankton occurred in 1985 for dry weights and in 1986 for AFDW (Figure 3-7). The effect of inorganic materials on the high 1985 dry weights has already been discussed. Zooplankton AFDW continued to increase in 1986 while phytoplankton chlorophyll *a* declined slightly. There was moderately good correlation ($r \approx 0.70$) between chlorophyll *a* concentrations and each zooplankton biomass parameter. When regression lines were fit to their data, the distribution of points was somewhat better for AFDW because dry weight was affected by the unusually large value for 1985. In the absence of biomass data, chlorophyll *a* concentrations could be used to estimate zooplankton standing crop.

3.4 SUMMARY AND CONCLUSIONS

3.4.1 Neosho River Phytoplankton Studies

Phytoplankton chlorophyll a concentrations and carbon fixation rates in the Neosho River from the tailwaters of John Redmond Dam to below the confluence with Wolf Creek have been monitored since 1973. Flow in the study area is controlled by releases from John Redmond Reservoir. During periods of moderate to high flows, chlorophyll concentrations and fixation rates immediately upstream and downstream of the confluence with the creek were very similar to those observed in the tailwaters. During low flow conditions, values for both parameters immediately upstream of Wolf Creek are often different (usually but not always higher) than those observed at the other locations. In 1987, both the average annual chlorophyll concentration (27.38 mg/m^3) and carbon fixation rate (29.86 mg C/m^3 hr) were within the respective ranges (3.81-63.38 mg Chl a/m^3, 12.18-238.22 mg C/m^3 hr) observed for previous annual averages. The 1987 results reflected a return to more normal conditions after the high phytoplankton values resulting from the generally low river flow of 1986. There has been no indication that adverse effects on the phytoplankton of the Neosho River have occurred as a result of the construction and operation of WCGS.

3.4.2 WCCL Plankton Studies

Phytoplankton chlorophyll a concentrations and carbon fixation rates (surface samples) as well as zooplankton biomass (vertical tows) in the WCGS cooling lake have been monitored bimonthly since initial lake filling in 1981. Average annual chlorophyll concentrations declined by approximately 30 percent from 1981 to 1982, remained fairly stable from 1982 through 1984, and returned to near 1981 levels in 1985 and 1986. The annual value in 1987 declined by approximately 35 percent to 6.6 mg/m^3 and was below the previous range (7.5-11.0 mg/m^3) of annual values. Temporally, phytoplankton standing crop has been generally greatest in late-summer or early autumn, and spatially, it has generally been least in the downlake deep water location near the dam. However, exceptions to these general patterns have been observed, and chlorophyll concentrations were unusually high in October and December 1985 and April 1986. Carbon fixation rates have been strongly influenced by phytoplankton standing crop as well as natural variations in ambient conditions (e.g. temperature), and as a result fixation rates have revealed few consistent spatial or temporal trends. Unlike 1986 when unusually high fixation rates were common, the annual mean rate in 1987 (9.1 mg C/m^3) was slightly below the previously observed range of annual values (11.7-64.4 mg $C/m^3/hr$).

Average annual zooplankton biomass, both dry and ash-free dry weights, declined from 1981 through 1984, although dry weight biomass appeared to stabilize in 1983 and 1984. Ash-free dry weight increased from 40 mg/m^3 in 1984 to 67 mg/m^3 in 1985 and 92 mg/m^3 in 1986, and then declined to 53 mg/m^3 in 1987. Dry weight peaked in 1985 (234 mg/m^3) and has since progressively declined in 1986 (154 mg/m^3) and 1987 (123 mg/m^3). Average annual dry weight in 1987 was less than that observed during lake filling in 1981 but greater than the 66 mg/m^3 minimum of 1984. Few consistent spatial and temporal trends have been observed for zooplankton biomass, but there has been a tendency for greater biomass in the uplake shallower water and for greater biomass in late winter or early spring from 1981-1985 with spring and fall peaks in 1985 and 1986. A spring peak also occurred in 1987, but zooplankton sampling was discontinued before the normal period of the fall peak.

Annual trends in phytoplankton and zooplankton through 1984 were considered representative of a new lake, with nutrient inputs from recently inundated soil and vegetation, that was initially filled with eutrophic water (from John Redmond Reservoir) and then gradually assumed its own character. Increases in plankton apparent in 1985 and 1986 were considered primarily a response to natural factors although operational effects of the thermal discharge and altered lake circulation patterns associated with WCGS start-up may have been contributing factors. Plankton declines to normal levels during WCGS operation in 1987 support the conclusion that station operation is not adversely affecting plankton production. Based on average annual chlorophyll a concentrations, the WCGS cooling lake remains in the mesotrophic classification.

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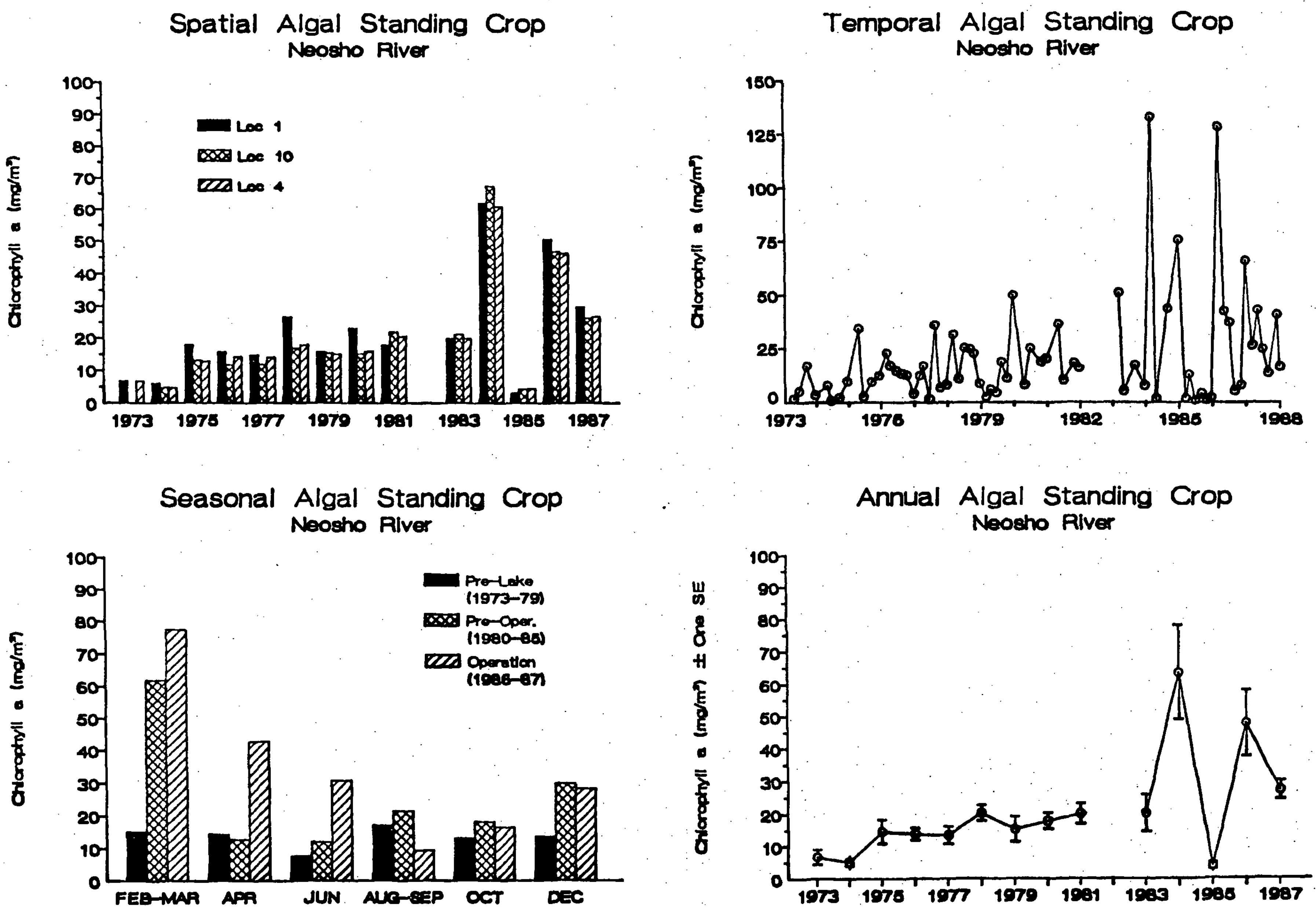

Figure 3-1. Phytoplankton standing crop trends in the Neosho River near Wolf Creek Generating Station, 1973-1987.

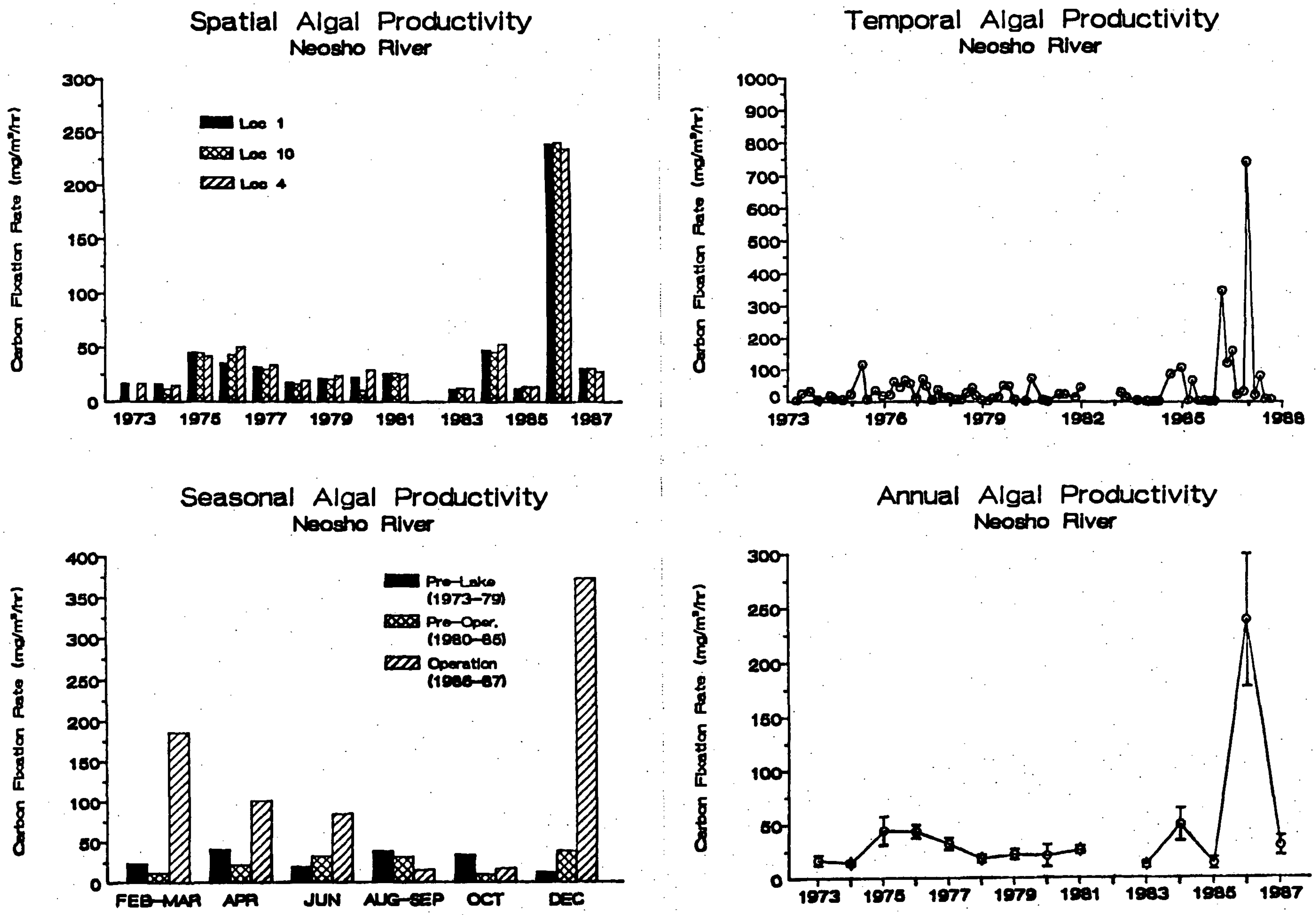

Figure 3-2. Phytoplankton productivity trends in the Neosho River near Wolf Creek Generating Station, 1973-1987.

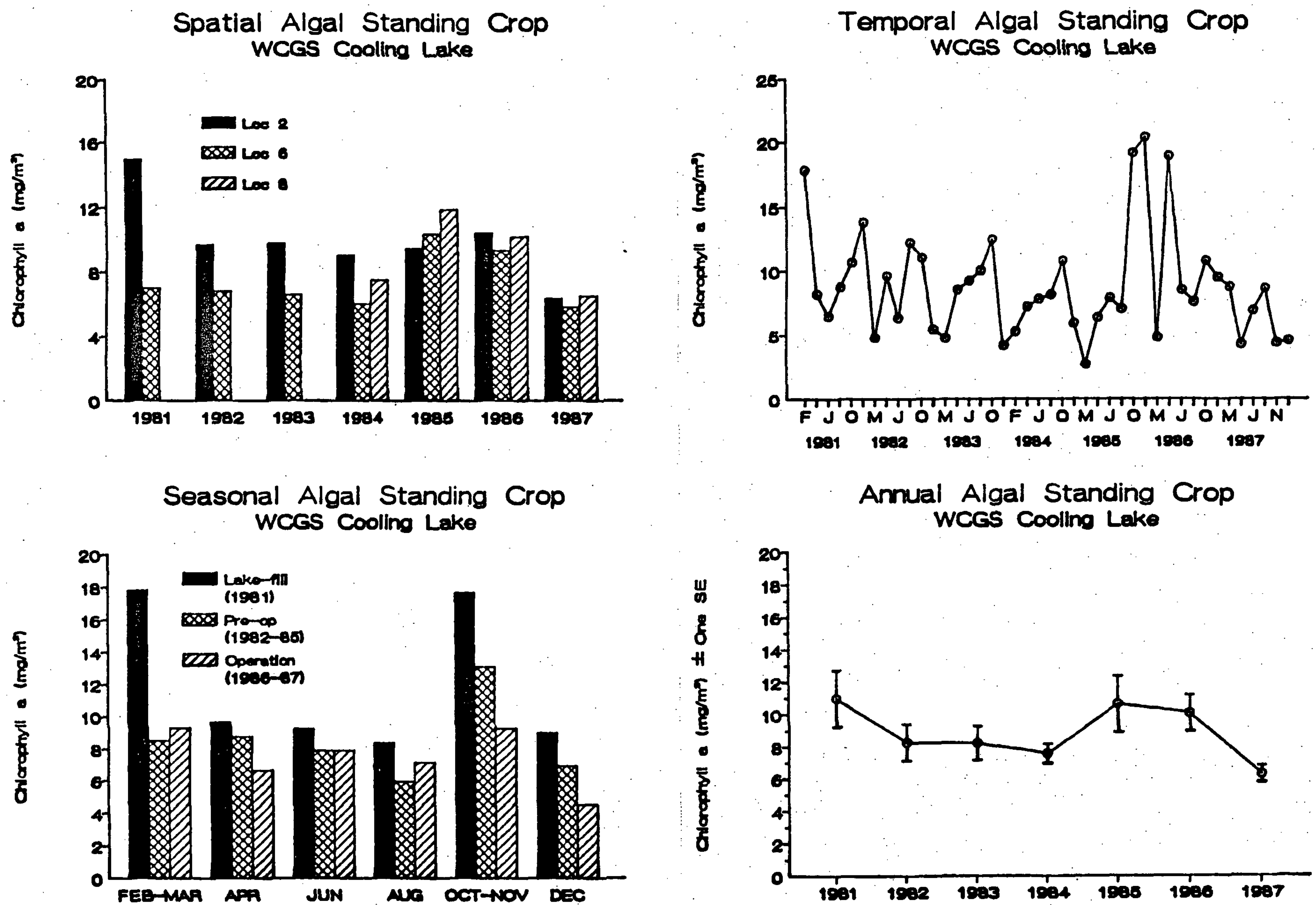

Figure 3-3. Phytoplankton standing crop trends in the cooling lake near Wolf Creek Generating Station, 1981–1987.

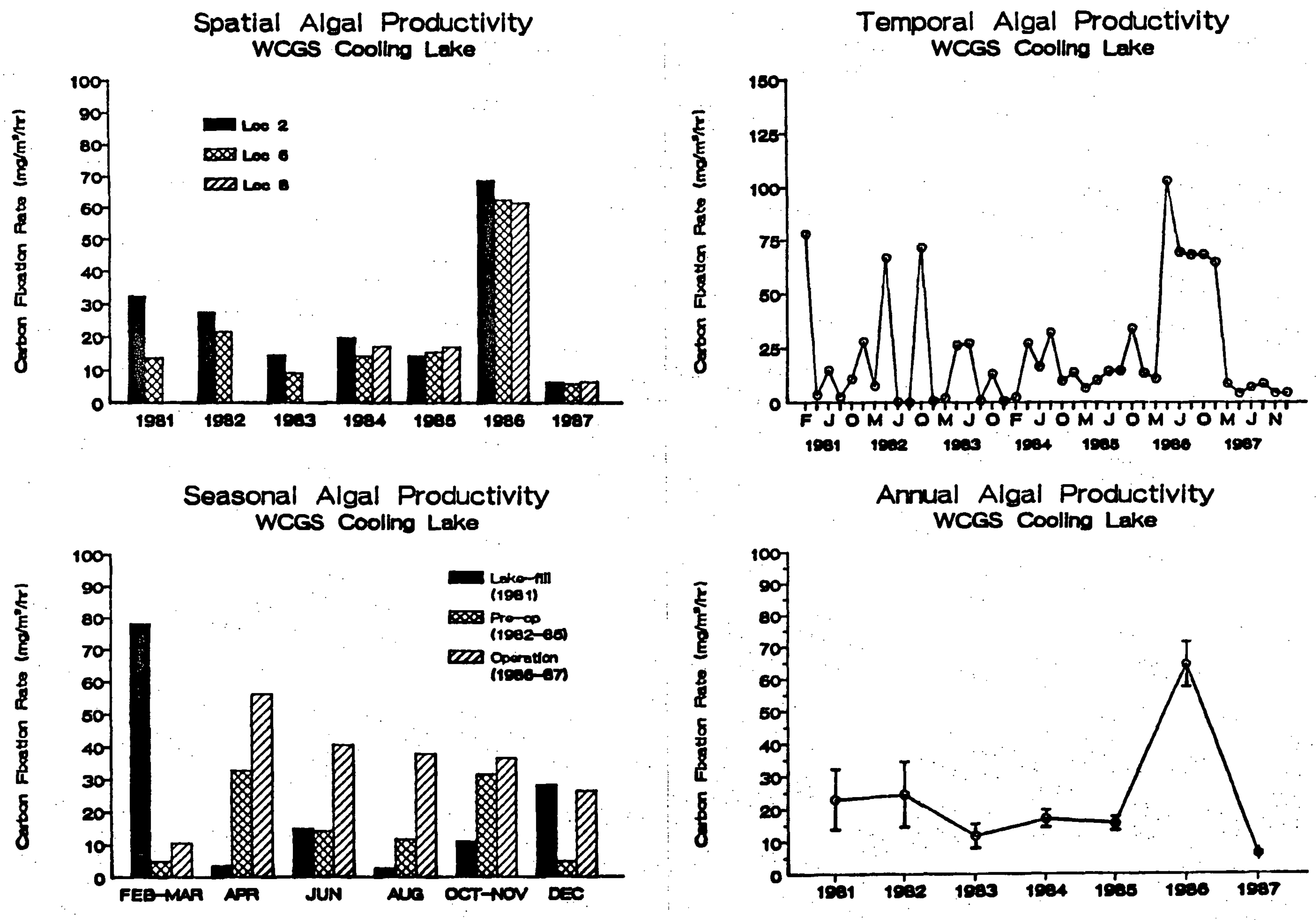

Figure 3-4. Phytoplankton productivity trends in the cooling lake near Wolf Creek Generating Station, 1981-1987.

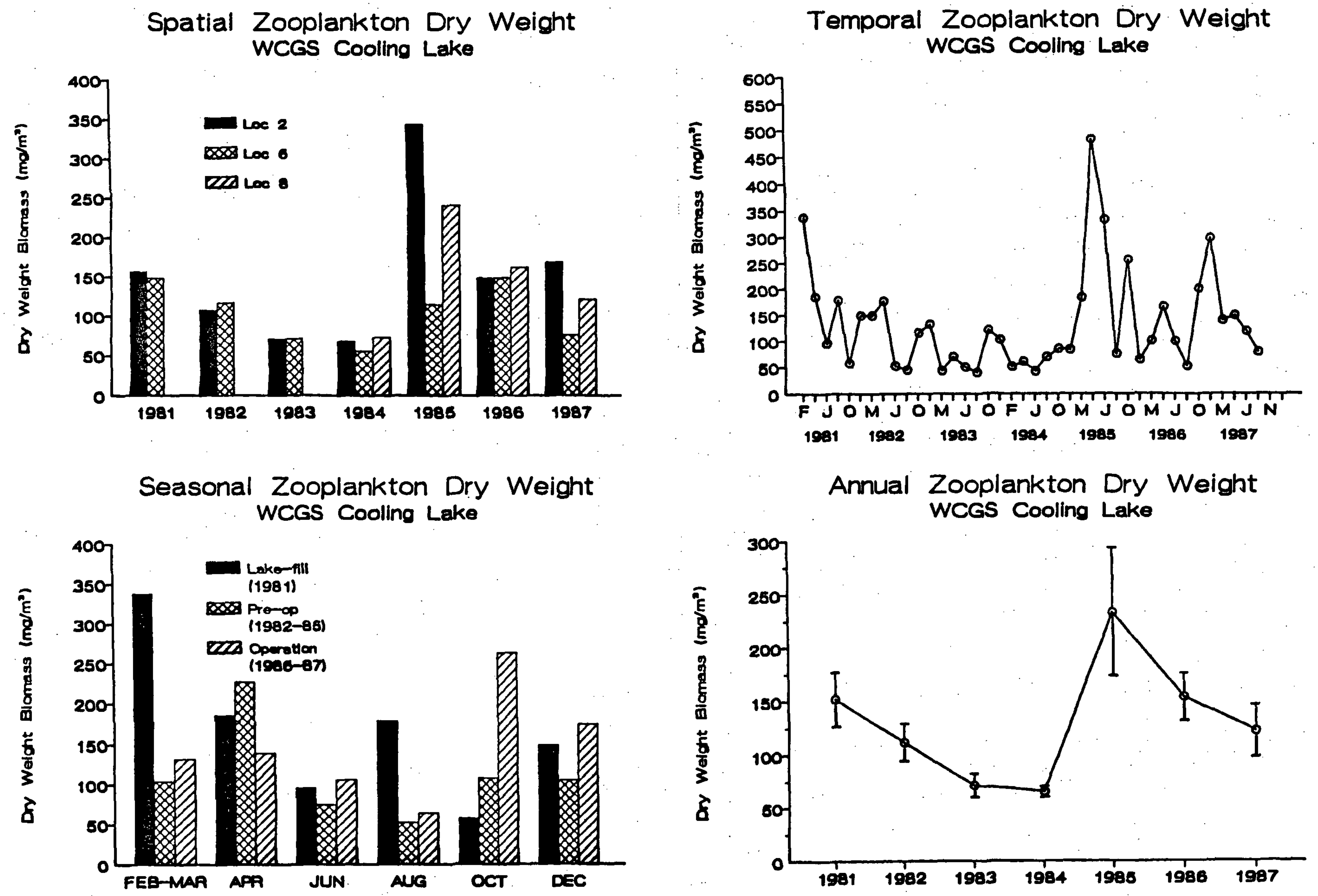

Figure 3-5. Zooplankton dry weight standing crop trends in the cooling lake near Wolf Creek Generating Station, 1981–1987.

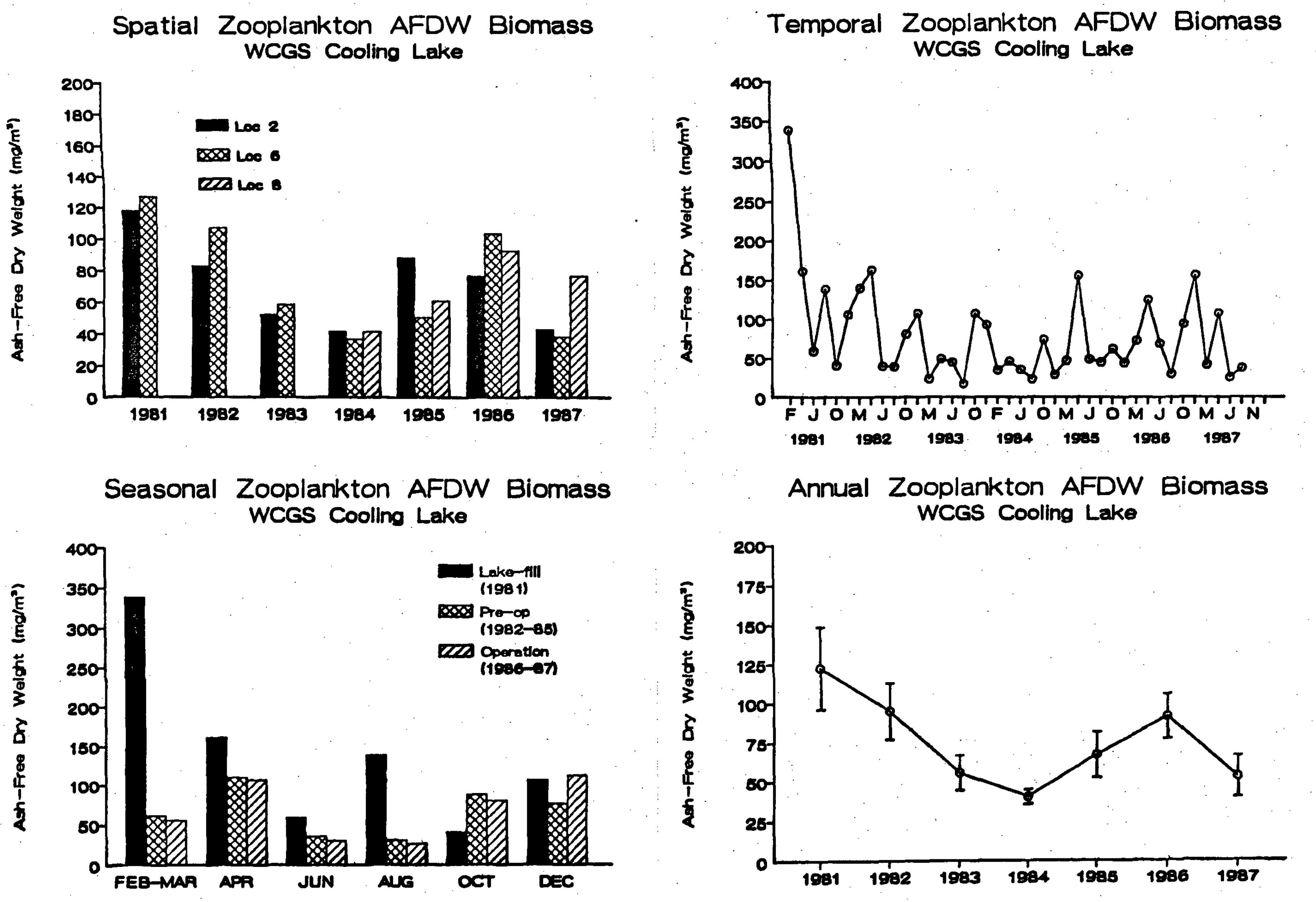

Figure 3-6. Zooplankton ash free dry weight trends in the cooling lake near Wolf Creek Generating Station, 1981-1987.

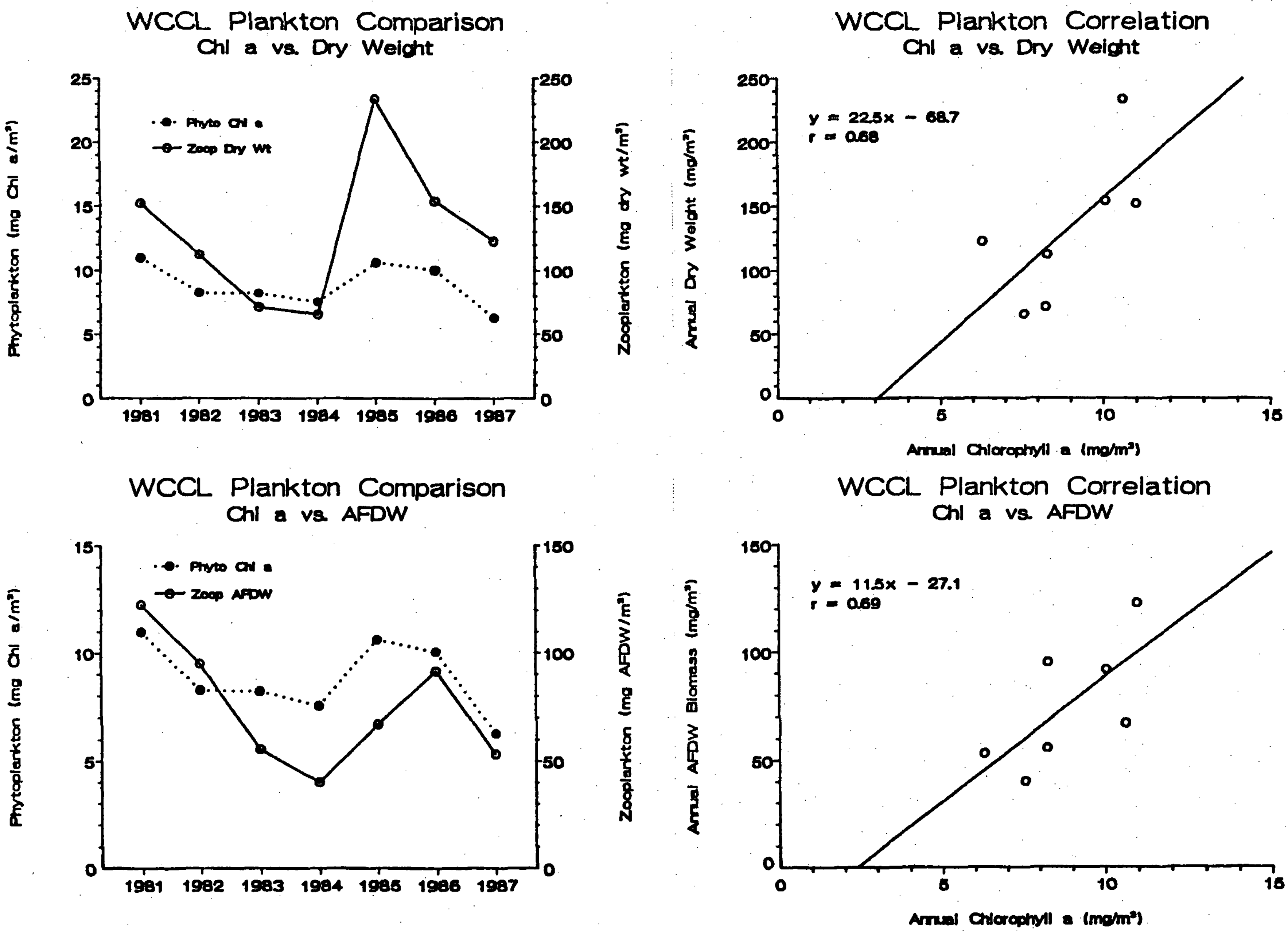

Figure 3-7. Relationship between phytoplankton and zooplankton standing crop in the cooling lake near Wolf Creek Generating Station.

TABLE 3-1 PHYTOPLANKTON STANDING CROP AND PRODUCTIVITY AT LOCATIONS 1, 10, AND 4 IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1973-1979

	Chlorophyll $\underline{a}$ Concentrations (mg/m^3)				Carbon Fixation Rates ($mg\ C/m^3/hr$)			
Date	1	10	4	Mean	1	10	4	Mean
12APR73	1.58	-	1.93	1.78	3.51	-	3.96	3.74
12JUN73	8.13	-	2.23	5.18	29.61	-	22.34	25.98
11SEP73	13.41	-	19.75	16.58	28.00	-	35.06	31.53
12DEC73	3.57	-	3.13	3.35	5.45	-	5.21	5.33
Mean	6.67	-	6.76	6.72	16.64	-	16.64	16.64
27MAR74	8.77	6.57	7.54	7.63	18.29	17.45	18.90	18.21
11JUN74	0.70	0.77	0.80	0.76	15.57	0.15	11.40	9.04
10SEP74	4.14	1.83	0.08	2.26	7.30	5.62	5.94	6.29
10DEC74	10.50	9.17	9.00	9.56	24.83	22.92	22.92	23.56
Mean	6.03	4.59	4.54	5.05	16.50	11.54	14.79	14.28
16APR75	34.97	33.33	34.00	34.10	90.90	125.98	130.65	115.84
10JUN75	3.67	1.84	2.27	2.59	14.24	6.87	2.54	7.88
9SEP75	10.97	10.34	6.70	9.34	44.26	36.82	24.66	35.25
3DEC75	21.67	6.57	7.87	12.04	32.18	10.39	10.38	17.65
Mean	17.82	13.02	12.71	14.52	45.40	45.02	42.06	44.16
25FEB76	38.67	11.67	17.33	22.56	21.66	20.35	20.82	20.94
6APR76	18.33	15.37	16.63	16.78	58.82	62.25	64.23	61.77
15JUN76	16.00	14.23	12.77	14.33	45.79	45.97	41.07	44.28
10AUG76	7.27	16.00	16.00	13.09	26.23	80.69	95.59	67.50
5OCT76	7.17	9.73	19.73	12.21	41.58	46.35	79.01	55.65
14DEC76	6.33	2.99	2.53	3.95	21.39	5.27	4.84	10.50
Mean	15.63	11.67	14.17	13.82	35.91	43.48	50.93	43.44
22FEB77	12.27	12.43	11.60	12.10	67.42	69.00	77.00	71.14
5APR77	21.33	14.53	14.33	16.73	55.25	45.02	45.32	48.53
9JUN77	1.53	1.47	1.53	1.51	5.30	5.75	7.04	6.03
9AUG77	35.90	28.54	43.25	35.90	34.28	33.34	45.35	37.66
4OCT77	8.54	6.32	5.26	6.71	15.09	13.30	13.22	13.87
13DEC77	8.20	7.61	7.96	7.92	15.42	14.47	13.99	14.63
Mean	14.63	11.82	13.99	13.48	32.13	30.15	33.65	31.98
22FEB78	35.04	29.85	28.98	31.29	6.71	8.08	6.56	7.12
25APR78	12.00	10.33	9.54	10.62	6.51	4.90	5.76	5.72
27JUN78	30.11	21.29	23.42	24.94	25.80	24.54	30.52	26.95
29AUG78	24.63	20.68	27.98	24.43	28.24	45.14	51.68	41.69
10OCT78	37.41	14.86	14.56	22.28	26.64	13.45	17.66	19.25
12DEC78	20.07	2.95	2.15	8.39	12.19	1.55	2.58	5.44
Mean	26.54	16.66	17.78	20.32	17.68	16.28	19.13	17.70
20FEB79	3.38	2.50	1.42	2.43	3.35	1.15	0.92	1.81
10APR79	6.40	5.61	5.41	5.81	12.00	10.42	9.77	10.73
12JUN79	2.66	5.61	4.64	4.30	11.18	16.59	16.65	14.81
7AUG79	21.53	17.07	16.62	18.41	43.60	56.46	61.55	53.87
9OCT79	11.52	10.21	11.11	10.95	50.85	46.04	48.32	48.40
11DEC79	48.06	50.96	50.64	49.89	6.99	6.19	6.72	6.63
Mean	15.59	15.33	14.97	15.30	21.33	22.81	23.99	22.71

Note: 1. Location 1 was in John Redmond Reservoir prior to 1976.
2. Dash (-) indicates location not sampled.

TABLE 3-2 PHYTOPLANKTON STANDING CROP AND PRODUCTIVITY AT LOCATIONS 1, 10, AND 4 IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION BURLINGTON, KANSAS, 1980-1987

Date	Chlorophyll a Concentrations (mg/m^3) 1	10	4	Mean	Carbon Fixation Rates ($mg\ C/m^3/hr$) 1	10	4	Mean
15APR80	7.31	8.81	7.91	8.01	2.84	2.69	2.64	2.72
17JUN80	25.48	20.97	28.06	24.84	77.78	33.14	108.78	73.23
23OCT80	31.28	11.37	12.76	18.47	7.74	3.47	4.45	5.22
16DEC80	27.41	18.56	14.12	20.03	0.48	1.49	1.18	1.05
Mean	22.37	14.93	15.71	17.84	22.21	10.20	29.26	20.56
28APR81	30.57	44.28	33.74	36.20	18.39	30.42	22.39	23.73
23JUN81	9.28	10.20	10.85	18.02	22.58	21.64	23.15	22.46
20OCT81	13.71	18.33	21.52	17.85	13.81	14.34	13.80	13.98
15DEC81	17.28	14.30	15.87	15.82	48.90	40.09	43.35	44.11
Mean	17.71	21.78	20.50	21.97	25.92	26.62	25.67	26.07
1MAR83	53.30	49.96	50.23	51.16	29.61	29.26	28.24	29.04
26APR83	5.34	5.05	5.17	5.19	13.68	13.37	13.14	13.40
30AUG83	9.88	22.98	17.77	16.88	1.91	5.07	4.99	3.99
13DEC83	10.94	6.16	5.81	7.64	0.70	2.84	3.26	2.27
Mean	19.86	21.04	19.74	20.22	11.48	12.64	12.41	12.18
28FEB84	126.46	143.83	127.40	132.56	1.60	2.12	1.76	1.83
17APR84	1.74	1.68	1.64	1.69	3.48	2.25	0.07	1.93
21AUG84	45.44	48.02	37.35	43.60	63.83	84.82	112.34	87.00
18DEC84	73.96	75.80	77.27	75.68	123.86	96.79	100.45	107.03
Mean	61.90	67.33	60.92	63.38	48.19	46.50	53.66	49.45
6MAR85	1.17	2.32	2.20	1.90	2.10	6.01	3.68	3.93
16APR85	9.67	13.82	14.85	12.78	63.68	66.84	68.78	66.43
25JUN85	1.14	0.66	1.06	0.95	1.21	2.93	2.14	2.09
27AUG85	3.86	4.21	4.03	4.03	4.08	4.41	4.21	4.23
22OCT85	0.59	1.48	0.92	1.00	0.47	0.86	1.30	0.88
10DEC85	1.73	2.30	2.64	2.22	1.68	3.48	3.29	2.82
Mean	3.03	4.13	4.28	3.81	12.20	14.08	13.90	13.40
4MAR86	142.75	123.35	118.17	128.09	295.06	403.68	350.68	349.81
29APR86	35.80	44.89	46.58	42.42	129.12	128.08	103.56	120.25
25JUN86	27.44	36.45	47.35	37.08	142.08	149.53	189.78	160.46
19AUG86	4.33	5.61	5.82	5.25	15.19	27.45	27.19	23.28
28OCT86	9.09	7.69	6.80	7.86	27.70	37.68	32.06	32.48
16DEC86	83.93	62.51	51.81	66.08	826.04	697.16	705.89	743.03
Mean	50.56	46.75	46.09	47.80	239.20	240.60	234.86	238.22
2MAR87	29.94	25.58	23.22	26.25	31.75	21.58	12.07	21.80
27APR87	43.97	40.55	44.32	42.95	74.14	87.59	82.99	81.58
22JUN87	31.71	21.45	20.39	24.52	10.77	7.15	7.91	8.61
24AUG87	13.01	12.63	14.84	13.49	6.82	7.45	8.10	7.46
23NOV87	-	39.37	42.20	40.79	-	-	-	-
28DEC87	-	17.34	15.29	16.31	-	-	-	-
Mean	29.66	26.15	26.71	27.38	30.87	30.94	27.77	29.86

Note: Dash (-) indicates location not sampled.

TABLE 3-3 PHYTOPLANKTON STANDING CROP AND PRODUCTIVITY AT LOCATIONS 2, 6, AND 8 IN THE COOLING LAKE OF WOLF CREEK GENERATING STATION BURLINGTON, KANSAS, 1981-1987

Date	Chlorophyll a Concentrations (mg/m^3)				Carbon Fixation Rates ($mg\ C/m^3/hr$)			
	2	6	8	Mean	2	6	8	Mean
24FEB81	25.5	10.2	-	17.9	115.8	40.2	-	78.0
28APR81	11.5	4.9	-	8.2	4.1	2.8	-	3.4
23JUN81	10.3	2.7	-	6.5	24.5	5.2	-	14.9
25AUG81	11.5	6.0	-	8.8	2.8	2.4	-	2.6
20OCT81	14.4	7.0	-	10.7	14.8	7.1	-	10.9
15DEC81	16.5	11.2	-	13.9	32.3	23.9	-	28.1
Mean	15.0	7.0	-	11.0	32.4	13.6	-	23.0
3MAR82	7.0	2.6	-	4.8	10.9	4.1	-	7.5
27APR82	12.3	7.0	-	9.7	88.9	44.6	-	66.8
22JUN82	6.0	6.7	-	6.4	0.5	0.1	-	0.3
31AUG82	16.9	7.6	-	12.3	0.2	0.0	-	0.1
19OCT82	9.7	12.4	-	11.1	62.8	80.3	-	71.6
7DEC82	6.3	4.6	-	5.5	1.5	0.1	-	0.8
Mean	9.7	6.8	-	8.3	27.5	21.6	-	24.5
1MAR83	5.4	4.1	-	4.8	2.0	2.1	-	2.0
26APR83	11.4	5.7	-	8.6	35.2	17.6	-	26.4
26JUN83	11.6	6.9	-	9.3	32.7	22.0	-	27.4
30AUG83	10.9	9.2	-	10.1	0.5	1.0	-	0.8
18OCT83	15.2	9.8	-	12.5	15.9	10.3	-	13.1
13DEC83	4.4	3.9	-	4.2	0.2	1.4	-	0.8
Mean	9.8	6.6	-	8.2	14.4	9.0	-	11.7
28FEB84	4.9	4.9	6.0	5.3	1.0	6.3	0.0	2.4
17APR84	8.0	6.8	6.9	7.2	28.2	26.9	26.8	27.3
19JUN84	12.4	4.4	6.7	7.8	26.3	7.0	16.1	16.5
21AUG84	11.1	5.6	7.8	8.2	40.8	22.0	33.9	32.2
16OCT84	12.6	9.3	10.6	10.8	11.8	7.8	10.4	10.0
18DEC84	5.4	5.3	7.1	5.9	10.8	15.0	15.7	13.8
Mean	9.1	6.0	7.5	7.5	19.8	14.2	17.2	17.1
6MAR85	1.8	3.3	2.9	2.7	7.1	6.8	5.5	6.5
16APR85	4.6	5.3	9.3	6.4	11.7	7.9	10.9	10.2
25JUN85	9.0	6.0	8.7	7.9	11.0	13.2	19.2	14.5
26AUG85	6.7	6.9	7.6	7.1	11.8	16.7	15.5	14.7
22OCT85	20.1	15.2	22.2	19.2	31.8	32.9	38.0	34.2
10DEC85	14.7	25.7	20.8	20.4	12.3	15.2	13.0	13.5
Mean	9.5	10.4	11.9	10.6	14.3	15.4	17.0	15.6
4MAR86	5.3	4.8	4.3	4.8	10.9	12.1	9.9	11.0
29APR86	19.6	17.7	19.5	18.9	115.3	100.9	94.6	103.6
25JUN86	7.6	9.2	8.8	8.5	80.4	67.9	61.0	69.8
19AUG86	8.6	6.3	8.0	7.6	62.7	73.3	69.1	68.4
28OCT86	14.3	7.9	10.3	10.8	93.5	50.1	62.1	68.6
16DEC86	7.5	10.5	10.6	9.5	50.2	71.6	73.3	65.0
Mean	10.5	9.4	10.3	10.1	68.8	62.7	61.7	64.4
2MAR87	10.4	8.4	7.5	8.8	6.5	8.7	7.0	7.4
27APR87	4.5	3.8	4.5	4.3	14.6	12.9	11.2	12.9
22JUN87	7.4	6.0	7.5	7.0	4.0	4.0	5.8	4.6
24AUG87	7.6	7.3	11.1	8.6	10.6	9.9	13.6	11.4
23NOV87	4.9	4.8	3.4	4.4	-	-	-	-
28DEC87	3.5	4.9	5.3	4.6	-	-	-	-
Mean	6.4	5.9	6.6	6.3	8.9	9.1	9.4	9.1

Note: Dash (-) indicates location not sampled.

TABLE 3-4 PLANKTON STANDING CROPS FOR SELECTED THERMALLY INFLUENCED LAKES IN MIDWESTERN AND GREAT PLAINS STATES

Lake	Year	Phytoplankton Chlorophyll a (mg/m^3) Mean	(Min - Max)	Zooplankton Biomass (mg/m^3, AFDW) Mean	(Min - Max)	Reference
WCCL, KS	1987*	6.3	(3.4-11.1)	53	(23-187)	Present Study
	1986*	10.1	(4.3-20)	91	(14-257)	EA 1987a
	1985*	10.6	(1.8-26)	67	(22-297)	EA 1986a
	1984	7.5	(4.9-13)	40	(15-88)	EA 1985b
	1983	8.2	(3.9-15)	56	(13-130)	Ecological Analysts 1984b
	1982	8.2	(2.6-17)	95	(18-183)	Ecological Analysts 1983b
	1981	11.0	(2.7-26)	123	(26-338)	Ecological Analysts 1982b
	Mean	8.8		75		
Nelson Lake, ND	1986**	27.0	(12.0-57)	213	(42-647)	EA 1987b
Turtle Creek Res., IN	1985**	22.8	(9.6-47)	-	-	EA 1986b
	1984**	41.2	(23-99)	-	-	EA 1985c
	1983*	9.5	(5-14)	-	-	WAPORA 1984
	1982*	14.4	(7-26)	-	-	WAPORA 1983
	1981	13.2	(6-24)	-	-	WAPORA 1982
	Mean	20.2				
Sutherland Res., NE	1984**	29.3	(7.0-83)	-	-	EA 1985a
	1983**	29.0	(10.4-91)	-	-	Ecological Analysts 1984a
	1982**	26.3	(10.3-67)	-	-	Ecological Analysts 1983a
	1981*	35.9	(13-104)	-	-	Ecological Analysts 1982a
	1980*	24.2	(6-79)	-	-	Ecological Analysts 1981a Ecological Analysts 1981b
	1975	26.0	(3.4-57)	-	-	Ecological Analysts 1981b
	1974	13.4	(5.0-22)	-	-	Ecologcial Analysts 1981b
	1973	15.3	(1.5-48)	-	-	Ecological Analysts 1981b
	Mean	24.9				
Clinton Lake, IL	1983	22.5	(2.7-116)	-	-	Willmore 1985
	1982	12.7	(2.6-37)	-	-	Willmore 1985
	1981	12.0	(2.0-38)	-	-	Willmore 1985
	1980	15.5		-	-	Willmore 1982
	1979	7.3		-	-	Willmore 1982
	1978	8.1		-	-	Willmore 1982
	Mean	13.0				
LaCygne Lake, KS	1974*	23.3	(1.5-259)	-	-	Willhite et al 1976
	1973*	12.6	(0.9-31)	-	-	Willhite et al 1976
	1972	22.7	(1.4-43)	-	-	Willhite et al 1976
	Mean	19.5				
Lake Sangchris, IL	1975-76*	-	-	78	(43-164)	Waite 1981
Lake Shelbyville, IL	1975-76	-	-	82	(18-134)	(preserved samples)

Note: Asterisk (*) indicate number of generating units operating during the year.

TABLE 3-5 ZOOPLANKTON BIOMASS STANDING CROP AT LOCATIONS 2, 6, AND 8 IN THE COOLING LAKE OF WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1981-1987

Date	Dry Weight (mg/m^3)				Ash-Free Dry Weight (mg/m^3)			
	2	6	8	Mean	2	6	8	Mean
23FEB81	-	338	-	338	-	338	-	338
28APR81	228	143	-	186	195	127	-	161
23JUN81	92	100	-	96	56	62	-	59
25AUG81	205	153	-	179	169	108	-	138
19OCT81	86	29	-	58	55	26	-	40
16DEC81	171	128	-	150	113	99	-	106
Mean	156	148	-	152	118	127	-	123
3MAR82	190	109	-	150	175	105	-	140
27APR82	194	161	-	178	178	148	-	163
22JUN82	44	61	-	52	23	56	-	40
31AUG82	24	66	-	45	18	60	-	39
19OCT82	117	115	-	116	71	90	-	80
7DEC82	76	190	-	133	32	183	-	108
Mean	108	117	-	112	83	107	-	95
1MAR83	30	57	-	44	17	29	-	23
26APR83	75	65	-	70	53	45	-	49
26JUN83	17	83	-	50	14	75	-	44
29AUG83	53	27	-	40	16	18	-	17
18OCT83	153	90	-	122	130	84	101	92
13DEC83	99	107	-	103	84	101	-	92
Mean	71	72	-	71	52	59	-	56
28FEB84	59	34	61	51	44	30	30	35
17APR84	87	43	52	61	60	36	41	46
19JUN84	27	34	67	43	20	29	57	35
21AUG84	64	53	93	70	32	15	21	23
19OCT84	82	95	78	85	63	88	70	74
18DEC84	87	75	89	84	31	24	31	29
Mean	68	56	73	66	42	37	42	40
5MAR85	252	103	199	185	63	30	47	47
15APR85	1052	136	261	483	297	59	112	156
24JUN85	231	97	676	335	29	40	76	48
26AUG85	46	87	94	76	22	70	42	45
22OCT85	392	196	187	258	54	65	67	62
10DEC85	88	72	35	65	66	41	25	44
Mean	344	115	242	234	88	51	62	67
3MAR86	78	106	119	101	46	91	81	73
29APR86	219	154	128	167	162	127	88	126
25JUN86	71	61	169	100	22	48	137	69
18AUG86	37	60	61	53	14	37	38	30
28OCT86	265	201	142	203	136	64	82	94
15DEC86	226	315	360	300	82	257	133	157
Mean	149	150	163	154	77	104	93	91
3MAR87	301	43	79	141	61	24	40	42
28APR87	93	93	265	150	66	71	187	108
22JUN87	200	95	65	120	23	28	25	25
24AUG87	83	76	79	79	23	32	57	37
Mean	169	77	122	123	43	39	77	53

Note: Dash (-) indicates location not sampled.

4. MACROINVERTEBRATES

4.1 INTRODUCTION

The macroinvertebrate fauna of freshwater lakes and rivers is mostly composed of aquatic insects, worms and roundworms. Their distribution within an aquatic macrohabitat is determined by the habits and habitat requirements of the various macroinvertebrate taxa. Habitat variables include current velocity, substrate type, organic matter content, temperature, and water depth. Habits can be mode of feeding (filterers, shredders, grazers, or predators) or the drifting phenomenon which occurs in some taxa found in lotic habitats. Voltinism of aquatic insects can affect density rates and make them highly variable on an annual basis.

Macroinvertebrates can either be primary consumers (detritivores-herbivores) or secondary consumers (carnivores) in aquatic food chains. Primary consumers are usually grazers, shredders, or filterers that feed on phytoplankton, bacteria, aquatic plants, protozoa, and organic detritus. Secondary consumers are predaceous feeding on zooplankton and other macroinvertebrates. Most fish are secondary or tertiary consumers that utilize macroinvertebrates in their diet either as fingerlings or adults. The diversity of macroinvertebrates gives a relative index of species composition, and is also an excellent indicator of water quality due to the narrow tolerance range of some macroinvertebrates to pollutants.

Macroinvertebrate studies at WCGS began on the Neosho River in 1973 and on the Wolf Creek Cooling Lake (WCCL) in 1981. These studies were directed towards the determination of taxa composition, macroinvertebrate density, and diversity from a qualitative and quantitative sampling regime. The primary purpose of this study was to examine spatial and temporal trends in the macroinvertebrate communities for effects of WCGS operation, which began in August 1985.

A macroinvertebrate occurring near WCGS and warranting special attention is the asiatic clam, Corbicula fluminae. The first report of Corbicula near WCGS was in August 1986 when immature clams were collected at a long term monitoring site located on the Neosho River (EA 1987). Quarterly and bimonthly surveys at these sites since 1974 had not produced evidence of Corbicula until 1986. The occurrence of Corbicula in the vicinity of intake structures poses potential biofouling problems associated with these clams as indicated by IE Bulletin 81-03 issued by the U.S. Nuclear Regulatory Commission (April 10, 1981), regarding flow blockage of cooling water to safety system components. Thus, sampling efforts associated with WCGS environmental monitoring program were increased in the fall of 1986 following the August report of Corbicula and the initiation of planned annual surveys began in 1987 to monitor Corbicula in the vicinity of WCGS.

4.2 METHODS

Macroinvertebrate samples were collected from the Neosho River either quarterly or bimonthly from 1973 to 1987 except in 1982, 1983 and 1984 when sampling was not conducted. In all years sampling occurred at Location 10 upstream of the confluence with Wolf Creek and at Location 4 downstream of Wolf Creek. Location 1 in the John Redmond Reservoir tailwaters was added to the sampling regime in 1976 (Figure 1-1). Macroinvertebrate samples were collected from the

WCCL bimonthly from 1981 through August 1987. Sampling at Location 2 near the WCGS discharge and Location 6 near the dam began in 1981. Location 8 near WCGS intake was added to the program in 1984.

Quantitative duplicate benthic macroinvertebrate samples were collected from Locations 4 and 10 on the Neosho River and Locations 2, 6, and 8 on the WCCL with a ponar dredge (area sampled=530 cm^2). The texture of sediment from each ponar sample was visually characterized and then sieved on a U.S. Standard No. 30 mesh (0.595 mm) screen. The sieve residue was preserved with 10 percent formalin and stained with rose bengal (Mason and Yevich 1967) in appropriately labeled containers. Qualitative river samples were obtained by seining and hand picking rocks at Locations 1, 10, and 4 on the same schedule as the ponar collections. Macroinvertebrates encountered were placed in vials and preserved with 10 percent formalin.

In the laboratory, ponar samples from the Neosho River and WCCL were further washed on a U.S. Standard No. 30 mesh screen prior to manually separating macroinvertebrates from debris under 10X magnification. Oligochaeta and Chironomidae were mounted in a nonresinous mounting medium (CMC-10) on glass slides and identified under a compound microscope at 78.75-1250X magnification. Other macroinvertebrates were identified under a binocular dissecting microscope at 10-70X magnification and preserved in 70 percent ethanol. All organisms were identified to the lowest positive taxonomic level using appropriate references. Organisms from the qualitative samples were identified and counted.

Overall trends for densities, taxa composition, and diversity were examined by graphing average annual values for each location. For this report, densities from the benthic macroinvertebrate ponar samples were reported as the mean number of organisms per meter square (No./m^2) annually, and by collection dates. Contribution of major taxonomic groups to the benthos community was graphed as average percent of the annual total density. Identified taxa numbers were reported annually for each sampling location. Diversity indices were calculated using Shannon's (1948) equation using base-2 logarithms and graphed by location for each sampling years. The resulting figures and tables permitted detailed examination of annual temporal cycles and variances between locations.

Sampling efforts for Corbicula during the 1986 survey occurred in August, November and December at Locations 10 and 4, in the vicinity of the makeup water pumphouse (MUSH), and at Hartford Rapids, all in the Neosho River. Sampling in the WCCL was conducted at the three established monitoring sites (Locations 2, 6, and 8), at the Makeup Water Discharge Structure (MUDS), and at the WCGS circulating water intake.

The 1987 survey for Corbicula near WCGS was conducted on 30 September - 1 October. Samples from the Neosho River were taken near the low water dam at Burlington, at U.S. 75 Highway bridge, and below John Redmond Dam in the vicinity of the MUSH. The Neosho River was also sampled at sites above John Redmond Reservoir between the 310 county road bridge and the public launch site at Hartford. Wolf Creek was sampled approximately 50 meters upstream of the FAS-10 bridge. The WCCL was sampled in the vicinity of the MUDS, circulating water screenhouse (CWSH), and the service spillway (Figure 1). Additional samples were taken along the "hilltop gravel" beach west of the service spillway.

Sampling was conducted with three gear types. Ponar grabs were taken at most sites where substrates were suitable. A clam rake with a 1/8-in mesh liner was used at some sites and a 15-ft common-sense seine of 1/8-in mesh was used in the Neosho River where currents allowed kick seining. Water temperature and depth was recorded at each site and substrates were visually characterized and recorded.

4.3 RESULTS AND DISCUSSION

4.3.1 Neosho River Macroinvertebrates

Macroinvertebrates collected during the 1973-1987 Neosho River study were represented by 179 taxa (Table 4-1). The benthic population was dominated by four taxonomic groups that accounted for 65 percent of the total identified taxa; aquatic midges composed 30 percent (54 taxa; Diptera), mayflies 15 percent (26 taxa; Ephemeroptera), aquatic worms 11 percent (20 taxa; Oligochaeta), and caddisflies 9 percent (16 taxa; Trichoptera). Other groups represented in the collections included mollusks (11 taxa), aquatic beetles (10 taxa; Coleoptera), leeches (9 taxa; Hirudinea), dragonflies (9 taxa; Odonata), miscellaneous arthropoda (6 taxa), stoneflies (4 taxa; Plecoptera), true bugs (4 taxa; Hemiptera), hydras (2 taxa; Cnidaria), planarians (2 taxa; Platyhelminthes), bryozoans (2 taxa; Entoprocta), and Collembola and Arachnida (one taxa each).

Macroinvertebrate taxa collected annually from the Neosho River ranged from a low of 26 taxa to a high of 132 taxa in 1973 and 1976, respectively (Table 4-2). The 1973 collection was restricted to Locations 10 and 4, whereas Locations 1, 10 and 4 were sampled in 1976. Annual trends of macroinvertebrate taxa showed no spatial differences between locations. The highest fluctuation in taxa numbers occurred in 1980 with 60 identified taxa from Location 10 and 46 from Location 4 representing a 23 percent difference. In 1977 an equal number of taxa was collected from both locations (Table 4-2).

On a temporal basis, taxa numbers showed an increase from 1973 (26 taxa) to peak taxa numbers in 1976 (132 taxa) when Location 1 was added. Stable taxa numbers occurred from 1976 to 1979 with a decline present in the 1979 and 1981 sampling years. Total taxa collected in 1985 showed a 32 percent decline from 1981 levels, and then gradually approached pre-1985 levels in 1986 and 1987 (Figure 4-1). The declines in taxa number during the 1985 sampling season were attributed to high river flows, which affected sampling efficiency.

Macroinvertebrate densities in the Neosho River ranged from a mean annual low of $48/m^2$ in 1985 to a high of $9{,}156/m^2$ in 1976 (Table 4-3). Total annual densities showed a gradual increase in numbers from 1973 to 1975, increased substantially in 1976 and 1977, and then stabilized between 2,000 and $5{,}000/m^2$ from 1975 to 1981 when the study was suspended. In 1985 when the study was resumed, the lowest annual density of the entire study occurred, apparently as a result of the increased water flows which occurred during that year. Due to the high river flows, collection schedules were altered and the sampling efficiency was affected contributing to the low densities. Density recovered eight fold in 1986 and remained stable in 1987. The same trend in total density occurred for both locations during the study.

Annual density lows were 65 and 48 specimens per square meter at Locations 10 and 4, respectively, with both occurring during the 1985 collections (Table 4-3). Respective maximum annual densities were 12,329 and 5,984/m^2, with both occurring during the 1976 collection season. Densities were highly variable within collection years, and these differences were attributed to climatic and limnological (e.g., flow) changes within the system and to life cycle patterns of the macroinvertebrates.

Of the four major macroinvertebrate taxa groups collected from the Neosho River during the study period, only oligochaetes and caddisflies showed location preferences. Oligochaete occurrence was annually more dominant at Location 4 than at Location 10, except in 1975 and 1977 (Figure 4-2). This difference would be attributable to variations in substrate types between the two locations. Location 10 is a riffle area with a rocky substrate while Location 4 is primarily a sand silt substrate. Annual caddisfly composition showed a preference for Location 10 except in 1977 when caddisflies were more numerous at Location 4 (Figure 4-2). Caddisflies often show preferences for hard substrates (e.g., rocks such as those predominant at Location 10) due to their habit and habitat requirements.

Mayflies showed a mixed distribution between Locations 10 and 4 with no obvious location preference (Table 4-4). Temporally the mayfly composition in the quantitative samples showed an initial high rate, then declined and fluctuated for the remainder of the study. Midges on an annual basis showed no preference for Location 10 or 4, which would be characteristic of the ubiquity of this group. Overall annual trends of midges showed a steady increase in their contribution to the macroinvertebrate composition from 1973-77. Their contribution remained fairly stable from 1977-1985 but declined in the 1980 season. The lowest occurrence of midges occurred in 1986 when they made up less than 6 percent of total density.

Diversity or species richness of macroinvertebrates in the Neosho River was considered moderate from 1975 to 1981 with no consistent spatial difference (Figure 4-1). Diversity during the period ranged between a high of 3.52 in 1980 and a low of 2.37 in 1981 (Table 4-3). Although Location 4 often had slightly higher diversity, Location 10 had the highest annual diversity at 3.81 in 1980. The high diversity peaks in 1980 and 1976 at Location 10 were due to the increased densities of stoneflies (Plecoptera); in 1980 stonefly density was $507/m^2$, and in 1976 it was $464/m^2$. The next highest density of stoneflies occurred in 1979 with $153/m^2$, and stonefly densities did not exceed $50/m^2$ in other years (Table 4-4).

Diversity trends during the sampling years of 1985 to 1987 show the lowest annual diversity of 0.98 recorded in 1985 (Table 4-3). An increase in diversity was seen in 1986, and stabilization occurred in 1987 at approximately 1986 levels. The low diversity from the 1985 samples was attributed to the high river flows which occurred during most of the year and affected sampling efficiency. A recovery period was evident during the sampling years of 1986 and 1987 when diversity increased to pre-1985 levels.

Linear regression was performed using annual densities and annual flows to examine the relationship between these two parameters. This analysis gave a correlation of r=0.75 (Figure 4-1), indicating a relatively strong, inverse relationship between the two variables. High flows can either affect sampling efficiency or the macroinvertebrate community itself by loss of habitat, particularly current velocity parameters, or actual removal of organisms by the increased stream load and its degrading effects. Increased flows can also affect the macroinvertebrate composition and the diversity of the community.

Macroinvertebrate studies of the Neosho River at the John Redmond Reservoir (JRR) tailwaters and upstream and downstream of the confluence with Wolf Creek have been conducted since 1973. Aquatic oligochaetes, mayflies, stoneflies, net-spinning caddisflies, and midge flies have been dominant organisms. No long-term patterns or empirical differences have been found that were attributable to the construction and/or operation of the WCCL and WCGS. The data have been highly variable which was attributed to fluctuating river flows that undoubtedly affected organism abundances but also greatly influenced sampling efficiency. The potential for WCGS to impact the Neosho River macroinvertebrate community has been minimal based on low diversion rates from the JRR tailwaters and the lack of substantial discharge from the WCCL.

4.3.2 Cooling Lake Macroinvertebrates

Benthic macroinvertebrates collected from the Wolf Creek Cooling Lake (WCCL) were represented by 70 taxa from the study period of 1981-1987 (Table 4-1). The benthic community was primarily dominated by the aquatic midges (Diptera) which accounted for 41 percent (29 taxa) of the taxa identified. Two other taxonomic groups which are important to lentic environments and collected from the WCCL were the oligochetes Naididae (7 taxa) and Tubificidae (12 taxa), comprising 10 percent and 17 percent of the taxa total respectively. Other groups represented in the collections were the Mollusca (7 percent, 5 taxa), Ephemeroptera (7 percent, 5 taxa; mayflies), Trichoptera (6 percent, 4 taxa; caddisflies), and Odonata (4 percent, 3 taxa; dragonflies). Groups represented by a single taxon included the Cnidaria, Platyhelminthes, Nematoda, Arthropoda and Arachnida.

Annually, the number of taxa identified from the VCCL remained fairly stable during the 7 year study ranging from a high of 32 taxa in 1981 to a low of 19 in 1987 (Table 4-2). Spatially, no consistent pattern was evident between sampling locations relative to the number of taxa collected during the study period (Figure 4-3). However, data collected show differences in the macroinvertebrate composition at certain locations due to differential location or substrate preferences between taxa groups (Figure 4-3).

For example, Locations 2 and 8 were dominated by the midge taxa group (Figure 4-3 and Table 4-5), based on average percent composition of the annual total macroinvertebrate density. The one exception to the pattern occurred in 1981 during lake filling, when Location 2 was dominated by tubificids and Location 8 was not sampled. The midge dominance at Locations 2 and 8 may be due to the shallower depth of these sampling locations, (4.5 and 7.5 meters respectively) when compared to Location 6 (19 meters). Another factor which could affect macroinvertebrate distribution at the three sampling locations was substrate composition, because prior to lake filling Location 2 was a cultivated field, Location 6 was an old quarry site, and Location 8 was an area of alluvial deposits. Spatially, tubificid taxa were predominantly more abundant at Location 6 during the study period, except in 1981 when tubificids were more abundant at Location 2 (Figure 4-3 and Table 4-5).

Naidid worms never dominated any sampling locations in terms of benthic composition during the study. The highest contribution by the naidids occurred in 1981-82 at Locations 2 and 6, and in 1986-87 at Location 6 only (Figure 4-3 and Table 4-4). During 1983-85, naidids were almost nonexistent in the benthic samples; the same was true for Location 8 throughout the study period. Macroinvertebrate densities in WCCL were typical of new reservoirs, which often exhibit initially high annual densities and then show a decline in numbers to a stable density (Figure 4-4). In WCCL, initially high macroinvertebrate densities occurred during the lake filling phase (1981-1982) and reflected the incorporation of two new temporary nutrient sources, one by the use of a shallow eutrophic reservoir (JRR) as the primary source of water for lake filling, and secondly by the inundation of vegetation. A decline in macroinvertebrate densities occurred in 1983 at the start of the preoperational phase (1983-85), and densities then remained stable for the duration of the study, reflecting the process of the lake assuming its own character.

Macroinvertebrate densities during the three WCCL operational phases ranged from a high of $1,521/m^2$ to a low $170/m^2$ in the lake fill phase (1981-82) and operational phase (1985-87), respectively (Table 4-6). Preoperational and operational densities (1983-1987) averaged $286/m^2$ for the five years, whereas the two year lake-filling average was $1,311/m^2$. Spatially, densities were variable between the sampling locations during preoperational and operational sampling years (1983-1987) with no location showing consistently higher densities. However, during lake-fill macroinvertebrate densities were 50 percent greater at Location 2 when compared to Location 6. The density differences between the two locations is probably due to the previously mentioned variations in depth and substrate type.

Different seasonal trends in benthic densities were evident for the three phases of the study (Figure 4-4). During lake-fill (1981-82), densities peaked in February-March and June, with the February-March peak being the greatest. Remaining sample periods during the lake-fill phase were reasonably stable with the lowest densities occurring in August. In the preoperational phase, peak densities occurred in April while the remaining collection periods were variable. During the operational phase, peak densities occurred in the February-March samples, declines were evident in April, and densities then remained fairly constant for the later collection dates.

Seasonal benthic densities showed the relatively high density which occurred during the lake-fill phase, the decline during the preoperational phase, and the stability during the operational phase that was also evident in the annual benthic density (Figure 4-4). This decreasing density pattern was evident for nearly all sampling seasons. Exceptions included the February-March season, when a minor density increase occurred between the preoperational and operational phases, and the April season when a minor decrease occurred between the lake fill and preoperational phases. Overall annual and seasonal density trends were considered representative of a new lake that was initially filled with eutrophic water and experienced nutrient loading, and thereafter gradually assumed its own character.

Diversity or species richness of the WCCL macroinvertebrate community showed no annual trends or consistent spatial differences during the study period. Low benthic diversity occurred in 1985 for Locations 2 and 6 at 1.14 and 0.88 respectively. Diversity maxima occurred at Location 6 in 1981 (1.89) and Location 2 in 1982 (2.00), and even these values were considered in the low to moderate range. On an average annual basis maximum diversity occurred in 1981 at 1.76, and the low was 1.06 in 1985 (Table 4-6). There were no evident changes in benthic diversity attributable to WCGS. Incidents of variations in benthic diversity both annually and seasonally could be attributed to climatic and limnological changes within the system.

Obvious differences were noted in diversity between the Neosho River (annual high 3.52) and WCCL (annual high 1.76). These differences reflect variations in the habitat requirements of certain benthic groups and the greater variety of habitats in the river. Two groups poorly represented in the WCCL but important in the Neosho River were the Ephemeroptera (mayflies, 26 taxa from the Neosho River) and Trichoptera (caddisflies, 16 taxa from the Neosho River). Both of these groups contain primarily lotic inhabitants. However, four taxa from each group were identified from the Wolf Creek Cooling Lake.

The quantitative dominance of the burrowing benthic Tubificidae and Chironomidae in the WCCL reflected the characteristic soft ooze-like substrates rich in organic matter typical of the lake bottom (Reid 1961). This benthic fauna is typical of most depositional lake bottom sediments (Brinkhurst 1974) and is similar to that of other midwestern reservoirs: John Redmond Reservoir, Kansas (Funk and Ransom 1977); Keystone Reservoir, Oklahoma (Ransom and Dorris 1972); Lakes Matanzas, Quiver and Chautauqua, Illinois (Paloumpus and Starrett 1960).

Benthic macroinvertebrates in the VCCL have been sampled bimonthly since 1981 when the cooling lake was initially filled. The 1986 program represented the second annual study since WCGS began operation and data were similar to previous lake-filling and preoperational data. The benthic fauna of the VCCL is fairly typical of lakes in general and midwestern reservoirs in particular. Quantitative dissimilarities in the faunas from the three sampling sites reflected differences in their respective depths, substrate composition, and organic matter content. The data have exhibited high annual variation from 1981 through 1987 that likely reflects various ecological, climatic, and limnological factors. Operation of WCGS has caused no apparent changes in the macroinvertebrate community. Declines in macroinvertebrate abundance that occurred after WCCL was initially filled represent normal responses to changes in productivity that occur as reservoirs begin to age.

4.3.3 Corbicula Distribution and Abundance

Asiatic clam (*Corbicula fluminea*) densities in the Neosho River below Burlington ranged from no clams to 9.4/m^2 at Location 10 and from 47.3 to 57.6/m^2 at Location 4 in 1986. The 1987 samples showed a 41 percent increase (57.6 to 79.9 m^2) at Location 4 and essentially no change at Location 10, (Table 4-7). These densities are considered indicative of pioneer populations. In the New River, Virginia, *Corbicula* increased from 30/m^2 to more than 10,000/m^2 in a two year period (Cherry et al. 1986).

Additional efforts to monitor the distribution of *Corbicula* in the vicinity of WCGS in 1987 (30 September - 1 October) showed an expansion upstream to the U.S. 75 bridge where one specimen was collected (Table 4-8). Additional locations sampled included FAS-10 Bridge on Wolf Creek, Burlington low water dam, John Redmond Reservoir (JRR) tailwaters, and the Hartford Boat Ramp area above JRR. Three Corbicula were collected near the Burlington Dam which is downstream of the U.S. 75 bridge, but no Corbicula were collected at the remaining sampling Locations (Table 4-8).

Corbicula surveys in the Neosho River near WCGS have shown a gradual increase in densities at downstream locations and an increase in distribution upstream to the U.S. 75 bridge. Further expansion of Corbicula distribution appears to be limited by substrate types found in the Neosho River upstream of Burlington. Corbicula are reported from nearly all substrate types, however, optimum conditions seem associated with loose gravel in shallow pools below riffles and sandy or rock-bottom streams of intermediate flow (Neck 1986).

Substrate types below JRR consists of extensive natural bedrock and coupled with high current velocities would be a limiting factor in this area. The reservoir itself has rich ooze and mud substrates which would also limit Corbicula colonization. The potential for Corbicula to become established in JRR or its tailwaters near the MUSH, which could be a possible vector for distribution into WCCL, appears to be limited due to the inhospitable substrate types.

Asiatic clams have not been collected from the Wolf Creek Cooling Lake. Sampling in the WCCL after the reported occurrence in the Neosho River consisted of 70 ponar grabs since August of 1986. Forty-two of those samples were taken bimonthly from established monitoring sites near the WCGS Intake (Location 8), the main dam of WCCL (Location 6), and an uplake site near the

VCGS discharge (Location 2). The additional 28 samples were taken in the 1986 and 1987 *Corbicula* surveys near the CVSH and MUDS.

The apparent lack of *Corbicula* upstream in JRR minimizes the potential that VCCL will have a future population because makeup water for the cooling lake is pumped from the Neosho River immediately below the JRR stilling basin. It is generally accepted that other than man-mediated dispersion, downstream drift of the planktonic larval stage is the main factor affecting range extensions. Therefore, before *Corbicula* could be introduced to the VCCL via makeup water, it would have to occur upstream in JRR.

4.4 SUMMARY AND CONCLUSIONS

4.4.1 Neosho River Macroinvertebrate Studies

Macroinvertebrates studies of the Neosho River at the John Redmond Reservoir (JRR) tailwaters as well as upstream and downstream of the confluence with Wolf Creek have been conducted since 1973. Aquatic oligochaetes, mayflies, stoneflies, net-spinning caddisflies, and midge flies have been dominant organisms. No long-term patterns, empirical, or statistical differences have been found that suggested any alterations attributable to the construction and/or operation of the WCCL and WCGS. The data have been highly variable which has been attributed to fluctuating river flows that undoubtedly affects organism abundances but also greatly influences sampling efficiency.

The macroinvertebrate monitoring program on the Neosho River was reimplemented in 1985 to coincide with start up of WCGS after the program was discontinued in

1982. High, variable flows in 1985 resulted in low sample recovery and benthic densities that approached the lowest recorded since monitoring was initiated in 1973. Species richness and abundance improved substantially in 1986 as flows were comparatively stable and low. In 1987, the number of taxa encountered remained stable, and mean annual ponar density exhibited continued improvement. The potential for WCGS to impact the Neosho River macroinvertebrate community has been minimal based on low diversion rates from the JRR tailwaters and the lack of substantial discharge from the WCCL.

4.4.2 WCCL Macroinvertebrate Studies

Benthic macroinvertebrates in the WCCL have been sampled bimonthly since 1981 when the cooling lake was initially filled. The benthic fauna of the WCCL is fairly typical of lakes in general and midwestern reservoirs in particular. The data have exhibited high annual variation from 1981 through 1987 that likely reflects various ecological, climatic, and limnological factors. While quantitative dissimilarities in the faunas from the three sampling sites reflected differences in respective depths, substrate composition, and organic matter content. Operation of WCGS caused no apparent changes in the macroinvertebrate community during the initial two years of operation.

Although mean annual benthic macroinvertebrate densities in 1987 (170 organisms/m^2) were at a low for the seven-year study, densities declined annually through 1984 after peaking in 1982 (1,521/m^2). Mean annual densities increased slightly in 1985 (332/m^2), the first year of station operation, but have since continued to decline. Down lake densities at the deep water (17-22 m) location near the main dam were primarily responsible for the annual trend.

At the organism level, primarily oligochaetes and chironomids influenced the trend as both groups declined annually after peaking in 1982 except for tubificid which recovered in 1985 and than declined to relatively low densities in 1986 and 1987. The 1985 recovery was due almost exclusively to mean annual tubificid densities at Location 6, which were the second highest recorded for the WCCL study. Apparent changes in the WCCL benthos reflect normal responses of pioneer organisms to newly-filled reservoirs and could be expected independent of WCGS operation.

4.4.3 Asiatic Clam-Corbicula

The 1987 survey for Asiatic Clams in the vicinity of Wolf Creek Generating Station verified that *Corbicula fluminea* remained established in the Neosho River below Burlington, Kansas. Further distribution of *Corbicula* upstream of Burlington appears to be limited by inhabitable substrate types in these reaches of the Neosho River. *Corbicula* has not been found in the WCCL. Possible colonization of WCCL could occur by man-mediated dispersion or by uptake of *Corbicula* larvae via the MUSH into WCCL. The absence of an established population in the JRR tailwaters or further upstream makes the second mode of introduction unlikely. However, substantial expansion in abundance and upstream dispersion would increase the likelihood that *Corbicula* could eventually occur in the WCCL.

Several factors which could possibly affect *Corbicula* distribution and abundance include substrate types in both the river and the cooling lake, anoxic conditions in the stratified cooling lake (Sickel 1986), and low winter temperatures and low flows in the Neosho River.

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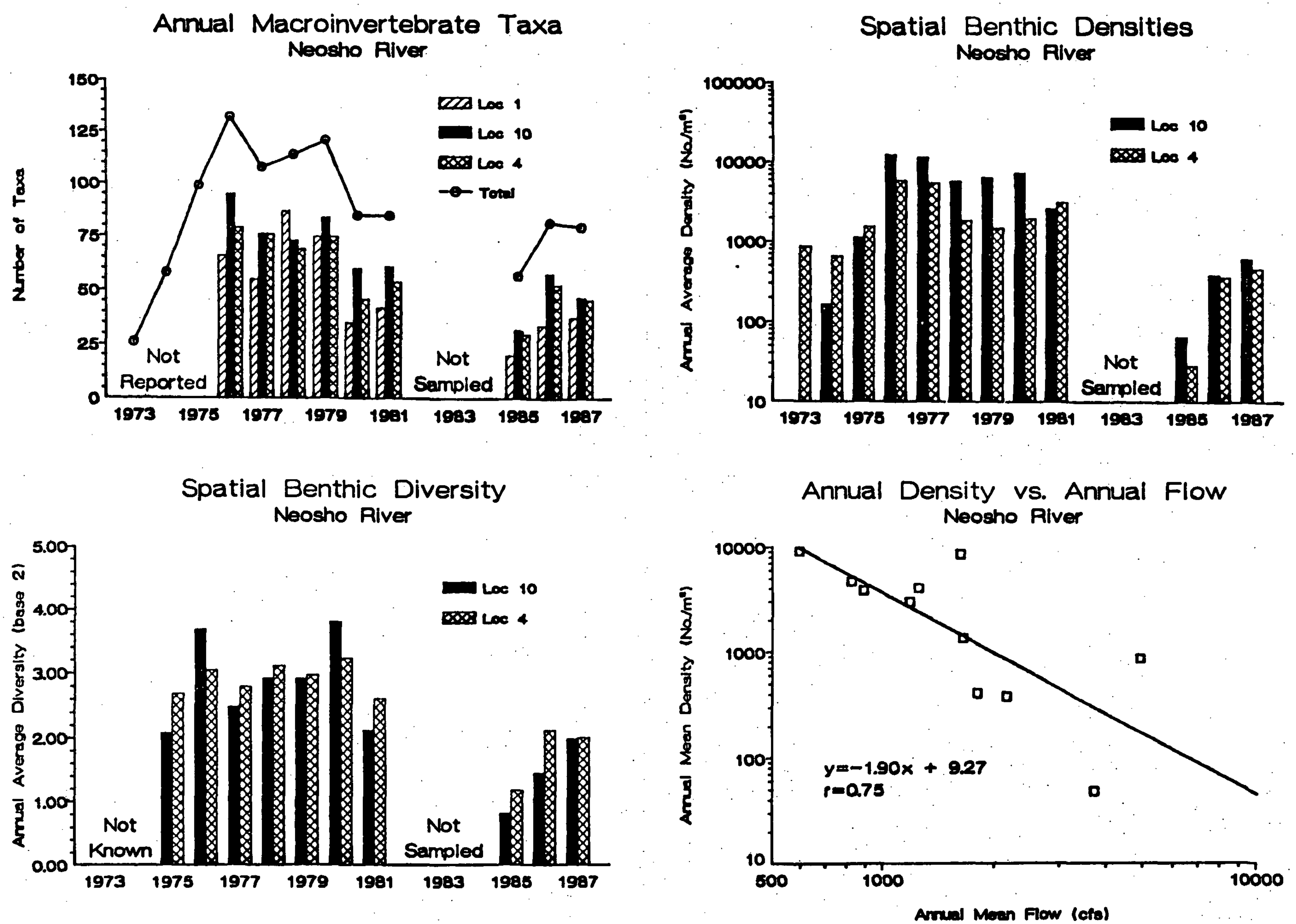

Figure 4-1. Macroinvertebrate density and diversity in the Neosho River near Wolf Creek Generating Station, 1973-1987.

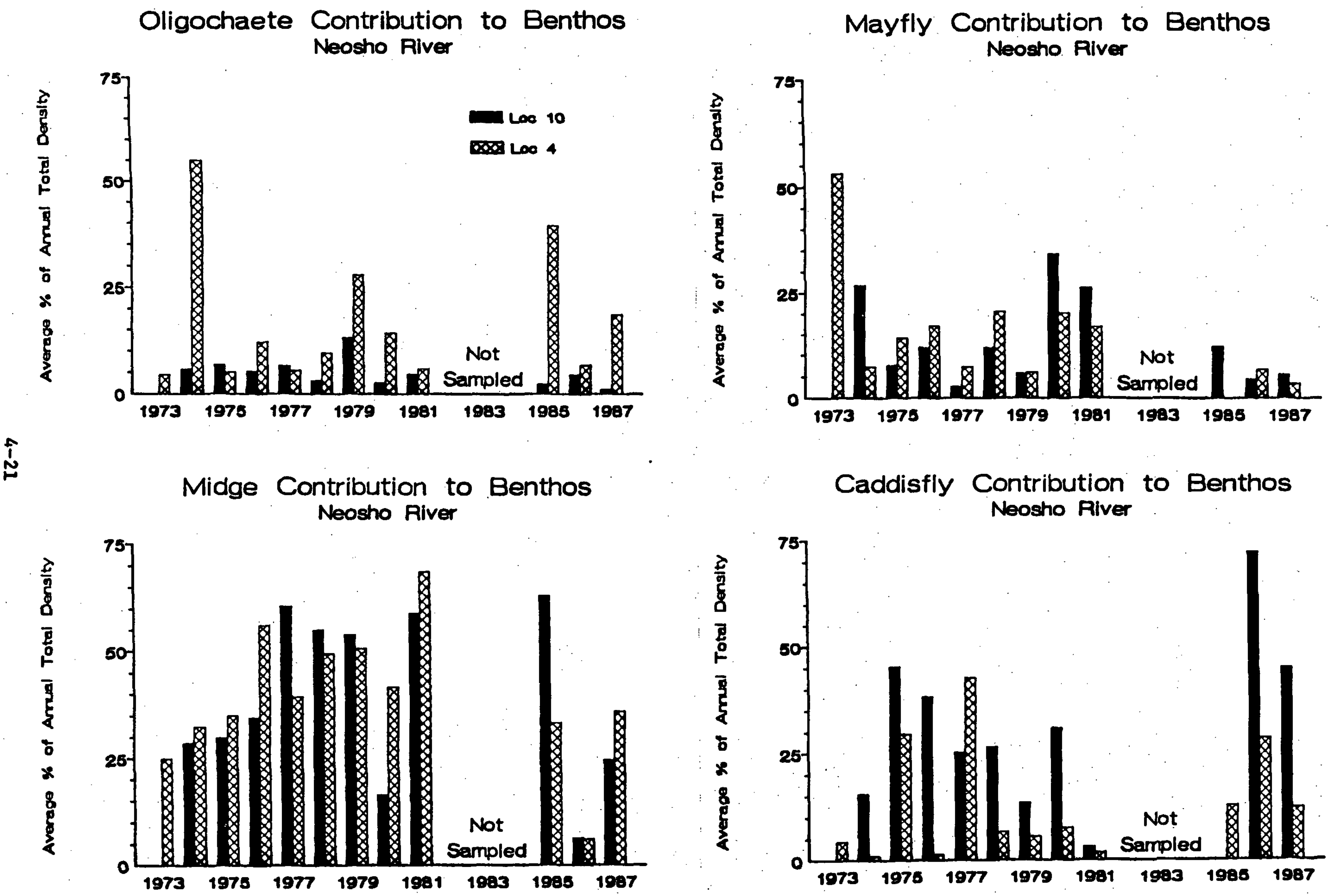

Figure 4-2. Spatial and temporal trends for major benthic groups in the Neosho River near Wolf Creek Generating Station, 1973-1987.

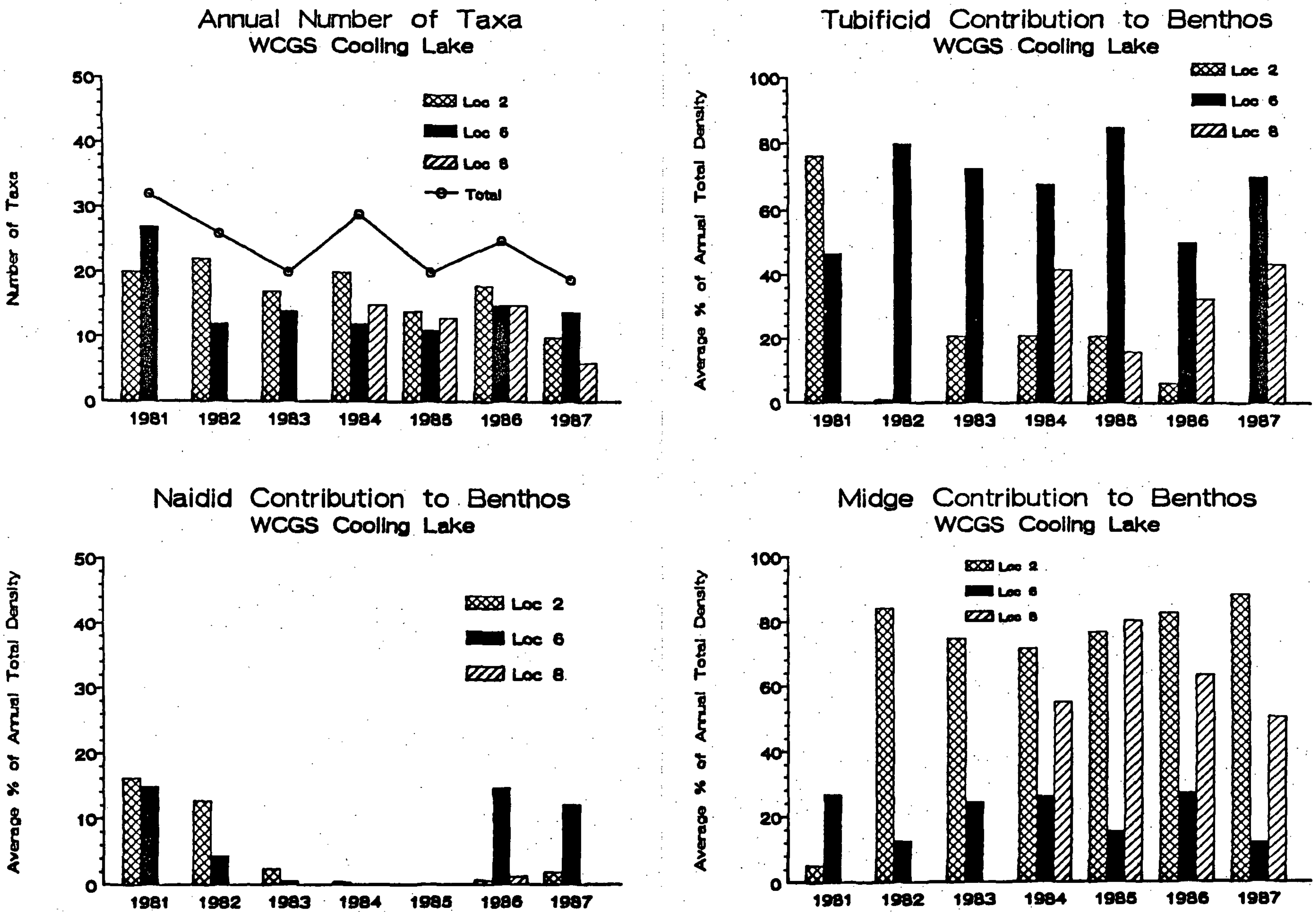

Figure 4-3. Spatial and temporal trends in total taxa and major benthic groups in the Cooling Lake at Wolf Creek Generating Station, 1981–1987.

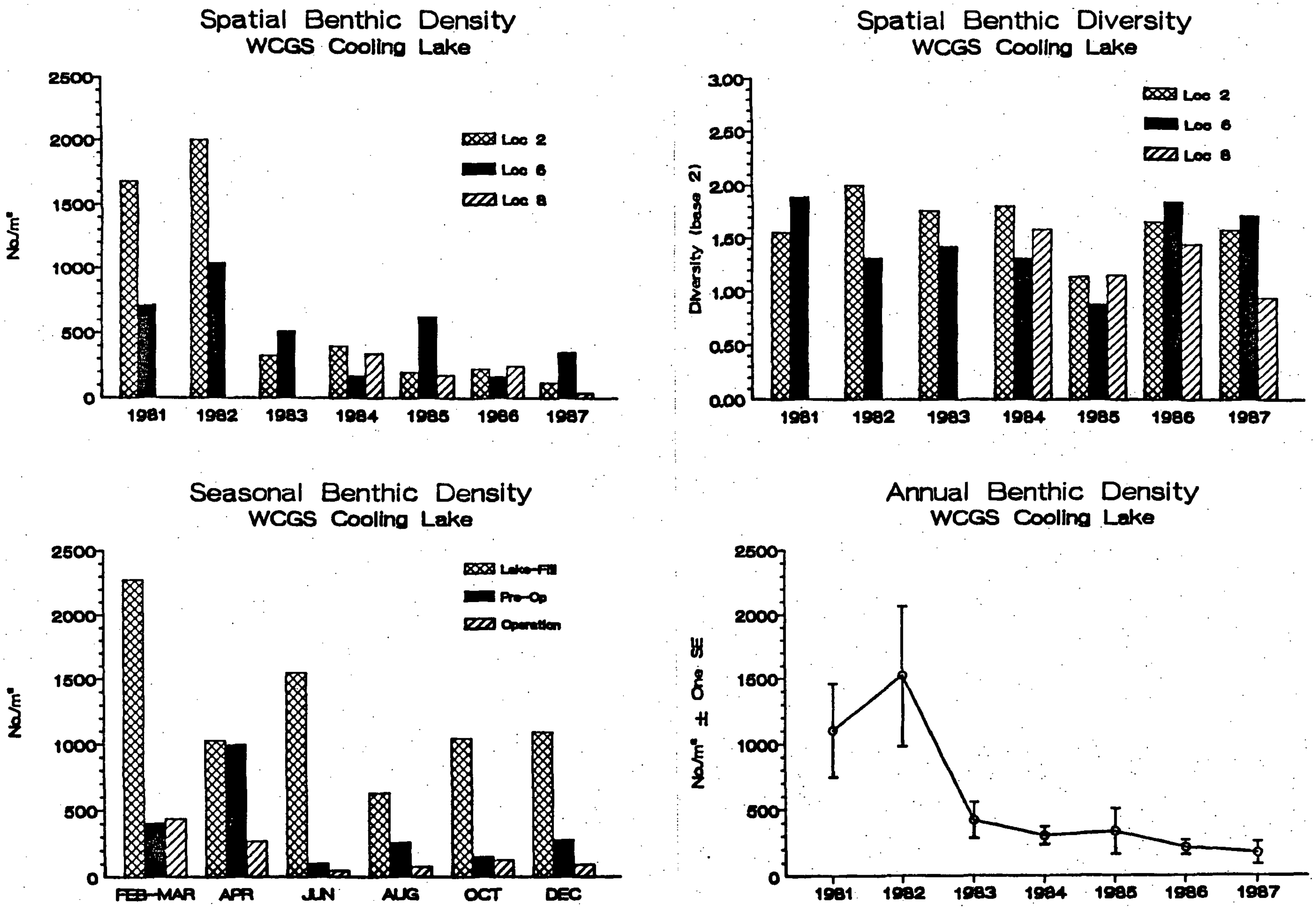

Figure 4-4. Macroinvertebrate density and diversity in the Cooling Lake at Wolf Creek Generating Station, 1981-1987.

TABLE 4-1 OCCURRENCE OF MACROINVERTEBRATES AT SAMPLING LOCATIONS IN THE NEOSHO RIVER AND COOLING LAKE NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS

Taxa	Neosho River			Cooling Lake		
	1	10	4	2	6	8
Cnidaria						
Hydrozoa						
Hdroidae						
Clavidae						
Cordylophora lacustris Allman			X			
Hydridae						
Hydra sp. Linnaeus	X	X	X			X
Platyhelminthes						
Turbellaria						
Tricladida						
Unidentified Tricladida	X					
Planariidae						
Dugesia sp. Ginard	X	X	X	X		
Nematoda						
Unidentified Nematoda				X	X	X
Entroprocta						
Phylactolaemata						
Plumetellidae						
Unidentified Plumatellidae	X	X				
Urnatellidae						
Urnatella gracilis Leidy	X					
Annelida						
Oligochaeta						
Plesiopora						
Enchytraeidae						
Unidentified Eachytraeidae		X	X			
Naididae						
Dero digitata Muller		X	X	X	X	
Dero trifida (Loden)				X		
Dero sp.					X	
Haemonais waldvogeli Bretcher				X		
Nais bretcheri (Michaelsen)		X	X			
Nais communis	X					
Nais elinquis Muller		X				
Nais pardalis	X					
Nais simplex Piquet	X	X				
Nais variabilis Piquet		X	X	X	X	X
Nais sp. (Muller)	X	X	X	X	X	
Ophidanais serpentina Muller					X	X
Pristina foreli Piquet			X			
Pristina longisoma leidyi	X					
Pristina sp.		X				
Tubificidae						
Imm. with cap. chaetae				X	X	X
Imm. without cap. chaetae		X	X	X	X	X
Aulodrilus limnobius Bretcher					X	
Aulodrilus piqueti Kowaleski			X	X	X	X
Branchiura sowerbyi Beddard	X	X	X	X	X	X
Ilyodrilus mastix (Brinkhurst)					X	
Ilyodrilus templetoni Southern				X	X	X
Limnodrilus cervix Brinkhurst			X	X	X	X
Limnodrilus claparedionus Claparede			X	X	X	X
Limnodrilus hoffmeisteri Claparede		X	X	X	X	X

TABLE 4-1 (Cont.)

Taxa	Neosho River			Cooling Lake		
	1	10	4	2	6	8
Limnodrilus profundicola Verril						X
Limnodrilus udekemianus Claparede				X	X	X
Branchiobdellidae						
Unidentified Branchiobdellidae	X	X	X			
Prosopora						
Lumbriculidae						
Unidentified Lumbriculidae			X			
Hirudinea						
Rhychobdellida						
Glossiphoniidae						
Unidentified Glossiphoniidae			X			
Immature Glassiphoniidae	X	X				
Actinobdella inequiannulata Moore	X	X				
Actinobdella triannulata Moore	X					
Placobdella multilineata Moore			X			
Placobdella ornata			X			
Pharyngobdellida						
Erpobdellidae						
Unidentified Brpobdellidae	X	X				
Immature Erpobdellidae	X					
Dina microstoma Moore		X				
Arthropoda						
Crustacea						
Amphipoda						
Gammaridae						
Crangonyx sp. Bate	X	X	X			
Talitridae						
Hyallella azteca (Saussure)			X		X	
Decapoda						
Astacidae						
Unidentified Astacidae	X	X	X			
Orconertes virilis Hagen	X	X	X			
Orconertes sp.		X				
Plaemoniidae						
Palaemonetes Kadiakensis Rathbun	X	X	X			
Arachnida						
Acarina						
Hydracarina						
Unidentified Hydracarina	X			X		
Insecta						
Collembola						
Isotomidae						
Isotomurus sp. Barner		X				
Ephemeroptera						
Siphlonuridae						
Siphlonurus sp. Eaton			X			
Baetidae						
Unidentified Baetidae		X				
Baetis sp. Walsh	X	X	X			
Oligoneuriidae						
Isonychia sp. Eaton	X	X	X			
Heptageniidae						
Unidentified Heptageniidae			X			
Immature Heptageniidae		X				
Heptagenia flavescens Walsh	X					
Heptagenia bebe McDunnough			X			

TABLE 4-1 (Cont.)

Taxa	Neosho River			Cooling Lake		
	1	10	4	2	6	8
Heptagenia sp. Walsh	X	X	X			
Stenacron interpunctatum Jensen	X	X	X			
Stenacron sp.	X		X			
Stenonema integrum McDunnough	X	X	X			
Stenonema pulchellum Walsh	X	X	X			
Stenonema terminatum Walsh	X	X				
Stenonema tripunctatum Banks	X	X	X			
Stenonema sp. Traver	X	X	X			
Tricarythidae						
Tricarthodes sp. Ulmer	X	X	X			
Caenidae						
Caenis sp. Stephens	X	X	X	X		
Patomanthidae						
Potamanthus myops grp.			X			
Potamanthus sp. Piclet	X	X	X		X	
Ephemeridae						
Hexagenia limbata (Serville)	X			X	X	
Hexagenia sp. (Walsh)		X		X		X
Polymitarcyidae						
Ephoron album Say		X	X			
Ephoron sp. Williamson		X	X	X		
Tortopus pimus	X					
Tortopus sp. McCunnough		X				
Odonata						
Zygoptera						
Unidentified Zygoptera		X				
Gomphidae						
Erpetogomphus sp.			X			
Gomphus sp. Leach	X	X	X			
Macromiidae						
Macromia illinoiensis Walsh			X			
Macromia sp.		X				
Libellulidae						
Sympetrum sp. Newman					X	
Coenagrionidae						
Unidentified coenagrionidae				X		
Argia apicalis	X					
Argia moesta Hagen	X	X	X			
Argia tibirallis	X	X	X			
Argia sp. Rambur	X	X	X	X		
Plecoptera						
Perlidae						
Unidentified Perlidae		X				
Acroneuria sp. Newman		X				
Neoperla clymene Newman		X	X			
Perlesta placida Hagen		X	X			
Hempitera						
Gerridae						
Metrobates sp. While		X	X			
Rheumatobates sp. Bergroth		X	X			
Trepobates sp. Uhler			X			
Corixidae						
Unidentified corixidae	X					
Megaloptera						
Sialidae						
Sailis sp. Latreille		X				

TABLE 4-1 (Cont.)

Taxa	Neosho River			Cooling Lake		
	1	10	4	2	6	8
Corydalidae						
Corydalus cornutus Linnagus		X	X			
Trichoptera						
Polycentropodidae						
Unidentified Polycentropodidae				X		
Cyrnellus fraternus Banks	X	X	X			
Cyrnellus sp. Banks	X					
Neuroclipsis sp. Melachlan		X	X			
Hydropsychidae						
Unidentified Hydropsychidae	X	X	X			
Cheumatopsyche sp. Wellengren	X	X	X			
Hydropsyche bidens Ross		X				
Hydropsyche orris Ross	X	X	X			
Hydropsyche simulans Ross	X	X	X			
Hydropsyche sp.		X				
Potamyia flava Hagen	X	X	X			
Hydroptilidae						
Hydroptila sp. Delman		X				
Limnephilidae						
Limnephilus sp. Leach				X		
Pycnopsyche sp. Banks			X			
Leptoceridae						
Unidentified Leptoceridae				X		
Ceraclea sp. Stephens			X			
Nectopsyche candida Hagen	X					
Nectopsyche sp. Muller			X			
Oecetis sp. McLachlan		X	X	X		
Coleoptera						
Unidentified Coleoptera		X				
Gyrinidae						
Unidentified Gyrinidae		X				
Dineutus sp. Macleay		X	X			
Gyretes sp.			X			
Gyrinus sp. Muller			X			
Dytiscidae						
Unidentified Dytiscidae		X	X			
Hydrophilidae						
Unidentified Hydrophilidae			X			
Tropisternus sp. Erichson		X				
Elmidae						
Unidentified Elmidae		X				
Stenelmis sp. Dufour	X	X	X			
Diptera						
Tipulidae						
Unidentified Tipulidae		X	X			
Hexatoma sp. Latreille		X	X			
Chaoboridae						
Chaoborus albatus (Jobas)				X		X
Chaoborus punctipennis (Say)	X	X	X	X	X	X
Ceratopogonidae						
Unidentified Ceretopoganidae	X		X	X	X	
Simuliidae						
Unidentified Simuliidae	X	X	X			
Prosimulium sp Rouband	X					
Simulium sp. Latreille	X	X				X
Chironomidae						

TABLE 4-1 (Cont.)

Taxa	Neosho River 1	Neosho River 10	Neosho River 4	Cooling Lake 2	Cooling Lake 6	Cooling Lake 8
Unidentified Chironomidae Pupa	X	X	X	X	X	
Chironominae						
Unidentified Chironominae			X			
Unidentified Chironmini	X					
Chernovskia amphitrite Saether					X	
Chironomus sp. (Meiqen)	X	X	X	X	X	X
Cladopelma sp. Kieffer				X		
Cladotanytarsus sp. Kieffer		X	X			
Cryptochironomus sp. (Kieffer)	X	X	X	X	X	X
Dicrotendepis sp. Kieffer	X	X	X	X	X	
Endochironomus sp. Kieffer				X		
Glyptotendipes lobiferus Say				X	X	
Glyptotendipes sp. Kieffer	X	X	X	X	X	X
Kiefferulus sp. Gaetghebuer				X		
Microchiranomus sp. Kieffer	X					
Microspectra sp. Kieffer		X				
Parachironomus sp. Lenz	X	X	X	X	X	
Paralauterborniella sp. Lenz		X				
Paratanytarsus sp. Kieffer				X		
Phaenopspectra sp. Kieffer		X				
Polypedilum ss convictum type (Walker)	X	X	X			
Polypedilum ss scalaenum type Schrank			X			
Polypedilum ss simulans type Townes		X	X			
Polypedilum sp. Kieffer		X	X	X	X	
Pseudochironomus sp. Malloch	X	X	X		X	
Rheotanytarsus sp. Bause		X	X			
Stictochironomus sp. Kieffer		X	X	X		
Tanytarsus sp. VanderWulp	X	X	X	X	X	
Tribelos sp.			X			
Xennchironomus anceus Roback		X		X		
Tanypodinae						
Unidentified Tanypodinae					X	
Ablabesmyia sp. Johannsen	X	X	X			
Coeleotanypus coacinnus (coquillett)				X		X
Coelotanypus sp. Kieffer	X	X	X	X	X	X
Labrundirala sp. Fittkan			X			
Larsia sp. Fittkau	X	X	X	X	X	
Procladius sp.	X		X	X	X	X
Pentaneura sp. Philippi		X				
Tanypus sp. Meiqen	X			X		X
Thienemanaimyia Group Fittkau		X	X	X	X	
Orthorladiinae						
Unidentified orthorcladiiae	X	X	X			
Corynoneura sp. Winnertz		X	X			
Cricotopus bicinctus group Merger	X	X	X			
Cricotopus fucus Kieffer		X				
Cricotopus ss intersectus Sensuhiruenaja		X				
Cricotopus tremulus group	X	X	X			
Circotopus ss tremulus type Sensuhiruenaja	X	X	X			
Cricotopus triannulatus Macquart		X				
Cricotopus vierriensis Goetghebuer		X				
Cricotopus sp. Van der Wulp	X		X			
Eukiefferiella sp Thieneman	X	X	X			
Hydrobaenus sp. Brundin		X	X			
Nanocladius sp. Kieffer	X	X	X			
Octhocladius oliveri Sapenis				X		

TABLE 4-1 (Cont.)

Taxa	Neosho River 1	3	4	Cooling Lake 2	6	8
Octhocladius sp. Van Der Vulp	X	X	X			
Thienemanniella sp. Kieffer	X	X	X			
Dolichopodidae						
Unidentified Dolichopadidae		X	X			
Mollusca						
Gastropoda						
Unidentified Gastropoda			X			
Pulmonata						
Physidae						
Physa sp Draparnaud	X	X	X	X	X	
Ancylidae						
Unidentified Ancylidae	X					
Ferrissio rivularis (Say)		X		X		
Ferrissia sp. Walker	X	X				
Pelecypoda						
Heterodonata						
Sphaeriidae						
Musculium transversum Muller	X	X	X		X	X
Pisidium sp. Pfeiffer						
Sphaerium transversum (Say)		X				
Sphaerium sp. Scopoli					X	
Corbiculidae						
Corbicula fluminea Muller		X	X			
Corbicula sp.		X	X			
Unianidae						
Anodanta grandis Say			X			
Lampsilis ovata Say		X				
Total Taxa	87	126	118	54	42	26
Combined Taxa		179			70	

TABLE 4-2 ANNUAL NUMBER OF MACROINVERTEBRATE TAXA COLLECTED FROM LOCATIONS 1, 10, AND 4 IN THE NEOSHO RIVER AND LOCATIONS 2, 6, AND 8 IN THE COOLING LAKE OF WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS 1973-1987

Site/Year	Location/Number of Taxa			
Neosho River	**1**	**10**	**4**	**Total**
1973	-	*	*	26
1974	-	*	*	58
1975	-	*	*	99
1976	66	95	79	132
1977	55	76	76	108
1978	87	73	69	114
1979	75	84	75	121
1980	35	60	46	85
1981	42	61	54	85
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	20	32	30	57
1986	34	58	53	82
1987	38	47	46	80
Cooling Lake	**2**	**6**	**8**	**Total**
1981	20	27	-	32
1982	22	12	-	26
1983	17	14	-	20
1984	20	12	15	29
1985	14	11	13	20
1986	18	15	15	25
1987	10	14	6	19

Notes:
1. Dash (-) indicates location not sampled.
2. Asterisk (*) indicates location results not reported separately.
3. Results for river include both qualitative and quantitative samplings.
4. Ponar sampling only was conducted in the cooling lake.

TABLE 4-3 MACROINVERTEBRATE DENSITY AND DIVERSITY IN PONAR COLLECTIONS FROM LOCATIONS 10 AND 4 IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1973-1987

Date	Density (No./m^2)			Diversity (base 2)		
	10	4	Mean	10	4	Mean
27MAR73	-	-	-	-	-	-
11JUN73	-	-	-	-	-	-
10SEP73	-	1598	1598	-	-	-
10DEC73	-	143	143	-	-	-
Mean	-	871	871	-	-	-
26MAR74	-	-	-	-	-	-
11JUN74	38	142	90	-	-	-
10SEP74	265	463	364	-	-	-
10DEC74	189	1370	780	-	-	-
Mean	164	658	411	-	-	-
17APR75	340	388	364	1.90	2.23	2.07
10JUN75	2646	2174	2410	2.05	2.67	2.36
9SEP75	974	1257	1116	1.01	2.41	1.71
3DEC75	567	2438	1503	3.36	3.47	3.42
Mean	1132	1564	1348	2.08	2.70	2.39
25FEB76	4366	3657	4012	3.78	3.30	3.54
6APR76	13098	8496	10797	4.32	3.76	4.04
15JUN76	350	1890	1120	2.31	2.10	2.21
9AUG76	23795	7590	15693	3.38	2.92	3.15
5OCT76	16282	4328	10305	4.05	2.62	3.34
14DEC76	16084	9941	13013	4.27	3.58	3.93
Mean	12329	5984	9156	3.69	3.05	3.37
22FEB77	35504	8902	22203	2.27	2.85	2.56
4APR77	15498	5746	10622	3.74	3.54	3.64
8JUN77	265	605	435	1.89	3.33	2.61
9AUG77	510	1701	1106	2.49	2.66	2.58
4OCT77	14317	14723	14520	1.83	2.09	1.96
13DEC77	2485	1852	2169	2.69	2.31	2.50
Mean	11430	5588	8509	2.49	2.80	2.64
21FEB78	104	718	411	1.88	2.39	2.14
25APR78	1606	1002	1304	3.43	3.62	3.53
27JUN78	9894	2022	5958	2.36	3.09	2.73
29AUG78	7881	1077	4479	3.54	3.03	3.29
10OCT78	4536	3449	3993	3.18	2.87	3.03
12DEC78	11179	3081	7130	3.18	3.71	3.45
Mean	5867	1892	3879	2.93	3.12	3.02

TABLE 4-3 (Cont.)

Date	Density (No./m^2) 10	4	Mean	Diversity (base 2) 10	4	Mean
20FEB79	30051	3270	16661	4.00	2.71	3.36
10APR79	775	633	704	3.57	3.79	3.68
12JUN79	576	983	780	2.13	3.10	2.62
6AUG79	869	813	841	2.61	3.02	2.82
8OCT79	7532	3307	5420	3.94	3.10	3.52
10DEC79	57	94	76	1.29	2.13	1.71
Mean	6643	1517	4080	2.92	2.98	2.95
15APR80	-	-	-	-	-	-
17JUN80	4413	1399	2906	3.98	3.23	3.61
28OCT80	17360	4111	10736	4.19	4.07	4.13
16DEC80	435	567	501	3.25	2.38	2.82
Mean	7403	2026	4714	3.81	3.23	3.52
27APR81	8713	6880	7797	3.86	2.84	3.35
22JUN81	1975	3478	2727	3.00	3.04	3.02
19OCT81	66	2750	1408	1.61	2.80	2.21
15DEC81	9	76	43	*	1.79	0.90
Mean	2691	3296	2993	2.12	2.62	2.37
5MAR85	28	38	33	0.92	1.50	1.21
16APR85	94	66	80	2.32	2.81	2.57
22JUL85	266	-	266	1.64	-	1.64
23SEP85	0	0	0	*	*	0.00
19NOV85	0	9	5	*	*	0.00
9DEC85	0	28	14	*	1.58	0.79
Mean	65	28	48	0.81	1.18	0.98
3MAR86	142	-	142	1.87	-	1.87
28APR86	227	236	232	2.70	2.47	2.59
22JUL86	1852	76	964	1.27	0.00	0.64
19AUG86	113	605	359	1.83	3.39	2.61
17NOV86	19	463	241	1.00	2.25	1.63
16DEC86	9	473	241	*	2.48	1.24
Mean	394	371	383	1.45	2.12	1.75
2MAR87	1783	1311	1547	2.95	3.51	2.32
28APR87	226	208	217	1.83	1.30	1.57
22JUN87	406	151	279	1.25	1.50	1.38
24AUG87	123	245	184	1.91	1.72	1.82
Mean	635	479	557	1.99	2.01	2.00

Notes: 1. Dash (-) indicates locations not sampled or diversity not calculated.

2. Asterisk (*) indicates diversity not calculated because <2 organisms collected. Diversity assumed to be 0.00 for mean calculations.

TABLE 4-4 SELECT MACROINVERTEBRATE TAXA DENSITIES IN PONAR COLLECTIONS FROM LOCATIONS 10 AND 4 IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1973-1987

Date	Oligochaetes		Mayflies		Stoneflies		Caddisflies		Midges	
	10	4	10	4	10	4	10	4	10	4
27MAR73	-	-	-	-	-	-	-	-	-	-
11JUN73	-	-	-	-	-	-	-	-	-	-
10SEP73	-	0	-	906	-	0	-	38	-	416
10DEC73	-	76	-	20	-	0	-	38	-	19
Mean	-	38	-	463	-	0	-	38	-	218
26MAR74	-	-	-	-	-	-	-	-	-	-
11JUN74	9	0	0	38	0	0	0	0	9	38
10SEP74	0	350	113	85	0	0	57	0	38	28
10DEC74	19	737	19	19	0	0	19	19	94	576
Mean	9	362	44	47	0	0	25	6	47	214
17APR75	218	38	0	19	0	0	0	114	86	104
10JUN75	28	10	264	567	19	0	1200	1163	1012	369
9SEP75	19	28	19	76	56	454	832	520	10	57
3DEC75	38	237	57	227	10	10	19	57	246	1664
Mean	76	78	85	222	21	116	513	464	339	549
25FEB76	397	217	57	132	38	1172	283	38	3147	1285
6APR76	2982	2675	142	160	775	671	1105	19	6709	4593
15JUN76	28	0	151	1200	0	66	66	321	57	113
9AUG76	47	245	1624	3676	737	85	18919	19	2240	3307
5OCT76	85	408	2930	312	225	38	3496	0	8533	3393
14DEC76	387	822	3827	672	1011	9	4403	75	4876	7475
Mean	639	728	1455	1025	464	340	4712	79	4260	3361
22FEB77	567	94	973	274	0	38	3034	9	29286	8108
4APR77	3374	1342	396	37	9	9	56	0	11000	3884
8JUN77	113	160	9	95	0	0	9	28	57	113
9AUG77	255	47	122	1125	9	47	0	311	104	151
4OCT77	56	141	302	841	246	208	12748	12748	652	756
13DEC77	85	38	9	37	9	76	1427	1228	539	217
Mean	742	304	302	402	46	63	2879	2387	6940	2205
21FEB78	28	85	0	19	0	9	38	482	38	104
25APR78	37	19	19	104	57	66	584	208	463	208
27JUN78	94	312	1029	916	19	19	7862	0	803	576
29AUG78	19	123	1654	19	9	0	793	28	5207	888
10OCT78	378	529	1143	1143	151	0	28	19	2693	2164
12DEC78	491	9	321	132	9	813	28	18	10140	1673
Mean	175	180	694	389	41	151	1556	126	3224	936

TABLE 4-4 (Cont.)

Date	Oligochaetes 10	Oligochaetes 4	Mayflies 10	Mayflies 4	Stoneflies 10	Stoneflies 4	Caddisflies 10	Caddisflies 4	Midges 10	Midges 4
20FEB79	5075	1739	1522	95	850	9	3534	28	15329	1304
10APR79	132	151	47	28	0	0	0	9	472	274
12JUN79	19	538	47	0	0	0	0	0	170	180
6AUG79	19	19	236	236	0	0	425	265	161	142
8OCT79	19	85	435	179	66	142	1370	189	5358	2665
10DEC79	9	19	0	9	0	0	9	19	28	47
Mean	879	425	381	91	153	25	890	85	3586	769
15APR80	-	-	-	-	-	-	-	-	-	-
17JUN80	0	0	397	350	265	47	1531	444	1909	519
28OCT80	331	472	7173	832	1210	66	5320	19	1682	1918
16DEC80	227	397	38	47	47	0	9	0	28	98
Mean	186	299	2536	410	507	38	2287	154	1206	845
27APR81	435	265	1691	76	123	0	217	0	5887	6067
2JUN81	47	208	1134	2117	0	0	113	208	444	766
19OCT81	0	274	19	47	0	2	9	28	19	2202
15DEC81	9	28	0	0	0	0	0	0	0	28
Mean	123	194	711	560	31	1	85	59	1588	2266
5MAR85	0	19	0	0	0	0	0	1	9	0
16APR85	9	28	0	0	0	0	0	0	66	238
22JUL85	0	-	47	-	0	-	0	-	170	-
23SEP85	0	0	0	0	0	0	0	0	0	0
19NOV85	0	0	0	0	0	0	0	9	0	0
9DEC85	0	9	0	0	0	0	0	9	0	9
Mean	2	11	8	0	0	0	0	4	41	9
3MAR86	19	-	0	-	0	-	9	-	104	-
28APR86	9	19	9	9	19	47	113	9	9	9
22JUL86	0	0	95	76	161	0	1588	0	9	0
19AUG86	76	95	0	38	0	104	0	170	28	95
17NOV86	0	9	0	0	0	38	0	151	0	9
16DEC86	0	0	0	0	0	57	0	198	0	0
Mean	17	25	17	25	30	49	285	106	25	23
2MAR87	18	349	104	38	76	0	679	76	613	679
28APR87	9	9	9	0	9	0	19	19	0	9
22JUN87	0	0	28	28	9	19	349	104	0	0
24AUG87	0	0	0	0	9	9	94	38	9	0
Mean	7	90	35	17	26	7	285	59	156	172

Notes: 1. Dash (-) indicates location not sampled.

TABLE 4-5 SELECT MACROINVERTEBRATE TAXA DENSITIES IN PONAR COLLECTIONS FROM LOCATIONS 2, 6, AND 8 IN THE COOLING LAKE OF WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1981-1987

	Naidadae			Tubificide			Midges			Other		
Date	2	6	8	2	6	8	2	6	8	2	6	8
23FEB81	-	0	-	-	208	-	-	766	-	-	10	-
28APR81	0	189	-	1162	57	-	0	38	-	19	19	-
23JUN81	38	9	-	3667	1625	-	142	142	-	28	312	-
24AUG81	369	0	-	302	19	-	66	142	-	19	9	-
20OCT81	680	387	-	0	0	-	132	28	-	28	0	-
15DEC81	-	151	-	-	85	-	-	28	-	-	0	-
Mean	272	123	-	1283	332	-	85	191	-	24	58	-
3MAR82	331	19	-	0	0	-	6483	104	-	28	0	-
27APR82	28	0	-	0	813	-	1682	104	-	9	0	-
22JUN82	19	0	-	0	0	-	189	9	-	0	0	-
31AUG82	860	0	-	0	473	-	132	0	-	0	0	-
19OCT82	9	208	-	66	1711	-	577	255	-	19	0	-
7DEC82	274	47	-	38	1985	-	1040	312	-	47	0	-
Mean	254	46	-	17	830	-	1684	131	-	17	0	-
1MAR83	9	0	-	95	217	-	633	28	-	39	9	-
25APR83	0	19	-	66	1143	-	567	482	-	9	18	-
23JUN83	0	0	-	28	76	-	142	142	-	0	0	-
29AUG83	38	0	-	113	680	-	47	85	-	0	0	-
18OCT83	0	0	-	85	19	-	19	0	-	0	0	-
13DEC83	0	0	-	19	85	-	38	9	-	0	0	-
Mean	8	3	-	68	370	-	241	124	-	8	5	-
29FEB84	0	0	0	217	9	605	170	19	312	0	0	0
17APR84	0	0	0	95	331	66	19	85	435	0	28	0
19JUN84	0	0	0	9	28	38	19	38	28	0	0	0
21AUG84	0	0	0	66	217	76	227	9	9	19	0	9
16OCT84	9	0	0	28	9	19	510	0	85	9	0	0
17DEC84	0	0	0	85	95	47	756	113	246	47	0	0
Mean	2	0	0	83	115	142	284	44	186	13	5	2
5MAR85	0	0	0	19	302	9	161	142	104	9	0	0
16APR85	0	0	0	198	2863	95	454	265	548	9	0	38
24JUN85	0	0	0	0	0	0	19	57	95	0	0	0
26AUG85	0	0	0	0	0	38	85	0	38	0	0	0
21OCT85	0	0	0	28	9	9	113	0	0	0	0	0
9DEC85	0	0	0	0	0	19	66	113	57	0	0	0
Mean	0	0	0	41	529	28	150	96	140	3	0	6
3MAR86	9	123	9	47	161	180	680	113	624	47	0	0
28APR86	0	0	9	0	9	28	76	104	104	19	0	19
24JUN86	0	0	0	0	57	47	28	19	0	9	9	0
19AUG86	0	0	0	19	113	47	151	0	19	19	0	0
27OCT86	0	19	0	9	104	142	85	19	142	9	28	0
16DEC86	0	0	0	9	47	38	104	9	38	19	0	0
Mean	2	24	3	14	82	80	187	44	155	20	6	3
2MAR87	9	104	0	0	28	47	208	76	38	28	66	0
28APR87	0	66	0	0	925	19	123	57	38	9	9	0
22JUN87	0	0	0	0	38	0	28	19	0	9	0	0
24AUG87	0	0	0	0	0	0	66	19	0	0	0	0
Mean	2	43	0	0	248	17	106	43	19	12	19	0

Note: 1. Dash (-) indicates location not sampled.

TABLE 4-6 MACROINVERTEBRATE DENSITY AND DIVERSITY IN PONAR COLLECTIONS FROM LOCATIONS 2, 6, AND 8 IN THE COOLING LAKE OF WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1981-1987

Date	Density (No./m^2)				Diversity (base 2)			
	2	6	8	Mean	2	6	8	Mean
23FEB81	-	992	-	992	-	2.92	-	2.92
28APR81	1181	302	-	742	0.75	2.36	-	1.56
23JUN81	3884	2088	-	2986	1.55	1.86	-	1.71
24AUG81	775	208	-	492	2.36	1.34	-	1.85
20OCT81	898	416	-	657	1.57	0.73	-	1.15
15DEC81	-	274	-	274	-	2.14	-	2.14
Mean	1685	713	-	1102	1.56	1.89	-	1.76
3MAR82	6936	198	-	3567	2.37	2.03	-	2.20
27APR82	1729	917	-	1323	2.19	1.57	-	1.88
22JUN82	208	9	-	109	1.48	*	-	0.74
31AUG82	1068	472	-	770	1.07	0.86	-	0.87
19OCT82	671	2202	-	1437	1.94	1.84	-	1.89
7DEC82	1399	2438	-	1919	2.97	1.56	-	2.27
Mean	2002	1039	-	1521	2.00	1.31	-	1.66
1MAR83	746	255	-	501	1.97	1.43	-	1.70
25APR83	643	1673	-	1158	2.22	1.98	-	2.10
23JUN83	170	217	-	194	1.40	1.56	-	1.48
29AUG83	217	765	-	491	2.77	0.79	-	1.78
18OCT83	104	38	-	71	1.31	1.00	-	1.16
13DEC83	57	113	-	85	0.92	1.78	-	1.35
Mean	323	510	-	417	1.77	1.42	-	1.59
29FEB84	387	38	964	463	2.57	1.50	2.39	2.15
17APR84	113	454	501	356	1.38	2.31	1.68	1.79
19JUN84	28	66	66	53	0.92	0.99	0.99	0.97
21AUG84	359	227	94	227	3.24	0.74	1.57	1.85
16OCT84	586	9	113	236	0.83	*	1.21	0.68
17DEC84	907	217	293	472	1.93	2.35	1.70	1.99
Mean	397	169	339	301	1.81	1.32	1.59	1.57
5MAR85	189	442	113	248	1.12	2.15	0.41	1.23
16APR85	662	3128	680	1490	2.64	2.20	2.23	2.36
24JUN85	19	57	94	57	0.00	0.92	1.30	0.74
26AUG85	85	0	76	54	0.50	*	1.91	0.80
21OCT85	151	9	9	56	2.00	*	*	0.67
9DEC85	66	113	76	85	0.59	0.00	1.07	0.55
Mean	195	625	175	332	1.14	0.88	1.15	1.06
3MAR86	784	406	822	671	1.97	2.73	2.48	2.39
28APR86	94	113	161	123	1.57	1.28	2.02	1.62
24JUN86	38	94	47	60	1.50	2.12	0.00	1.21
19AUG86	189	113	66	123	1.98	0.65	0.86	1.16
27OCT86	113	170	293	192	1.21	2.59	2.33	2.04
16DEC86	142	76	76	98	1.74	1.75	1.00	1.50
Mean	227	162	244	211	1.66	1.85	1.45	1.65
2MAR87	245	274	85	201	2.25	2.66	2.20	2.37
28APR87	132	1057	57	415	1.20	2.31	1.58	1.70
22JUN87	38	57	9	35	1.50	0.92	*	0.81
24AUG87	66	19	0	28	1.38	1.00	*	0.79
Mean	120	352	38	170	1.58	1.72	0.95	1.42

Notes: 1. Dash (-) indicates location not sampled.
2. Asterisk (*) indicates diversity not calculated because <2 organisms collected. Diversity assumed to be 0.00 for mean calculations.

TABLE 4-7 SUMMARY OF ASIATIC CLAM (*CORBICULA FLUMINEA*) ABUNDANCE IN PONAR GRABS FROM TWO LOCATIONS ON THE NEOSHO RIVER, BURLINGTON KANSAS

	Location 4		Location 10	
Date	No.	Density (No./m^2)	No.	Density (No./m^2)
AUG 86	6	56.7	1	9.4
NOV 86	5	47.3	0	0.0
DEC 86	5	47.3	1	9.4
MAR 87	6	56.7	2	18.9
APR 87	2	18.9	1	9.4
JUN 87	0	0.0	1	9.4
AUG 87	17	79.9	1	9.4
Mean		43.8		9.4

Note: Density data represents mean of duplicate samples from each location.

TABLE 4-8 SUMMARY OF SAMPLES COLLECTED DURING SURVEY FOR ASIATIC CLAMS IN THE VICINITY OF WOLF CREEK GENERATING STATION, 30 SEPTEMBER - 1 OCTOBER 1987

Site	Location/Replicate	Water Temperature (C)	Water Depth (ft.)	Gear[a]	Substrate Type[b]	No. of Asiatic clams
WCCL	CWSH					
	1	21.3	4	P	Clay, gravel	0
	2	-	4	P	Clay, gravel	0
	3	-	5	P	Ooze, clay	0
	4	-	5	P	Ooze, clay, gravel, rock	0
	5	-	15	P	Silt, gravel	0
	6	-	18	P	Clay, gravel, rock	0
	7	-	6	P	Ooze, detritus, Fine gravel	0
	8	-	6	P	Ooze, detritus, Fine gravel	0
WCCL	MUDS					
	1	23.7	7	P	Silt, clay, detritus	0
	2	-	5	P	Silt, clay, detritus	0
	3	-	3	P	Silt, clay, detritus	0
	4	-	4	P	Silt, clay, detritus	0
	5	-	2	P	Silt, clay, detritus	0
	6	-	3	P	Silt, clay, detritus	0
	7	-	1	P	Silt, clay, detritus, Gravel	0
	8	-	1	P	Silt, clay, detritus, Gravel	0
WCCL	Service Spillway					
	1	23.1	3	P	Detritus, silt, clay	0
	2	-	3	P	Detritus, silt, clay	0
	3	-	4	P	Detritus, silt, clay	0
	4	-	4	P	Detritus, silt, clay	0
WCCL	Gravel Beach					
	1	23.1	1-2	R	Upland gravel	0
	2	-	1-2	R	Upland gravel	0
	3	-	1-2	R	Upland gravel	0
Wolf-Creek	FAS-10 Bridge					
	1	21.5	<1	R	Silt, gravel	0
	2	-	<1	R	Silt, gravel	0
	3	-	<1	R	Silt, gravel	0
Neosho River	Burlington Dam Downstream					
	1	20.5	<1	PP	Gravel, sand, silt	1
	2	-	<1	PP	Gravel, sand, silt	1
	3	-	<1	PP	Gravel, sand, silt	1/2
	4	-	<1	PP	Gravel, sand, silt	1/2

TABLE 4-8 (Cont.)

Site	Location/Replicate	Water Temperature (C)	Water Depth (ft.)	Gear[a]	Substrate Type[b]	No. of Asiatic clams
Neosho River	MUSH					
	Chute below MUSH	19.7	<1-3	S, R	Bedrock, gravel, silt	0
	Chute below Island- and Stilling Basin	-	<1-2	S, R	Gravel, bedrock	0
	U.S. 75 Bridge					
	Upstream 50 m	19.5	8	P	Gravel	0
	At bridge	-	1	P	Clay	0
			1	P	Clay	0
	Downstream-150 m	19.5	4	P	Clay	0
	200 m	-	3	P	Detritus, silt	0
		-	6	P	Detritus, silt	1
	300 m	19.6	5	P	Clay, woody debris	0
		-	4	P	Clay, woody debris	0
Neosho River	Hartford Boat Ramp					
	Downstream	19.1	2	P	Silt, detritus	0
	Upstream					
	1	19.1	2	P	Silt, clay	0
	2	-	2	P	Silt, clay	0
	3	-	2	P	Gravel, rock, silt	0
	4	-	1	P	Gravel, rock, silt	0
	5	-	1-2	R	Gravel, rock, silt	0
	6	-	3	P	Silt, clay	0
	7	-	2	S	Silt, gravel	0
	8	-	1-3	S	Gravel	0
	9	-	1-3	S	Gravel	0
	10	-	1-3	S	Gravel	0

(a) Gear: P=ponar, PP=petite ponar, R=clam rake, S=seine.
(b) Substrate types listed in order of dominance.

5. FISHERIES

5.1 INTRODUCTION

Adult, juvenile, and larval fish were monitored in the Neosho River and Wolf Creek to provide data on potential construction and operational impacts of WCGS on the aquatic communities since 1973. Baseline information was obtained from the tailwaters of John Redmond Reservoir (JRR) to determine potential impingement and entrainment losses at the make up water screenhouse. Areas upstream and downstream of the Wolf Creek and Neosho River confluence were monitored to determine potential effects of construction and dam closure. The occurrence of fishes in Wolf Creek was monitored to (1) establish seasonal and spatial patterns, (2) monitor construction effects, and (3) to establish the value of Wolf Creek as a spawning and/or nursery area.

This report section summarizes adult and juvenile data collected from the Neosho River from 1973 through 1982 and 1985 through August 1987. The data represent the seining and electrofishing program that provided a basis for preoperational-operational comparisons. Data from program components that were not incorporated into the operational study initiated in 1985 (EA 1986) were not included in this report. Preimpoundment fisheries data from Wolf Creek were obtained through 1980 and results are summarized in annual monitoring reports and the WCGS environmental report (KGE 1981). Results of post-impoundment cooling lake fisheries studies are presented in annual reports prepared by Ecological Analysts (1983) and WCNOC (1988).

5.2 FIELD AND ANALYTICAL PROCEDURES

Surveys of the Neosho River from the tributaries of JRR to below the Wolf Creek confluence were conducted seasonally from 1973 through 1982 and 1985 through 1987. Locations and gears changed during early study years. Location 1 was in John Redmond Reservoir upstream of the dam until 1977 when the tailwaters location replaced the reservoir location. Gill and hoop nets were also part of the program but were discontinued when the reservoir location was replaced in 1977 and when electrofishing proved more effective than hoop nets to determine species composition and relative abundance in the Neosho River. Locations were added in 1975 to include Location 10 upstream of the confluence with Wolf Creek and Location 11, a riffle immediately below the confluence that was monitored only for Neosho madtom.

Data collected from 1977 through 1981 and 1985 through 1987 were most comparable because of the above changes. Differences between these data sets, which essentially represent preoperational-operational data are summarized in Table 5-1. Program changes were made as milestones were met at WCGS. The actual sampling scheme reflects schedule changes resulting from weather and water conditions. Cold weather often resulted in sampling in early March rather than February, and high water conditions occasionally caused sampling to be delayed or missed.

An AC boat-mounted boom shocker has been used since 1977 to collect fish at Locations 1, 10, and 4. Sampling consisted of a 30-minute effort at each location and encompassed approximately 800 meters of shoreline. Changes in the electrofishing equipment used during the study probably contributed to lower catches in recent years. The three-phase 230 volt AC generator used from 1977 through 1980 was replaced by a 3,000 watt single-phase generator in 1981. From 1982 through 1987, a single-phase 3,500 watt generator was used with a Coffelt model UVP-15 unit. An operating comparison (Heidinger et al. 1983) of three electrofishing systems similar to those used in this study indicate substantial differences in efficiency with the Coffelt unit the least efficient. The difference between the Coffelt and the Homelite systems (which were very similar to that used in the Neosho River from 1977-1980) was attributed to a combination of electrode array and amperage drawn. The electrode array for the Neosho River study remained the same, although the electrodes were changed in 1981.

A 1.8 x 4.6 meter straight seine with 0.3 centimeter Ace mesh was used to collect forage-sized fish from shallow areas at Locations 1, 10, and 4 on the Neosho River. Generally two to four straight seine hauls were performed at each location when water levels were suitable. Since 1976 qualitative kick seines have been performed at Location 11 using the standard seine to document the presence of the Neosho madtom, listed as threatened in Kansas (Kansas Administrative Regulations, 1987). All Neosho madtoms collected using this method were measured and released at the time of capture.

Fish collected by electrofishing were identified, weighed, measured, and released alive unless needed for radiological/environmental samples. Seine samples (excluding Neosho madtom) were preserved in 10 percent formalin and returned to the laboratory for analysis. Each fish collected was identified, measured, and weighed (if greater than 10 g). Species represented by more than 25 individuals were counted after 25 lengths were recorded.

Catch per unit effort (CPE) was defined as the number of fish collected per 30 minutes (No./30 min.) of electroshocking. Seine catches were presented as the number of fish collected per seine location (excluding Location 11). Spatial and temporal comparisons were based on CPE data.

5.3 RESULTS AND DISCUSSION

5.3.1 Overview

Surveys of the Neosho River from 1973 through 1987 (exclusive of 1983 and 1984) from the tailwaters of John Redmond Reservoir (JRR) to below the confluence with Wolf Creek yielded 52 species representing 12 families (Table 5-2). Annual surveys encountered 29 to 41 species, with 13 species reported during each of the 13 years, including gizzard shad, carp, golden shiner, ghost shiner, red shiner, river carpsucker, smallmouth buffalo, channel catfish, white bass, green sunfish, orangespotted sunfish, white crappie, and freshwater drum. Nine additional species occurred during 11-12 annual surveys, and four (shorthead redhorse, blue suckers, flathead catfish, and mosquitofish) were collected each year after electrofishing was initiated in 1977 (Table 5-2). Similarly, Neosho madtom were encountered each year except 1978 after kick seining at Location 11 was added to the program. All reported species from the study area are common to the Neosho River system except wiper and walleye which were introduced through stocking activities of the Kansas Department of Parks and Wildlife.

Electrofishing and seine catches from 1977 - 1982 and 1985 - 1987 were utilized to examine species composition and relative abundance of the Neosho River fish community. The combined gear provided the best representation of species encountered in the study. The total catch of 35,400 fish captured during the 9 years that both gears were used was dominated by cyprinids and herrings (i.e. gizzard shad), which accounted for 65 and 17 percent, respectively. Comparison of preoperational (1977-82) and operational (1985-87) data sets indicated only slight shifts in relative abundance at the family level:

Family	RELATIVE ABUNDANCE 1977-82 (Preoperational)	1985-87 (Operational)
Gars	0.3	0.3
Herrings	16.4	16.8
Minnows/Carp	61.2	73.0
Suckers	7.8	2.0
Catfishes	3.1	1.4
Topminnows	<0.1	<0.1
Livebearers	0.8	2.7
Silversides	0.4	0.1
Temperate basses	1.7	0.4
Sunfishes	4.6	2.0
Perches	0.3	0.2
Drums	3.5	1.0

The greatest difference between data sets occurred for cyprinids which increased by nearly 12 percent. That increase primarily reflected lower relative abundance for all families except gars, herrings, topminnows, and perches which were relatively unchanged and livebearers which increased. The increase of livebearers was due to a large 1987 catch of mosquitofish (317 fish) that accounted for 61 percent of the total 9-year catch for these fish.

Thirteen species contributed 83 to 97 percent to the annual catches and accounted for 95 percent of the total catch for the 9 years that both electrofishing and seining were conducted. Annual differences were apparent at the species level, although red shiner was the most abundant species all years except 1982 (Table 5-3). The 1982 survey included only tailwater collections where red shiner catches were typically low (Section 5.3.3). Gizzard shad were codominant except in 1980 and from 1985-1987 when ghost shiner catches were higher. Approximately 74 percent of the ghost shiner captured in the 9-year study were collected during the operational study period.

5.3.2 Electrofishing

Electrofishing in the Neosho River from 1977-1982 and 1985-1987 captured 7,918 fish representing 37 species and two hybrids (Table 5-4). Gizzard shad accounted for 35 percent of the total electrofishing catch and was the most abundant species except in 1979 and 1980 when river carpsucker catches were highest. River carpsucker accounted for 13 percent of the total electrofishing catch and other catostomids as a group contributed 10 percent. Few catostomids were collected by seining (Section 5.3.3) and all blue sucker were taken by electrofishing. Blue sucker were considered a threatened fish in Kansas until

May 1, 1987 when it was removed from the list (Kansas Administrative Regulations, 1987).

Total catch per unit effort (CPE) ranged from 39.0 to 90.1 during the 1977-82 preoperational study, compared to 16.1 to 38.5 during the 1985-87 operational study (Table 5-4). Changes in electrofishing equipment after 1980 (Section 5.2) likely contributed to lower CPE in recent years which averaged 40.5 after the change compared to 70.9 from 1977-80. The low catch in 1980 before the equipment change was due primarily to the lowest annual catch of gizzard shad and relatively low catches of white bass and white crappie (Table 5-4). Catches of all three species are typically highest at Location 1 in the JRR tailwaters and appear related to year-class strength in John Redmond Reservoir and seasonal releases from JRR dam.

Relative abundance and the average CPE for predominant species in the electrofishing catch declined during the operational study except for increased relative abundance of gizzard shad, smallmouth buffalo, and flathead catfish (Table 5-5). Overall operational catches averaged 55 percent lower than the preoperational average with percent reductions ranging from 34 (gizzard shad) to 82 percent (white bass). Catch rates of flathead catfish were similar between preoperational and operational study periods because of high catches in 1986 and 1987 that ranked second and third for the 9-year study (Table 5-4).

Consistent spatial differences were apparent throughout the 9-year study with higher total electrofishing catches from the JRR tailwaters (Location 1), followed by Location 10 upstream of the confluence with Wolf Creek (Table 5-6). Catch rates below the Wolf Creek confluence were consistently lower except in

1981 and 1987 when average CPE was slightly higher than at Location 10. Higher catches from the JRR tailwaters resulted primarily from catches of gizzard shad, although average catch rates of most other predominant species were also higher in the tailwaters than in the lower river. Exceptions included freshwater drum, carp, and flathead catfish. Freshwater drum and carp catches averaged highest upstream of the Wolf Creek confluence (Location 10), whereas flathead catfish catch rate averaged highest below the confluence (Location 4). Annual catches generally reflected the overall spatial differences as there were only 17 exceptions (7 percent), primarily for carp, smallmouth buffalo, and flathead catfish, species with relatively low average catch rates.

Higher catches at Location 1 have been attributed to habitat differences between the tailwaters and the lower river locations and to the proximity of Location 1 to JRR. Several species (e.g., gizzard shad, white bass, and white crappie) are thought to originate primarily from JRR. Catch rates for the ten predominant species, as a group, averaged 61 percent higher upstream of the confluence with Wolf Creek than at the downstream sampling site. Catches between the two lower locations were most similar in 1981 and 1987 (Table 5-6). Habitat differences also existed between Locations 10 and 4 and probably contributed to differences in catches from the lower river. Location 10 includes a large riffle and gravel bar with a long shallow run downstream of the riffle, whereas Location 4 is on a bend in the river below the riffle at Location 11 and includes a deep pool and smaller gravel bar.

5.3.3 Seining

Neosho River seine collections from 1973-1982 and 1985-1987 captured 36,306 fish. Collections were dominated by gizzard shad, ghost shiner, and red shiner, which collectively accounted for over 90 percent of the seine catches during the 12-year study (Table 5-7). Annual catches of red shiner ranked first except in 1973, and catches of gizzard shad and ghost shiner generally ranked second or third. Data from 1973-1975 included seine collections only below the confluence with Wolf Creek (Location 4), whereas after 1975 three sites (Locations 1, 10, and 4) were surveyed. The occurrence of Neosho madtom after 1975 resulted from the addition of qualitative kick seining at a riffle immediately below the Wolf Creek confluence (Location 11), although subsequent sampling at Locations 10 and 4 also yielded Neosho madtom. The numbers of fish per seine collection did not exhibit a long-term trend. The lowest catch occurred in 1973 and the highest in 1985 when WCGS began operation.

Total catches during the 1973-82 preoperational study ranged from 207 to 5,944, compared to 1,956 to 7,314 during the 1985-87 operational study. Preoperational catches from 1976-82 were compared to the operational catches to evaluate potential shifts in species composition. Operational catches averaged 29 percent higher, due primarily to higher catches of ghost shiner (Table 5-8). Most other predominant species increased only slightly, although mosquitofish increased more than 3-fold because of a large catch in 1987 at the lower river locations (Table 5-9). The game fish catch declined by nearly 35 percent during the operational study. This group included nine species (black bullhead, channel catfish, flathead catfish, white bass, bluegill, spotted bass, largemouth bass, white crappie, and freshwater drum) but only contributed three percent to the total catch from 1976-1982 and 1985-1987. Bullhead minnow catches declined by 82 percent during operational study. Lower bullhead minnow catches were apparent both upstream and downstream of the Wolf Creek confluence with nearly identical reductions between preoperational and operational catch rates (Table 5-9). Bullhead minnow occurred in the JRR tailwater collections only in 1980 and 1985.

Seine catches of the predominant species were highest at the lower river collection sites except for catches of gizzard shad and game fish which averaged highest from the JRR tailwaters (Location 1; Table 5-9). As was indicated for the electrofishing data, the abundance of gizzard shad, white bass and white crappie at Location 1 suggest tailwater catches reflect the influence of releases from JRR reservoir. Cyprinid catches were much higher at the downstream sites, although ghost shiner catches at Location 1 ranked higher than upstream of the Wolf Creek confluence at Location 10. Ghost shiner collected from Location 1 were taken from a small shallow (<2 ft.) cove adjacent to the main channel leading from the JRR stilling basin, habitat apparently preferred by ghost shiner (Cross 1967).

As a group, cyrpinids comprised over 90 percent of the seine catch from the lower river, compared to 46 percent of the tailwaters. Habitat at the lower river locations include gravel bars, pools, and riffles (during normal flow) which are preferred by most cyprinid species. Juveniles of fish which are thought to originate primarily from JRR occurred most often in the tailwaters. Red shiner have generally been the most abundant species in the Neosho River, probably because it is very adaptable to environmental variation (Cross 1967, Pflieger 1975) which may give it a competitive advantage over other cyprinid species.

5.4 SUMMARY AND CONCLUSIONS

The fish community in the Neosho River at the John Redmond Reservoir (JRR) tailwaters, and above and below the confluence with Wolf Creek has been monitored since 1973. The study was curtailed in 1981 and discontinued from 1982-1984 before reinstatement in 1985 to coincide with start up of WCGS. Potential operational effects of WCGS on the fishery were limited to diversion of water from JRR tailwaters for raw water and/or makeup water for the WCCL and the effect discharges from the WCCL would have downstream of the confluence with Wolf Creek. Following initial lake filling in 1981, maximum diversion of river water occurred 2-11 August 1987 when use of two make-up water pumps diverted 100 cfs, which was equivalent to 40 percent of the mean daily discharge from JRR during this period. Maximum diversion of river water based on mean monthly flows also occurred in August 1987 (3.1 percent) and was higher than the previously observed maxima. Closure of the WCCL dam eliminated flood stage flows in Wolf Creek and generally improved the water quality.

Trends in electrofishing and seining data between locations upstream and downstream of the Wolf Creek confluence suggested changes in Wolf Creek due to the WCCL and operation of WCGS had no effects on the Neosho River fishery. Overall, few long-term trends were apparent and annual differences were related to natural variability, releases from JRR, and river flows which influenced gear efficiency. Changes in electrofishing gear that occurred in 1981 contributed to lower catches during the operational study. Catch data did not reflect potential influences of commercial fishing in 1980, impingement losses at the WCGS makeup water screenhouse in 1981, or a documented fish kill in August in 1986.

5.5 REFERENCES

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TABLE 5-1 SUMMARY OF SAMPLING SCHEDULE FOR SURVEYS OF THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION

Year/Gear	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973												
Seine	-	-	1,4	-	-	1,4	-	-	1,4	-	-	1,4
1974												
Seine	-	-	1,4	-	-	1,4	-	-	1,4	-	-	1,4
1975												
Seine	-	-	-	1,4	-	1,4	-	-	1,4	-	-	1,4
1976												
Seine	-	1,10,11,4	-	1,10,11,4	1	1,10,11,4	1	1,10,11,4	-	1,10,11,4	-	1,10,11,4
1977												
Electro	-	1,10,4	-	1,10,4	1	1,10,4	1	1,10,4	-	1,10,4	-	1,10,4
Seine	-	1,10,11,4	-	1,10,11,4	1,11	1,10,4	-	1,10,11,4	-	1,10,11,4	-	1,10,11,4
1978												
Electro	-	1,10,4	-	1,10,4	1	1,10,4	1	1,10,4	-	1,10,4	-	-
Seine	-	1,10,11,4	-	1,10,11,4	1	1,10,11,4	1	1,10,11,4	-	1,10,11,4	-	1,10,11,4
1979												
Electro	-	1	-	1,10,4	1	1,10,4	1	1,10,4	-	1,10,4	-	1,10,4
Seine	-	1	-	1,10,4	1,11	-	1	1,10,11,4	-	1,10,11,4	-	1,10,11,4
1980												
Electro	-	-	-	1,10,4	1	1,10,4	1	-	-	1,10,4	-	1,10,4
Seine	-	-	-	-	1	1,10,11,4	1	-	-	1,10,11,4	-	1,10,11,4
1981												
Electro	-	1	1	1,10,4	1	-	1	1	1	-	1,10,4	1,10,4
Seine	-	-	-	1,10,11,4	1	1,10,11,4	1	-	-	1,10,11,4	-	1,10,4
1982												
Electro	-	-	1	1	1	1	1	1	1	1	1	-
Seine	-	-	-	1	-	-	1	1	1	1	-	-
1985												
Electro	-	-	1,10,4	1,10,4	-	1,10,4	-	1,10,4	-	-	1,10,4	10,4
Seine	-	-	1,10,4	1,10,11,4	-	-	1,10,11	1	10,11,4	-	1,10,11,4	1,10,4
1986												
Electro	-	-	1,10,4	1,10,4	-	1,10,4	-	1,10,4	-	-	1,10,4	1,10,4
Seine	-	-	1,10,11,4	1,10,11,4	-	1,10,11,4	-	1,10,11,4	-	-	1,10,11,4	1,10,11,4
1987												
Electro	-	-	1,10,4	1,10,4	-	1,10,4	-	1,10,4	-	-	-	-
Seine	-	-	1,10,11	1,10,11,4	-	1,10,11,4	-	1,10,11,4	-	-	-	-

Note: Location 1 was in John Redmond Reservoir prior to 1976.

TABLE 5-2 CHECKLIST OF FISHES COLLECTED FROM THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS

Scientific Name	Common Name	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1985	1986	1987
Lepisosteidae (gars)														
Lepisosteus platostomus	Shortnose gar	X		X	X	X	X	X			X	X	X	X
Lepisosteus osseus	Longnose gar				X	X	X	X	X	X		X	X	X
Clupeidae (herrings)														
Dorosoma cepedianum	Gizzard shad	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyprinidae (carps and minnows)														
Campostoma anomalum	Central stoneroller	X		X	X	X			X		X		X	
Cyprinus carpio	Common carp	X	X	X	X	X	X	X	X	X	X	X	X	X
Carassius auratus	Goldfish							X						
Hybopsis x punctata	Gravel chub								X					
Notemigonus crysoleucas	Golden shiner	X	X	X	X	X	X	X	X	X	X	X	X	X
Notropis buchanani	Ghost shiner	X	X	X	X	X	X	X	X	X	X	X	X	X
Notropis luetrensis	Red shiner	X	X	X	X	X	X	X	X	X	X	X	X	X
Notropis rubellus	Rosyface shiner		X	X	X									
Notropis stramineus	Sand shiner		X	X	X	X	X		X			X		
Notropis umbratilis	Redfin shiner		X	X	X									
Phenacobius mirabilis	Suckermouth minnow	X	X	X	X	X	X	X	X			X	X	X
Pimephales notatus	Bluntnose minnow	X	X	X	X	X	X	X	X		X		X	X
Pimephales promelas	Fathead minnow	X	X		X	X	X	X	X		X			X
Pimephales tenellus	Slim minnow		X	X	X	X	X	X	X	X		X	X	X
Pimephales vigilax	Bullhead minnow	X	X	X	X	X	X	X	X	X		X	X	X
Catostomidae (suckers)														
Carpiodes carpio	River carpsucker	X	X	X	X	X	X	X	X	X	X	X	X	X
Carpiodes cyprinus	Quillback								X	X		X	X	
Ictiobus bubalus	Smallmouth buffalo	X	X	X	X	X	X	X	X	X	X	X	X	X
Ictiobus cyprinellas	Bigmouth buffalo					X	X	X	X	X	X	X	X	X
Ictiobus niger	Black buffalo					X	X	X	X			X		
Moxostoma erythrurum	Golden redhorse	X				X	X	X						
Moxostoma macrolepidotum	Shorthead redhorse	X		X		X	X	X	X	X	X			X
Cycleptus elongatus	Blue sucker				X	X	X	X	X	X	X	X	X	X
Ictalaridae (freshwater catfishes)														
Ictalurus melas	Black bullhead	X	X	X	X	X	X	X	X			X		X
Ictalurus natalis	Yellow bullhead		X	X										
Ictalurus punctatus	Channel catfish	X	X	X	X	X	X	X	X	X	X	X	X	X
Pylodictis olivaris	Flathead catfish	X				X	X	X	X	X	X	X	X	X
Noturus flavus	Stonecat				X	X	X				X		X	
Noturus placidus	Neosho madtom				X	X		X	X	X	X	X	X	X
Noturus nocturnus	Freckled madtom								X					
Cyprinodontidae (topminnows)														
Fundulus notatus	Blackstripe topminnow	X	X	X	X			X	X	X		X		X
Poecilliidae (livebearers)														
Gambusia affinis	Mosquitofish		X	X	X	X	X	X	X	X	X	X	X	X

TABLE 5-2 (Cont.)

Scientific Name	Common Name	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1985	1986	1987
Atherinidae (silversides)														
Labidesthes sicculus	Brook silversides		X		X	X		X	X	X	X	X	X	X
Percichthyidae (temperate basses)														
Morone chrysops	White bass	X	X	X	X	X	X	X	X	X	X	X	X	X
Morone saxatilis x *M. chrysops*	Wiper											X	X	
Centrarchidae (sunfishes)														
Lepomis cyanellus	Green sunfish	X	X	X	X	X	X	X	X	X	X	X	X	X
Lepomis humilis	Orangespotted sunfish	X	X	X	X	X	X	X	X	X	X	X	X	X
Lepomis macrochirus	Bluegill	X	X	X	X	X			X	X	X	X	X	X
Lepomis megalotis	Longear sunfish		X	X	X	X		X	X	X	X	X	X	X
Lepomis macrochirus x *L. megalotis*	Hybrid sunfish												X	
Micropterus punctulatus	Spotted bass	X				X	X	X	X	X		X	X	X
Micropterus salmoides	Largemouth bass	X	X	X	X	X	X	X	X	X	X		X	
Pomoxis annularis	White crappie	X	X	X	X	X	X	X	X	X	X	X	X	X
Percidae (perches)														
Etheostoma chlorosomum	Bluntnose darter		X		X									
Etheostoma spectabile	Orangethroat darter	X			X			X	X			X	X	X
Percina phoxocephala	Slenderhead darter			X	X	X	X	X	X	X			X	
Percina caprodes	Logperch	X	X	X	X	X	X	X						
Stizostedion vitreum	Walleye	X					X	X	X	X	X			
Sciaenidae (drums)														
Aplodinotus grunniens	Freshwater drum	X	X	X	X	X	X	X	X	X	X	X	X	X
No. of Species		30	31	32	37	39	36	39	41	31	29	34	36	31
Accumulated No. of Species		30	39	40	44	46	46	47	50	50	50	51	52	52

Note: Nomenclature follows Robins 1980.

TABLE 5-3 RELATIVE ABUNDANCE OF THIRTEEN PREDOMINANT FISHES IN COMBINED ELECTROFISHING AND SEINING CATCHES FROM THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS

Species	1977	1978	1979	1980	1981	1982	1985	1986	1987
Red shiner	31.9	40.0	51.4	77.7	48.3	9.9	51.9	39.8	30.0
Gizzard shad	16.2	29.2	8.5	2.6	27.9	14.0	15.4	20.9	16.7
Ghost shiner	13.4	4.5	5.2	0.4	4.3	5.9	25.9	22.3	24.5
River carpsucker	6.5	2.5	6.6	3.5	3.2	6.5	0.2	2.1	2.1
Freshwater drum	6.2	3.7	4.0	1.2	1.8	7.6	0.7	1.5	1.0
Carp	3.8	2.2	3.0	0.9	1.1	3.7	0.3	1.8	0.9
Channel catfish	3.4	2.4	2.4	0.7	1.4	5.5	0.5	1.7	0.5
White crappie	3.0	1.5	5.3	0.7	2.2	6.0	0.6	2.2	1.7
Smallmouth buffalo	2.6	1.9	1.4	1.3	1.4	7.4	0.3	0.8	1.3
Bigmouth buffalo	2.4	0.5	0.7	0.2	0.3	2.6	<0.1	0.3	0.4
White bass	1.6	1.1	2.5	0.5	1.7	10.0	0.0	0.7	1.0
Mosquitofish	1.6	1.2	<0.1	0.1	0.5	3.9	0.3	0.2	13.1
Bullhead minnow	0.4	2.9	3.8	4.8	1.6	0.0	0.6	0.3	0.5
Total Catch	3,095	5,950	4,945	4,903	2,914	800	7,579	2,785	2,429

Note: Combined data from Locations 1, 10 and 4, except in 1982 when only Location 1 was surveyed.

TABLE 5-4 NUMBER AND RELATIVE ABUNDANCE OF FISH COLLECTED BY ELECTROFISHING IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1977-1982 AND 1985-1987

Species	1977		1978		1979		1980		1981		1982		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Longnose gar	6	0.4	7	0.5	9	0.6	7	1.3	8	0.7	0	0.0	6	2.3	4	0.7	5	1.1
Shortnose gar	2	0.1	3	0.2	9	0.6	0	0.0	0	0.0	2	0.4	7	2.6	8	1.4	2	0.4
Gizzard shad	457	31.1	563	36.7	271	18.5	62	11.4	720	64.4	101	21.2	94	35.5	250	42.6	276	59.7
Goldfish	-	-	-	-	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Common carp	116	7.9	101	6.6	149	10.2	43	7.9	33	3.0	29	6.1	21	7.9	48	8.2	21	4.5
Golden shiner	-	-	-	-	-	-	-	-	-	-	-	-	1	0.4	0	0.0	0	0.0
Ghost shiner	1	0.1	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2
Red shiner	4	0.3	2	0.1	7	0.5	1	0.2	1	0.1	4	2.6	0	0.0	3	0.5	1	0.2
Sand shiner	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Suckermouth minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.3	0	0.0
Fathead minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2
Slim minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.3	0	0.0
Bullhead minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0	0.0
Notropis spp.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0
River carpsucker	199	13.5	139	9.1	323	22.1	152	27.8	91	8.1	51	10.7	18	6.8	46	7.8	31	6.7
Quillback	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	1	0.4	3	0.5	0	0.0
Blue sucker	33	2.2	38	2.5	21	1.4	7	1.3	10	0.9	8	1.7	1	0.4	8	1.4	2	0.4
Smallmouth buffalo	79	5.4	63	4.1	58	4.0	46	8.4	42	3.8	58	12.2	24	9.1	22	3.8	31	6.7
Bigmouth buffalo	73	5.0	28	1.8	36	2.5	8	1.5	8	0.7	21	4.4	6	2.3	8	1.4	10	2.2
Black buffalo	1	0.1	5	0.3	9	0.6	2	0.4	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0
Golden redhorse	3	0.2	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Shorthead redhorse	1	0.1	3	0.2	1	0.1	2	0.4	7	0.6	6	1.3	0	0.0	0	0.0	1	0.2
Black bullhead	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	1.1	0	0.0	2	0.4
Channel catfish	93	6.3	78	5.1	93	6.4	35	6.4	37	3.3	40	8.4	5	1.9	40	6.8	6	1.3
Flathead catfish	14	1.0	17	1.1	11	0.8	42	7.7	18	1.6	22	4.6	1	0.4	34	5.8	23	5.0
Mosquitofish	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Brook silverside	15	1.0	0	0.0	0	0.0	2	0.4	15	1.3	0	0.0	0	0.0	1	0.2	0	0.0
White bass	48	3.3	54	3.5	120	8.2	15	2.7	35	3.1	31	6.5	9	3.4	10	1.7	6	1.3
Wiper	-	-	-	-	-	-	-	-	-	-	-	-	3	1.1	1	0.2	0	0.0
Green sunfish	26	1.8	153	10.0	52	3.6	15	2.7	3	0.3	2	0.4	5	1.9	22	3.8	3	0.6
Orangespotted sunfish	2	0.1	3	0.2	1	0.1	0	0.0	2	0.2	2	0.4	3	1.1	5	0.8	1	0.2
Bluegill	2	0.1	0	0.0	0	0.0	0	0.0	2	0.2	1	0.2	2	0.8	1	0.2	0	0,0
Longear sunfish	11	0.7	9	0.6	4	0.3	5	0.9	3	0.3	4	0.8	4	1.5	5	0.8	7	1.5
Bluegill X Longear sunfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0	0.0
Spotted bass	8	0.5	6	0.4	9	0.6	5	0.9	0	0.0	0	0.0	2	0.8	4	0.7	3	0.6
Largemouth bass	1	0.1	1	0.1	2	0.1	1	0.2	2	0.2	1	0.2	0	0.0	1	0.2	0	0.0
White crappie	83	5.7	31	2.0	75	5.1	30	5.5	25	2.2	34	7.1	2	0.8	16	2.7	6	1.3
Walleye	0	0.0	5	0.3	8	0.5	4	0.7	4	0.4	3	0.6	0	0.0	0	0.0	0	0.0
Freshwater drum	190	12.9	221	14.4	192	13.1	60	11.0	52	4.6	57	11.9	45	17.0	41	7.0	23	5.0
No. Species	26		24		24		23		21		20		24		25		22	
Total No. Fish	1,469		1,532		1,462		546		1,118		477		265		587		462	
Units of Effort	20.0		17.0		18.0		14.0		18.0		9.0		16.5		17.9		12.0	
Catch Per Unit of Effort	73.4		90.1		81.2		39.0		62.1		53.0		16.1		32.8		38.5	

Note: 1977-81 and 1985-87 data include fish collected from Locations 1, 4, and 10; 1982 data only from Location 1.

TABLE 5-5 SUMMARY OF PREOPERATIONAL (1977-82) AND OPERATIONAL (1985-87) CATCH DATA FOR PREDOMINANT FISHES COLLECTED BY ELECTROFISHING IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS

	Pre-Operational Catches (1977-82)			Operational Catches (1985-87)		
Species	No.	%	CPE	No.	%	CPE
Gizzard shad	2,714	32.9	20.3	620	47.2	13.4
Carp	471	7.1	4.4	90	6.8	1.9
River carpuscker	955	14.5	8.9	95	7.2	2.0
Smallmouth buffalo	346	5.2	3.2	77	5.9	1.6
Bigmouth buffalo	174	2.6	1.6	24	1.8	0.5
Channel catfish	376	5.7	3.5	51	3.9	1.1
Flathead catfish	124	1.9	1.2	58	4.4	1.2
White bass	303	4.6	2.8	22	1.9	0.5
White crappie	278	4.2	2.6	24	1.8	0.5
Freshwater drum	772	11.7	7.2	109	8.3	2.3

TABLE 5-6 AVERAGE ELECTROFISHING CPE FOR PREDOMINANT FISHES IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1977-1982 AND 1985-1987

Species	Year									
	1977	1978	1979	1980	1981	1982	1985	1986	1987	Mean
Location 1										
Gizzard shad	53.9	67.1	28.5	5.3	66.6	11.2	15.6	8.8	65.0	35.8
River carpsucker	18.1	13.2	35.8	20.2	6.9	5.7	1.8	3.1	4.8	12.2
Freshwater drum	6.9	9.6	9.8	3.5	1.9	6.3	5.8	2.5	1.8	5.3
Channel catfish	8.1	5.3	6.5	5.2	3.3	4.4	0.4	5.4	0.5	4.3
Smallmouth buffalo	5.4	3.7	3.8	3.3	2.3	6.4	1.8	1.4	3.2	3.5
White bass	5.6	7.3	14.2	2.3	3.3	3.4	1.8	1.5	1.5	4.5
White crappie	10.0	4.0	8.1	4.7	2.5	3.8	0.4	2.2	0.8	4.1
Carp	1.8	6.4	11.5	5.5	2.0	3.2	1.8	1.2	3.2	4.1
Bigmouth buffalo	9.1	3.1	2.0	1.3	0.7	2.3	0.9	1.0	2.0	2.5
Flathead catfish	1.4	1.7	1.0	3.5	0.6	2.4	0.2	2.2	1.5	1.6
Total CPE	120.3	121.4	121.2	54.8	90.1	49.1	30.5	29.3	84.3	77.9
Location 10										
Gizzard shad	1.1	10.2	6.4	0.8	5.3	-	3.8	32.0	2.0	7.7
River carpsucker	7.7	3.8	3.4	3.8	3.0	-	1.2	1.8	0.8	3.2
Freshwater drum	14.0	17.4	15.8	8.5	5.8	-	1.3	2.5	2.2	8.4
Channel catfish	4.0	6.2	4.4	0.8	0.3	-	0.3	1.0	0.8	2.2
Smallmouth buffalo	4.3	5.0	4.0	5.2	2.0	-	1.3	1.0	3.0	3.2
White bass	0.2	0.2	0.6	0.0	2.0	-	0.2	0.0	0.0	0.4
White crappie	0.3	0.2	1.6	0.5	0.0	-	0.0	0.2	0.0	0.4
Carp	12.3	8.8	3.8	2.2	1.5	-	1.3	4.8	1.5	4.5
Bigmouth buffalo	0.0	1.2	3.0	0.0	0.3	-	0.0	0.2	0.5	0.6
Flathead catfish	0.2	0.4	0.4	2.5	0.3	-	0.0	0.7	0.5	0.6
Total CPE	44.1	53.4	43.4	24.3	20.5	-	9.4	44.2	11.3	31.3
Location 4										
Gizzard shad	3.2	8.4	2.2	6.8	8.3	-	0.2	1.0	2.0	4.0
River carpsucker	1.7	5.4	4.0	4.0	2.5	-	0.5	2.8	2.2	2.9
Freshwater drum	8.5	13.4	7.0	1.2	2.5	-	1.8	1.8	1.8	4.8
Channel catfish	0.7	2.0	3.8	0.2	0.8	-	0.2	0.3	0.2	1.0
Smallmouth buffalo	1.7	2.4	1.6	1.2	2.8	-	1.3	1.3	1.5	1.7
White bass	0.3	0.4	0.6	0.2	0.3	-	0.0	0.2	0.0	0.2
White crappie	0.3	0.4	0.4	0.0	0.0	-	0.0	0.3	0.8	0.3
Carp	4.7	2.4	7.6	0.2	1.8	-	0.8	2.0	0.5	2.5
Bigmouth buffalo	0.2	0.0	1.0	0.0	0.0	-	0.3	0.2	0.0	0.2
Flathead catfish	0.3	0.6	0.2	2.8	2.8	-	0.0	2.8	3.8	1.7
Total CPE	21.6	35.4	28.4	17.8	21.8	-	5.1	12.7	12.8	19.4

Notes: 1. CPE = number of fish caught per 30 min. of effort.
2. Dash (-) indicates location not sampled.

TABLE 5-7 NUMBER OF SELECTED FISHES COLLECTED BY SEINING IN THE NEOSHO RIVER NEAR THE WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1973 THROUGH 1981 AND 1985 THROUGH 1987

	Year											
Species	1973	1974	1975	1976	1977	1978	1979	1980	1981	1985	1986	1987
Gizzard shad	0	0	3	1,669	41	1,174	149	66	94	1,072	333	130
Ghost shiner	35	21	100	606	412	270	264	21	125	1,962	621	594
Red shiner	42	910	1,558	2,928	981	2,381	2,536	3,808	1,405	3,934	1,153	728
Bluntnose minnow	0	2	3	43	31	11	29	3	0	0	2	13
Bullhead minnow	92	2	14	238	12	174	188	236	47	42	6	13
Slim minnow	0	7	64	32	6	0	22	6	13	113	15	4
Neosho madtom	0	0	0	12	19	46	12	6	34	8	19	1
Mosquitofish	0	24	108	54	49	69	2	4	15	24	6	317
Total fish (All species)	207	990	1,920	5,944	1,626	4,418	3,491	4,357	1,829	7,314	2,254	1,956
No. collections	8	8	8	26	26	28	25	14	16	17	18	11
No. fish per collection	26	124	240	229	63	158	140	311	114	430	124	179

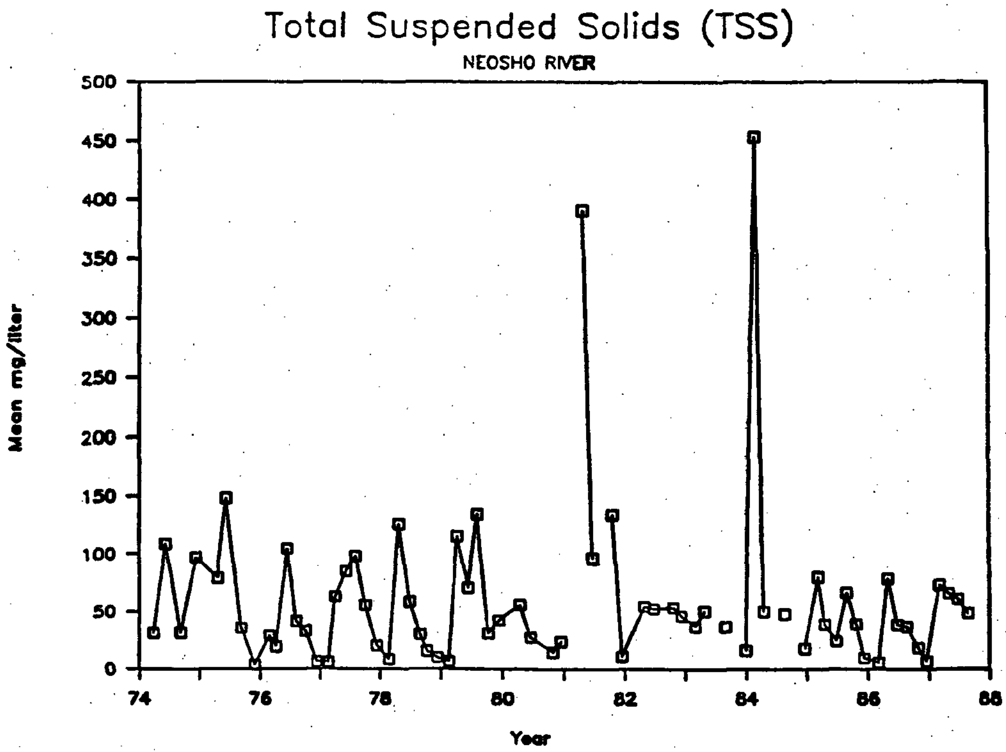
TABLE 5-8 SUMMARY OF PREOPERATIONAL (1976-82) AND OPERATIONAL (1985-87) CATCH DATA FOR PREDOMINANT FISHES COLLECTED BY SEINING IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS

Species	Preoperational catches			Operational catches		
	No.	%	Average catch per collection	No.	%	Average catch per collection
Gizzard shad	3,088	15.3	29.7	1,535	13.4	33.4
Ghost shiner	1,711	8.5	16.5	3,177	27.6	69.1
Red shiner	12,836	63.6	123.4	5,768	50.2	125.4
Bullhead minnow	766	3.8	7.4	61	0.5	1.3
Mosquitofish	219	1.1	2.1	347	3.0	7.5
Game fish	729	3.6	7.0	237	2.1	5.2
Other	819	4.1	7.9	362	3.2	7.9
Total	20,168		193.9	11,487		249.7

TABLE 5-9 NUMBER OF PREDOMINANT FISHES COLLECTED BY SEINING AT THREE LOCATIONS ON THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, 1976-82, AND 1985-87

Species	1976	1977	1978	1979	1980	1981	1982	1985	1986	1987	Total No.	No. Per Sampling Date	% of Total
Location 1													
Gizzard shad	1,664	37	1,054	148	29	88	11	1,056	297	78	4,462	72.0	42.6
Ghost shiner	422	195	205	165	18	13	47	540	317	30	1,952	31.5	18.6
Red shiner	49	130	438	153	1,184	146	78	535	59	30	2,802	45.2	26.7
Bullhead minnow	0	0	0	0	17	0	0	2	0	0	19	0.3	0.2
Mosquito fish	5	0	42	0	4	3	31	13	0	6	104	1.7	1.0
Game fish	194	13	74	179	17	46	72	45	49	36	725	11.7	6.9
Other	39	30	58	38	81	16	84	43	7	18	414	6.7	4.0
Total	2,373	405	1,871	683	1,350	312	323	2,234	729	198	10,478	169.0	
Location 10													
Gizzard shad	4	4	2	1	0	4	-	16	4	5	40	0.9	0.5
Ghost shiner	87	71	19	7	3	44	-	245	103	133	712	15.8	8.5
Red shiner	433	276	787	1,068	1,987	308	-	1,095	273	464	6,691	148.7	79.7
Bullhead minnow	8	2	66	26	215	7	-	23	1	2	350	7.8	4.2
Mosquito fish	10	12	13	1	0	0	-	6	1	143	186	4.1	2.2
Game fish	13	8	13	19	4	8	-	39	7	4	115	2.6	1.4
Other	43	25	61	25	40	17	-	33	33	24	301	6.7	3.6
Total	598	398	961	1,147	2,249	388	-	1,457	422	775	8,395	186.6	
Location 4													
Gizzard shad	1	0	2	0	37	2	-	0	32	47	121	2.8	0.9
Ghost shiner	77	143	44	83	0	68	-	1,177	201	431	2,224	51.7	17.4
Red shiner	1,222	554	1,131	1,302	637	953	-	2,304	774	234	9,111	211.9	71.3
Bullhead minnow	106	8	108	159	4	40	-	17	5	11	458	10.7	3.4
Mosquito fish	34	37	14	1	0	12	-	5	5	168	276	6.4	2.2
Game fish	8	3	14	13	22	9	-	12	11	34	126	2.9	1.0
Other	65	25	54	51	55	12	-	108	38	58	466	10.8	3.6
Total	1,513	770	1,367	1,609	755	1,096	-	3,623	1,066	983	12,782	297.3	

APPENDIX A
SUPPLEMENTAL WATER QUALITY FIGURES



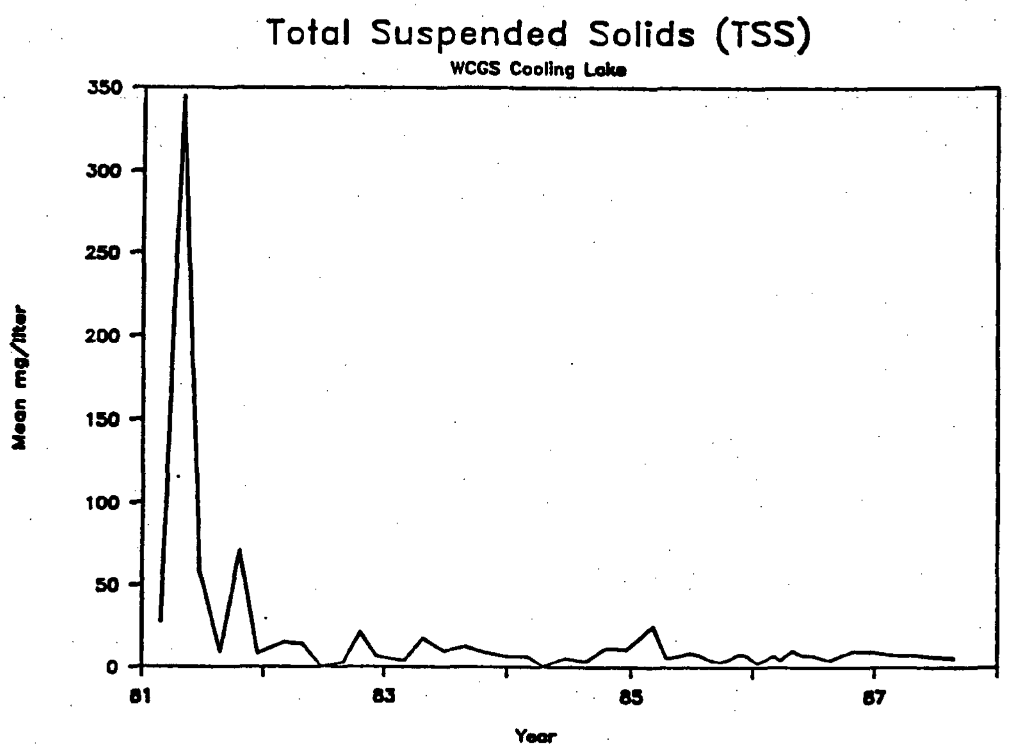
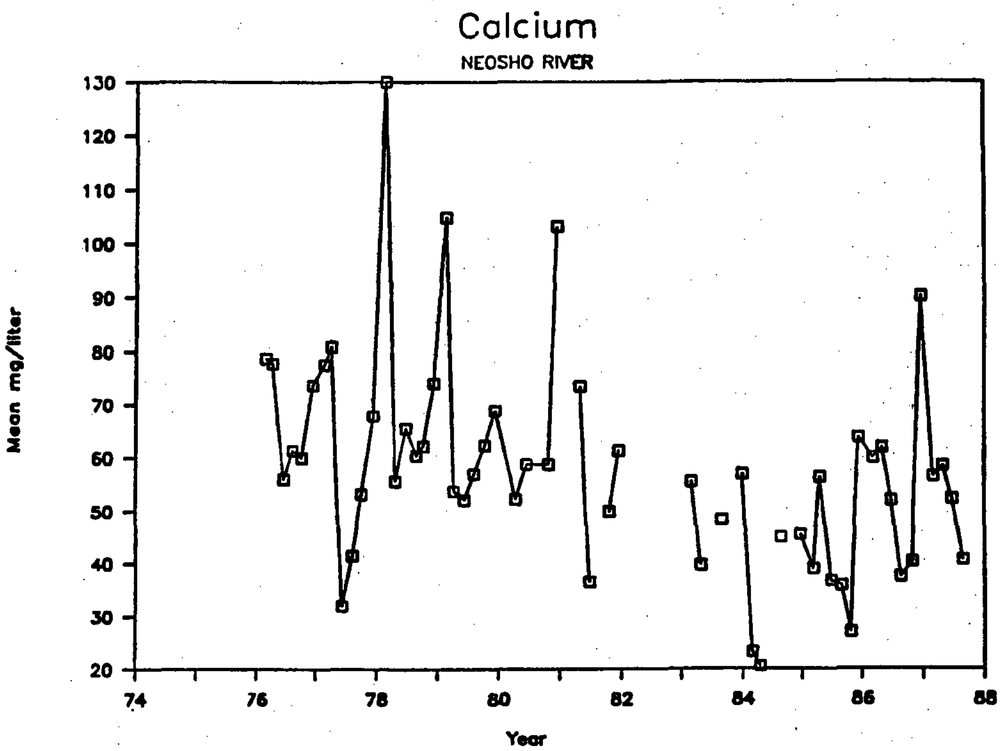


Figure A–1. Temporal variations in total suspended solids (TSS) for the Neosho River and WCGS Cooling Lake, 1974–1987.



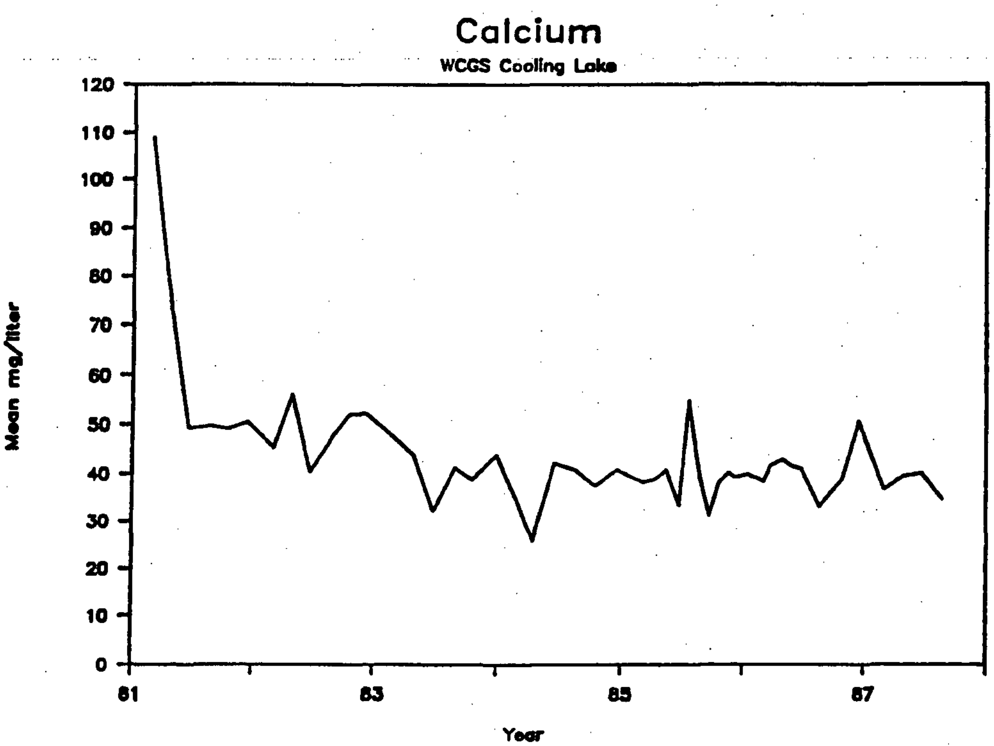
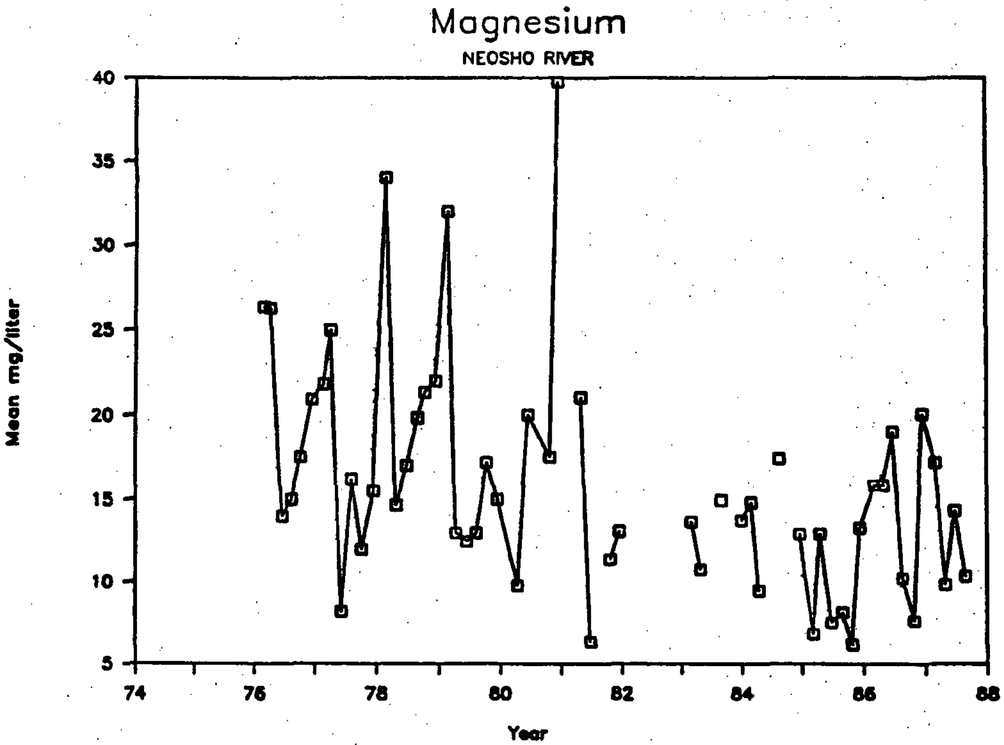


Figure A-2. Temporal variations in calcium concentrations for the Neosho River and WCGS Cooling Lake, 1974–1987.



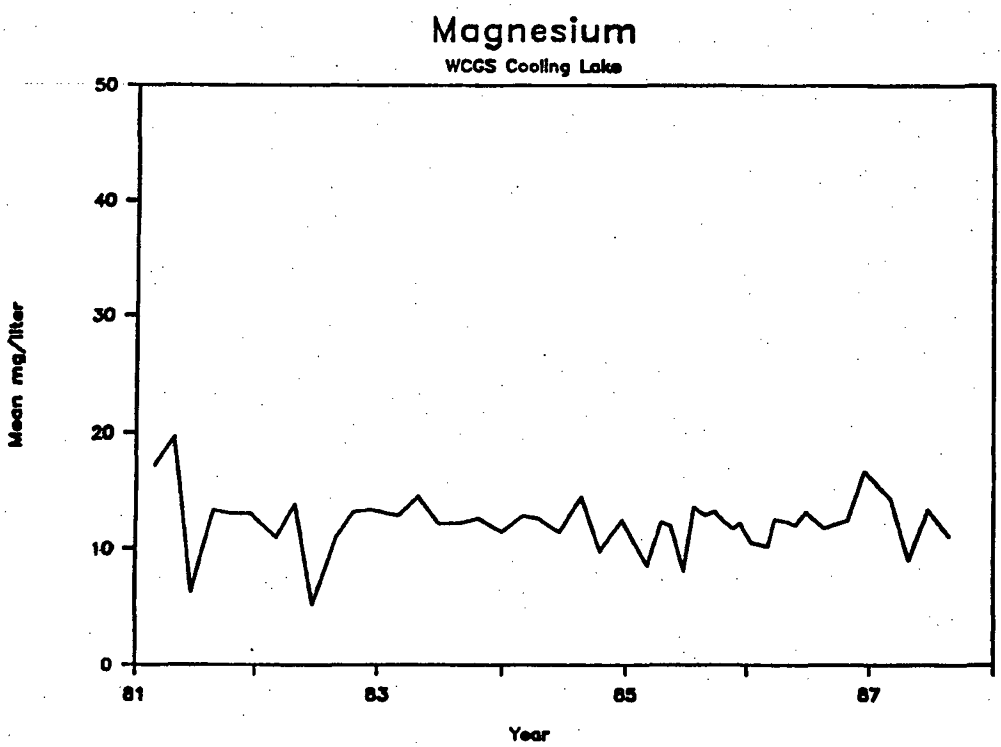
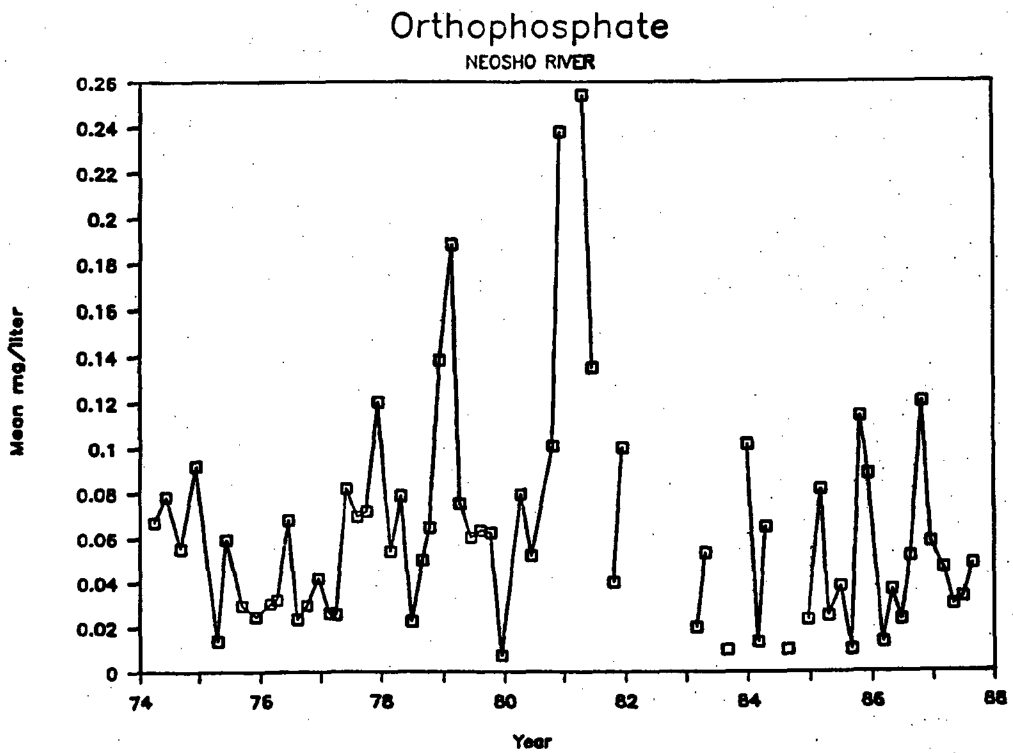


Figure A-3. Temporal variations in magnesium concentrations for the Neosho River and WCGS Cooling Lake, 1974–1987.



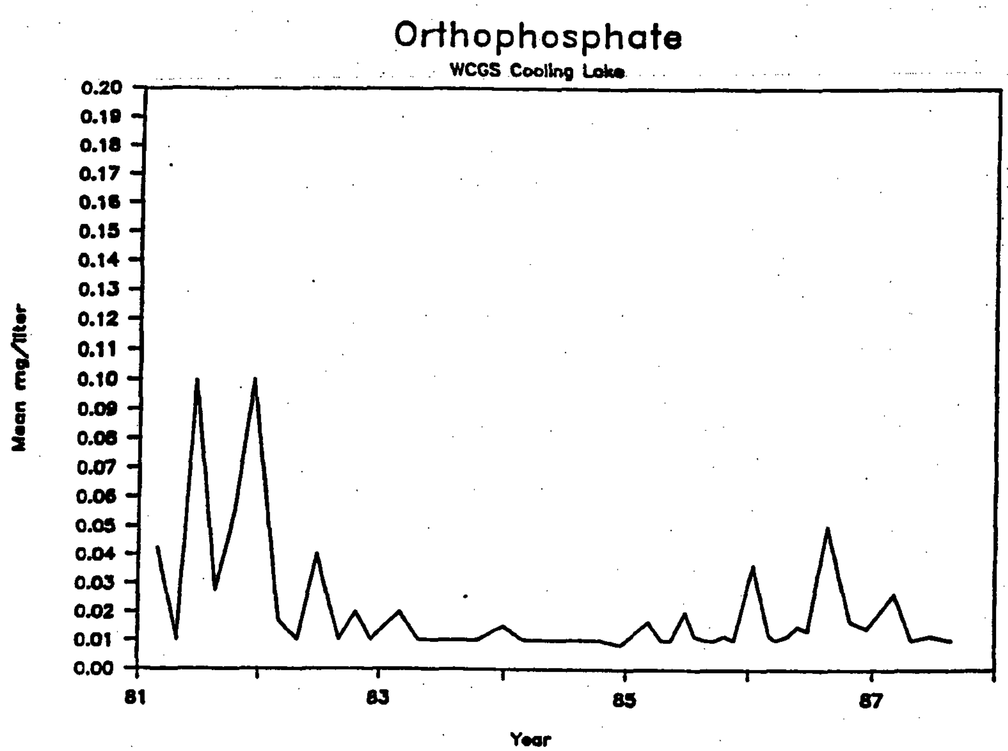
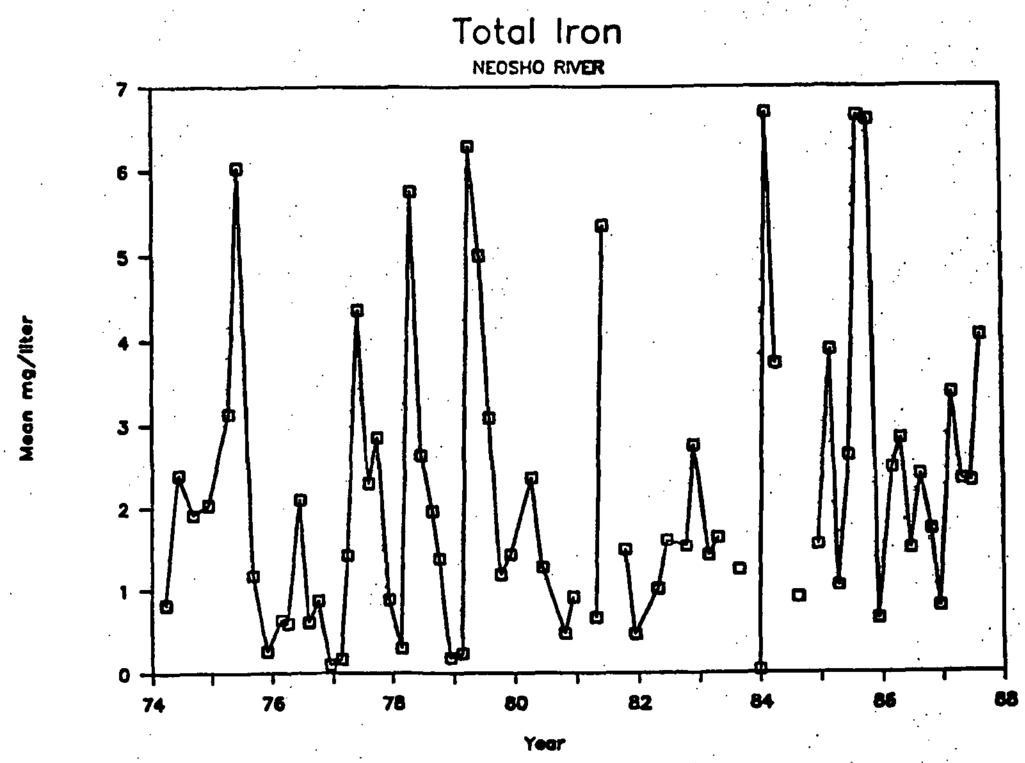


Figure A-4. Temporal variations in soluble orthophophate for the Neosho River and WCGS Cooling Lake, 1974-1987.



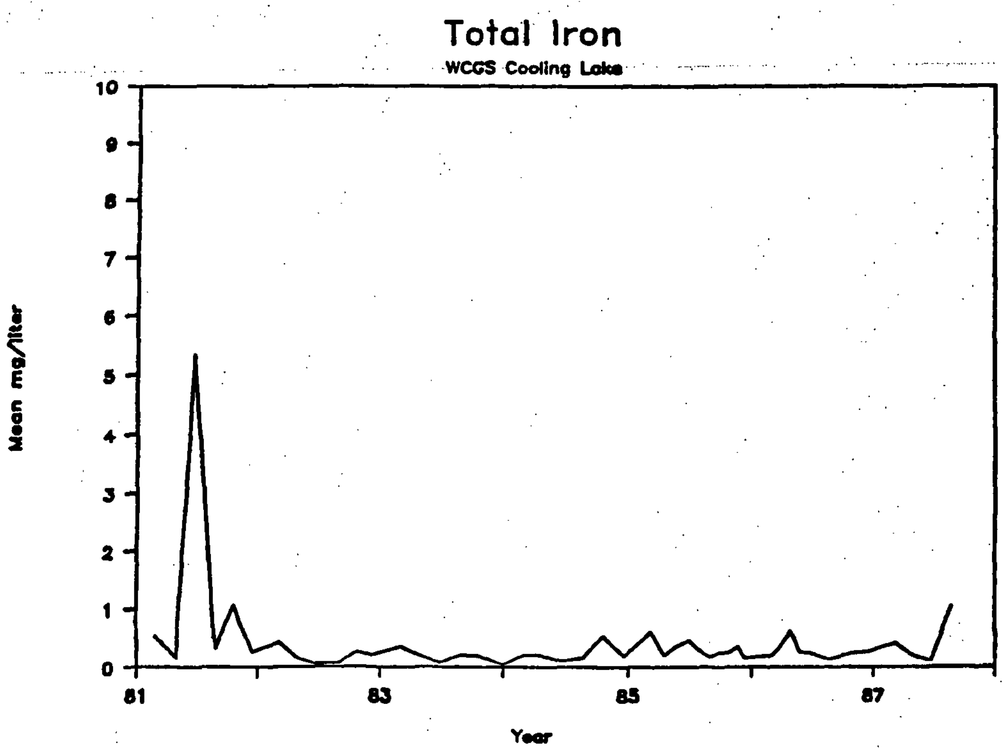
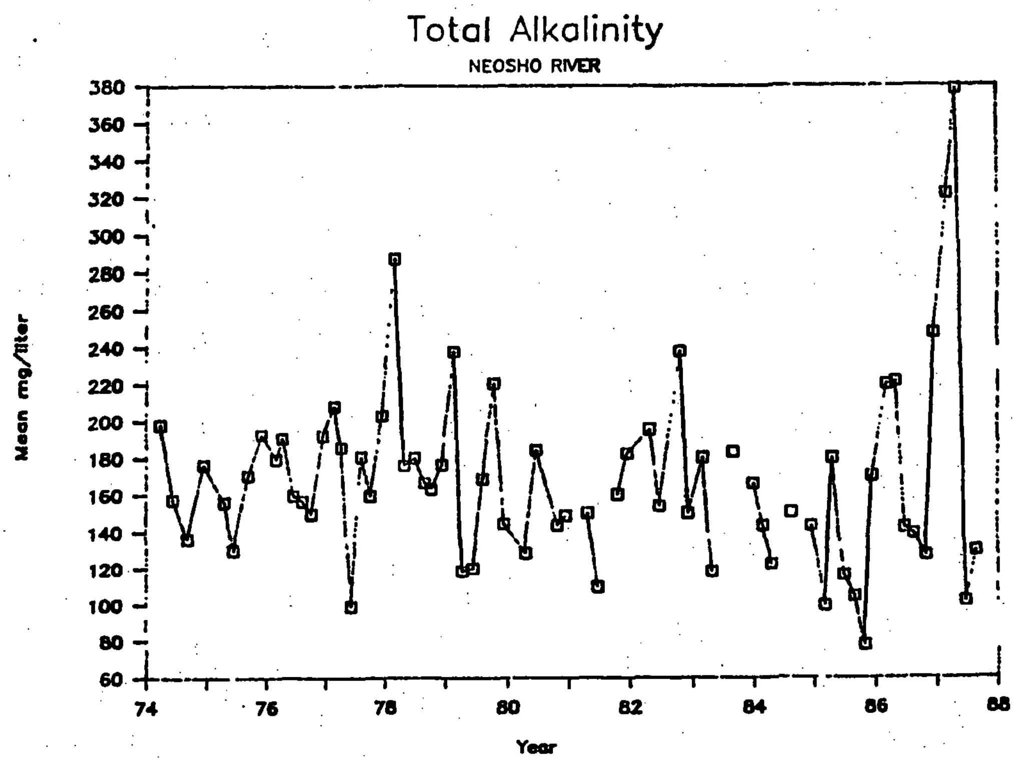


Figure A-5. Temporal variations in total iron concentrations for the Neosho River and WCGS Cooling Lake, 1974-1987.



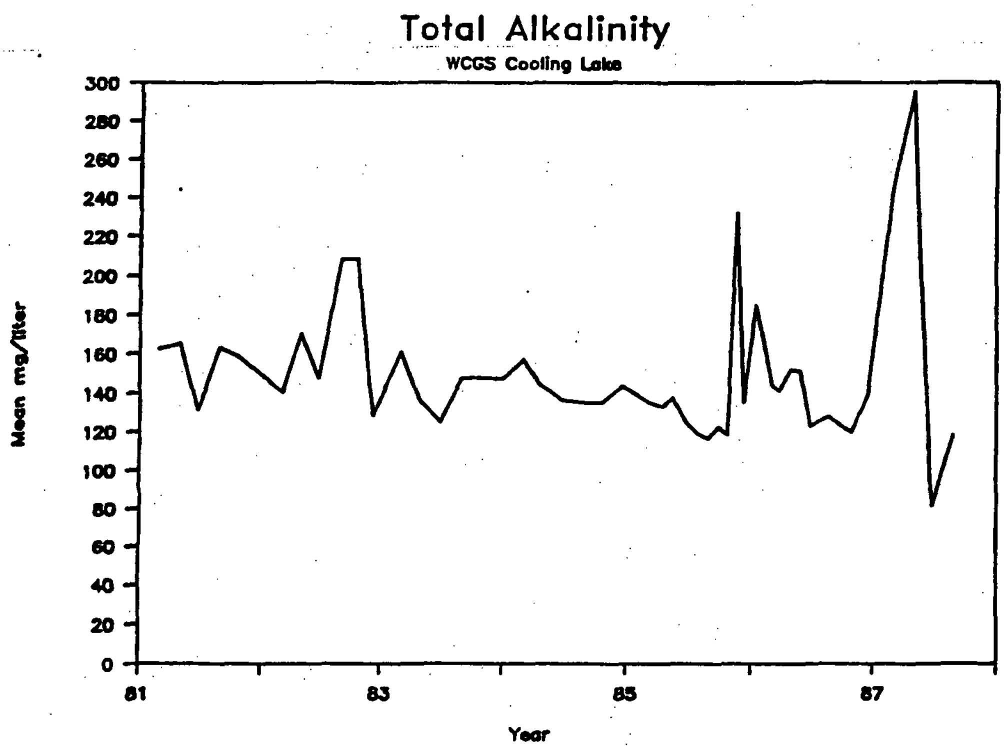
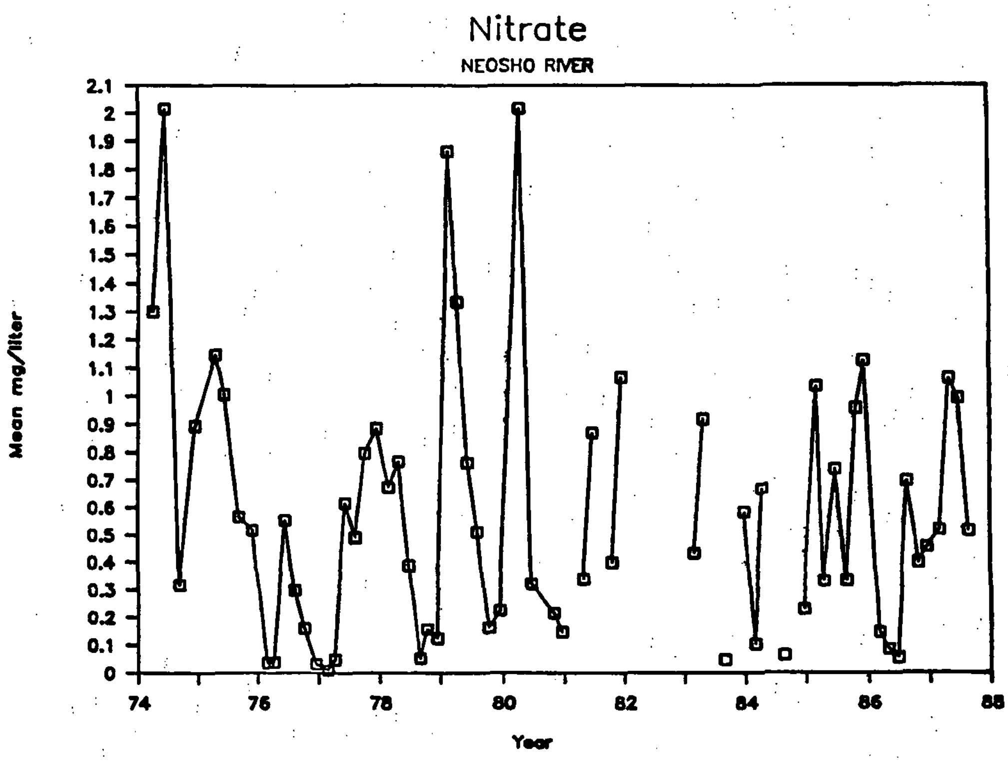


Figure A-6. Temporal variations in total alkalinity for the Neosho River and WCGS Cooling Lake, 1974–1987.



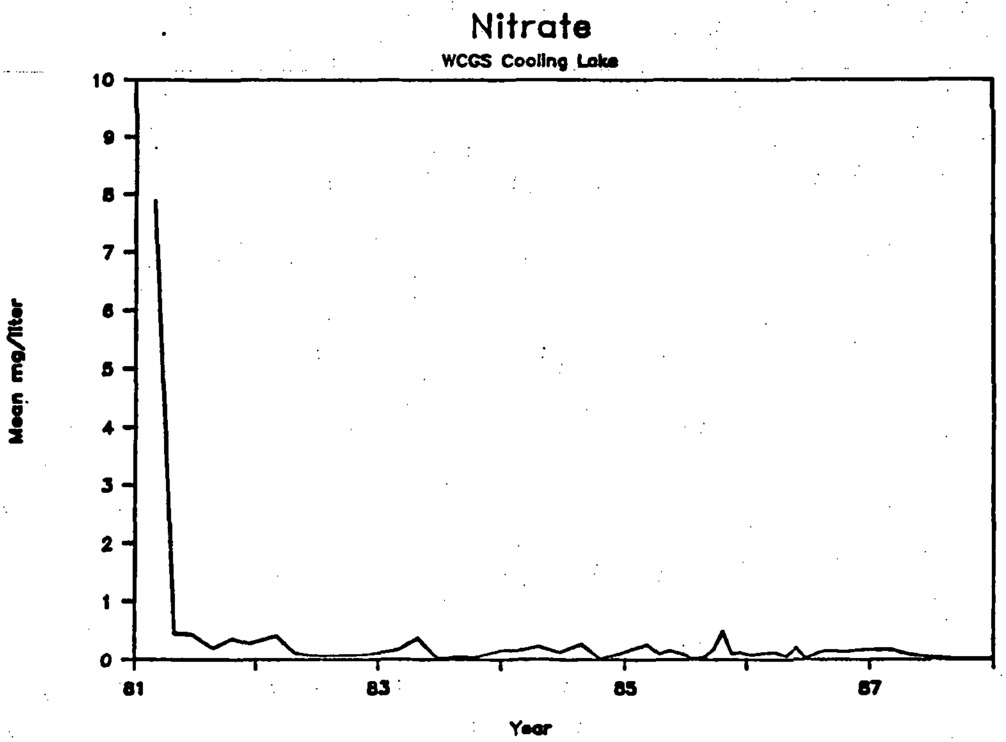
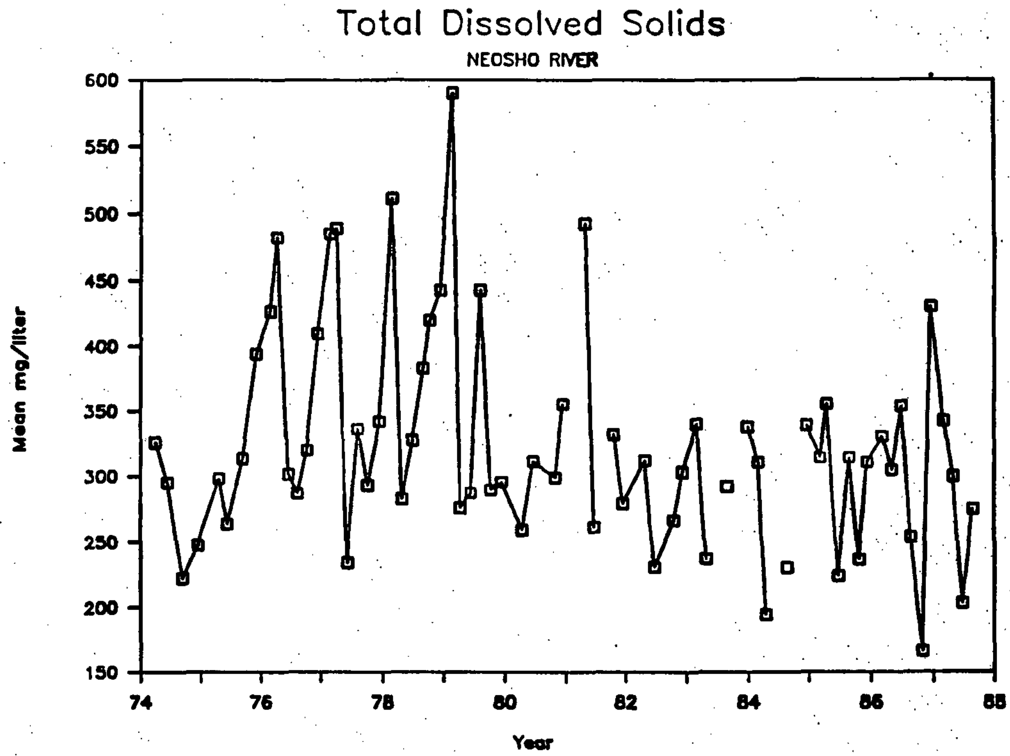


Figure A-7. Temporal variations in nitrate concentrations for the Neosho River and WCGS Cooling Lake, 1974–1987.



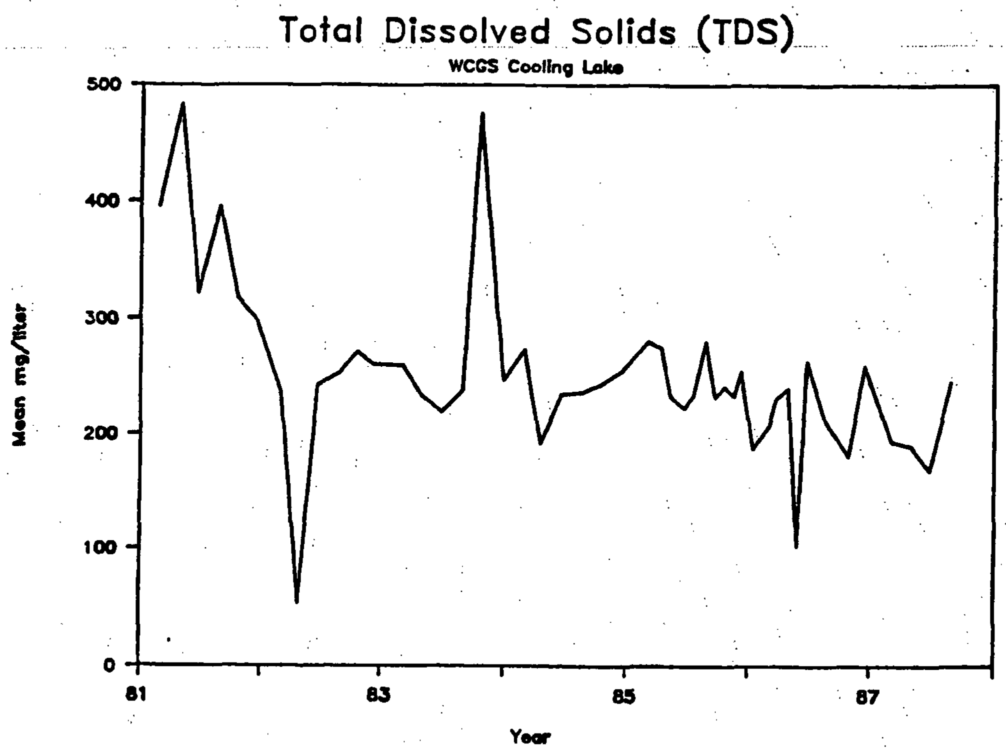
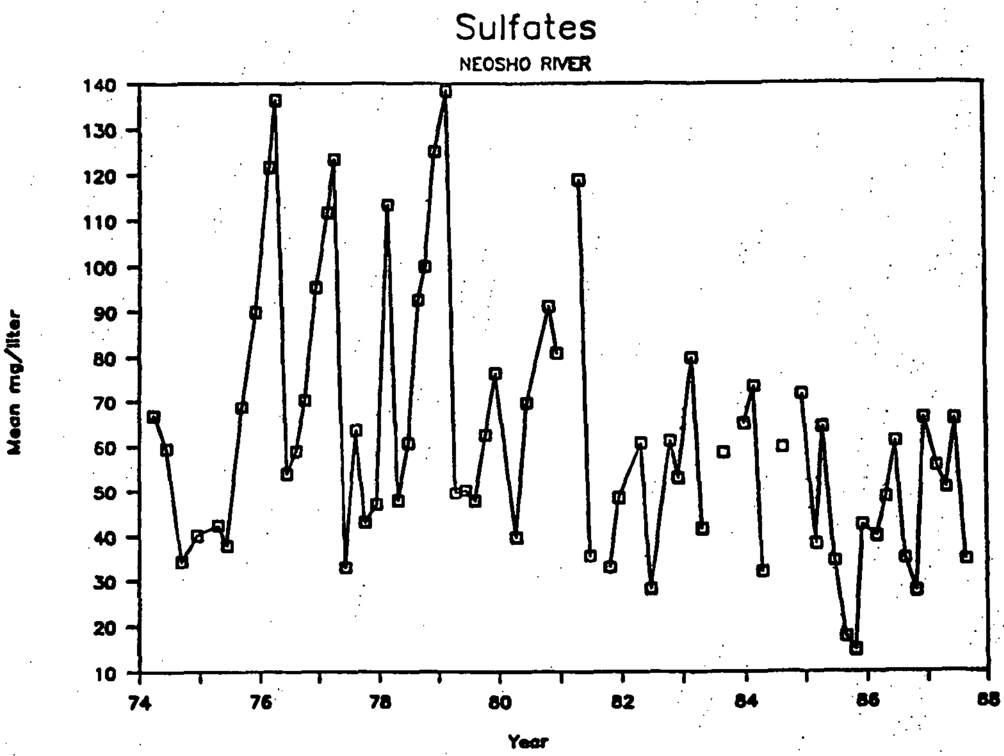


Figure A-8. Temporal variations in total dissolved solids (TDS) for the Neosho River and WCGS Cooling Lake, 1974–1987.



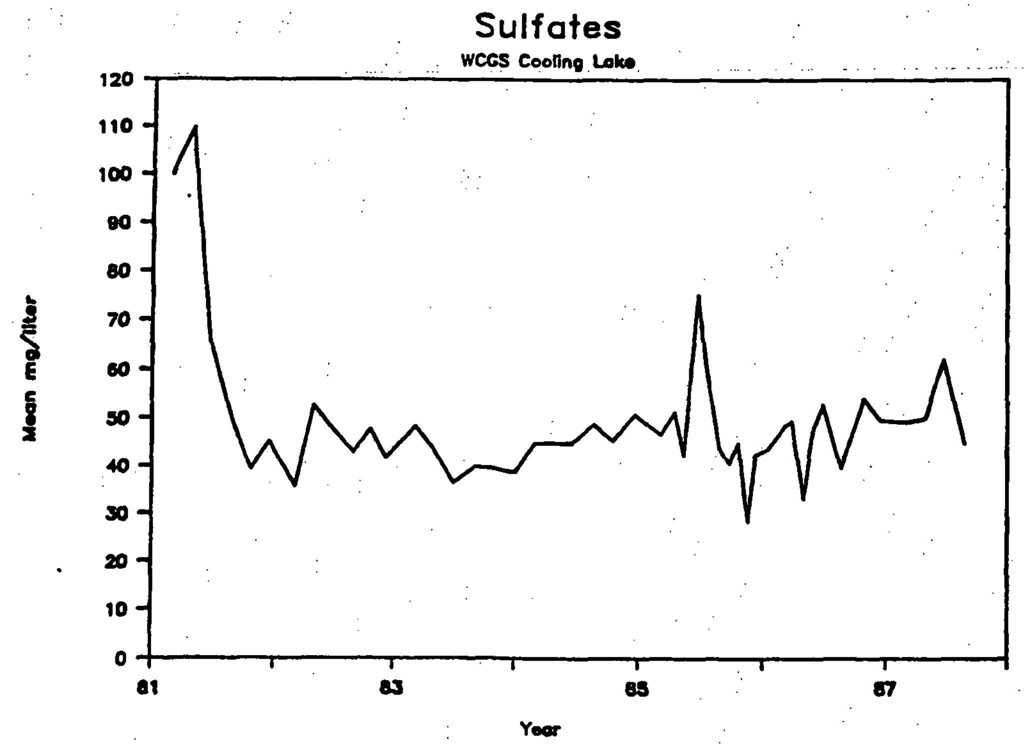
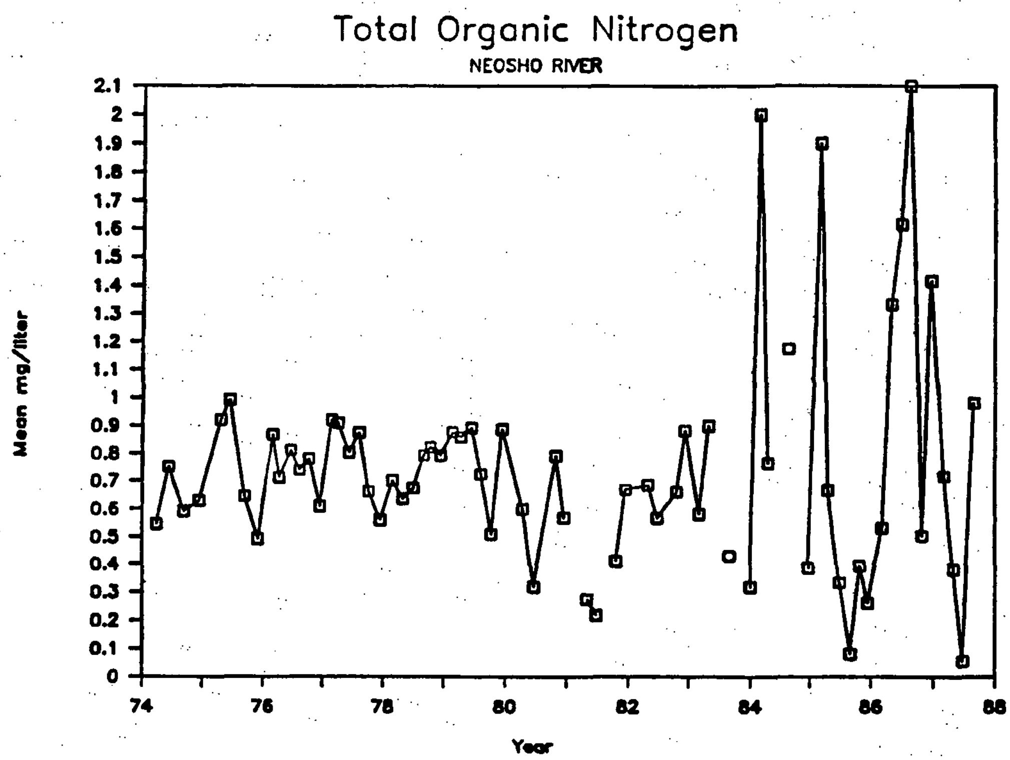


Figure A-9. Temporal variations in sulfate concentrations for the Neosho River and WCGS Cooling Lake, 1974-1987.



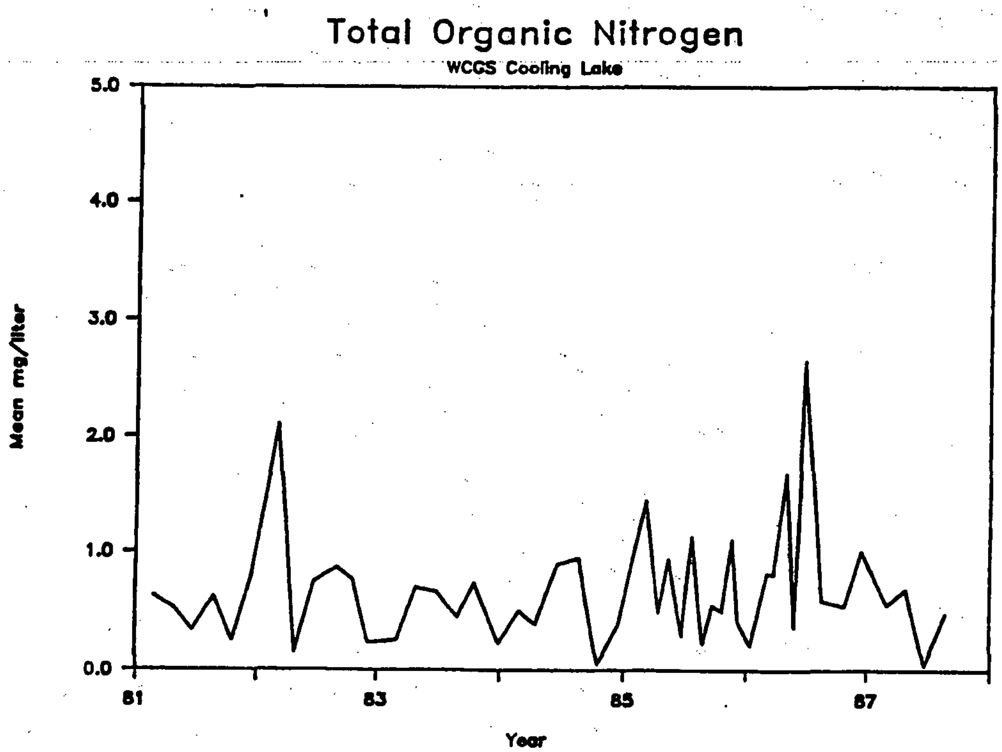
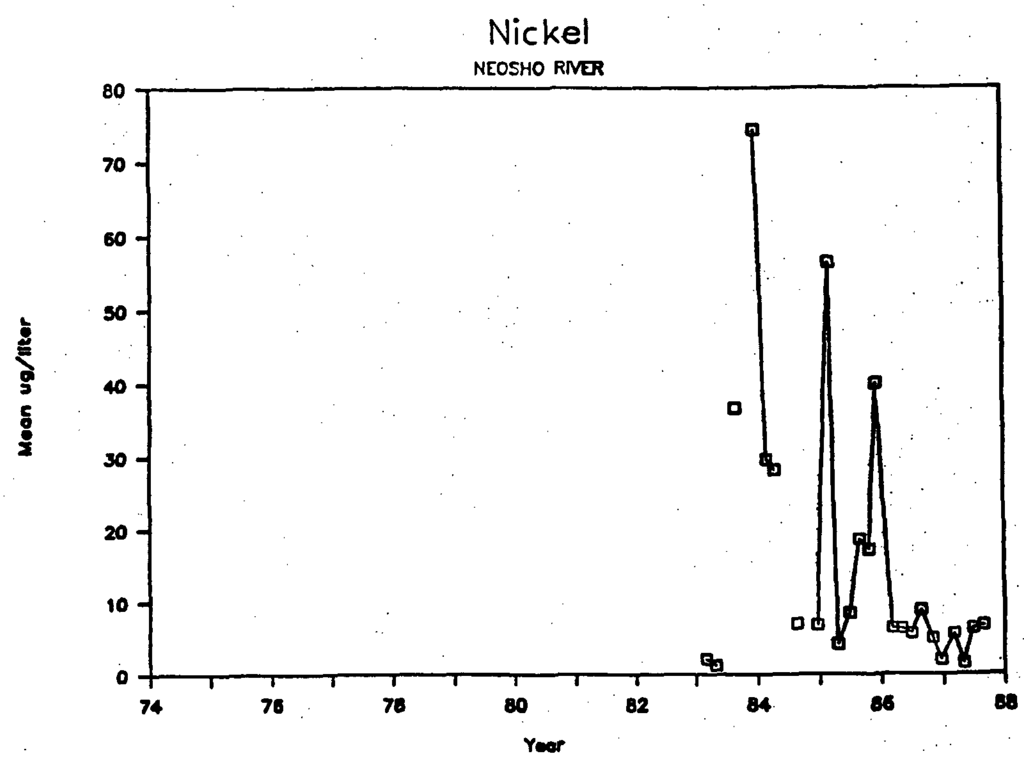


Figure A-10. Temporal variations in total organic nitrogen (TON) for the Neosho River and WCGS Cooling Lake, 1974-1987.



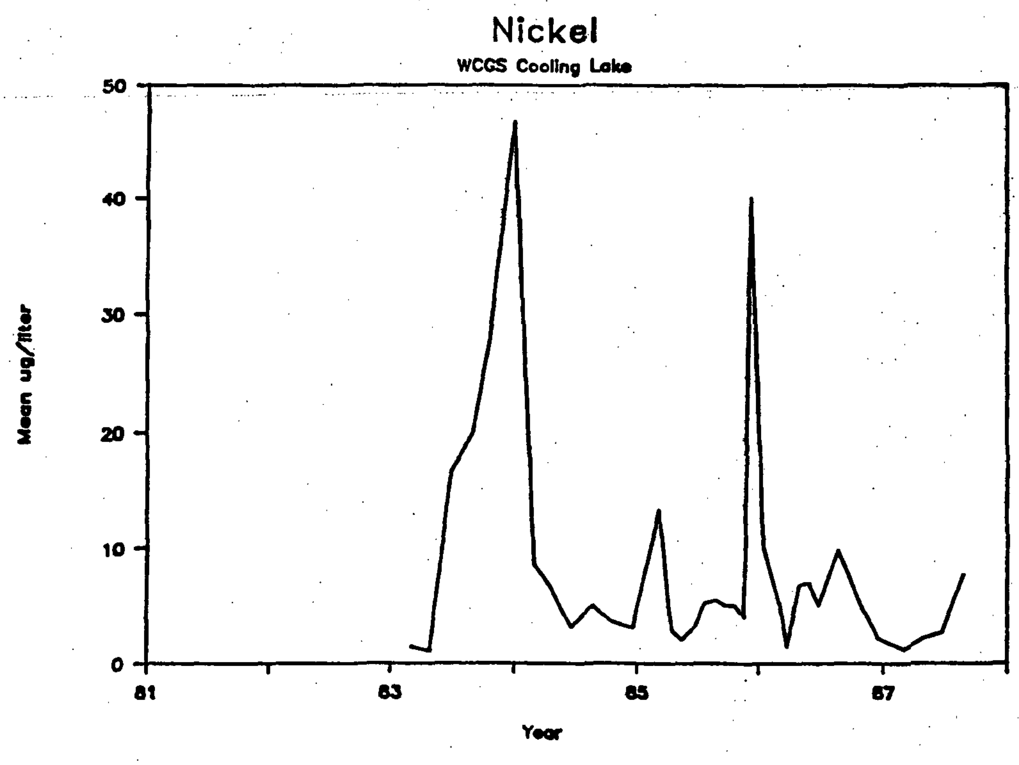
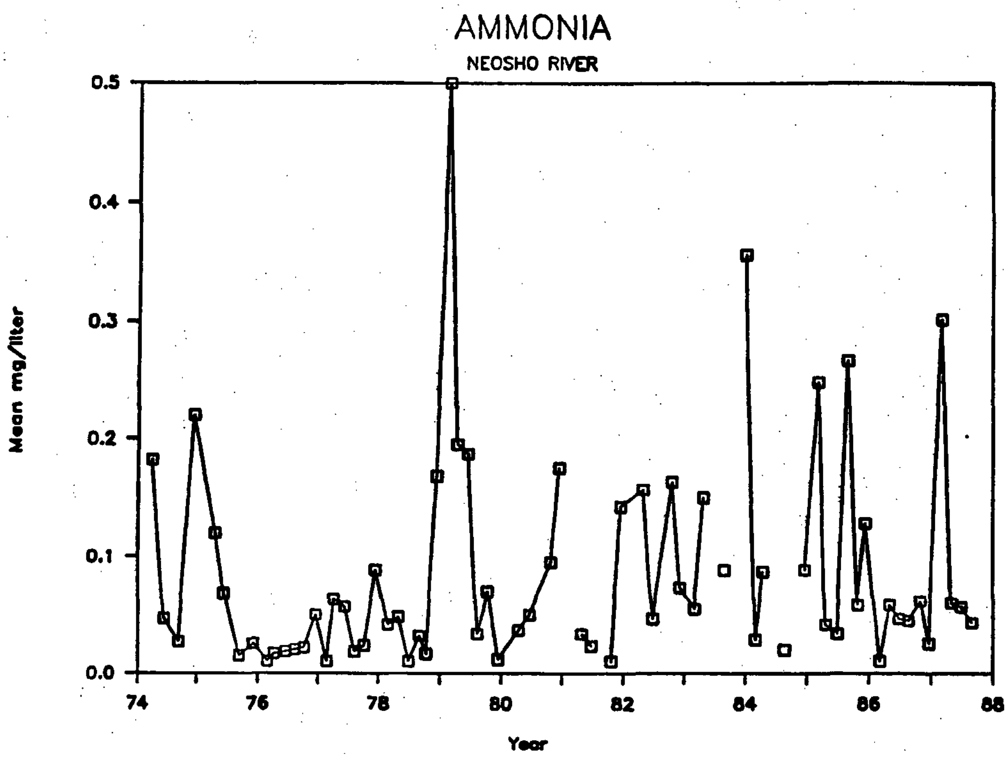


Figure A-11. Temporal variations in nickel concentrations for the Neosho River and WCGS Cooling Lake, 1983-1987.



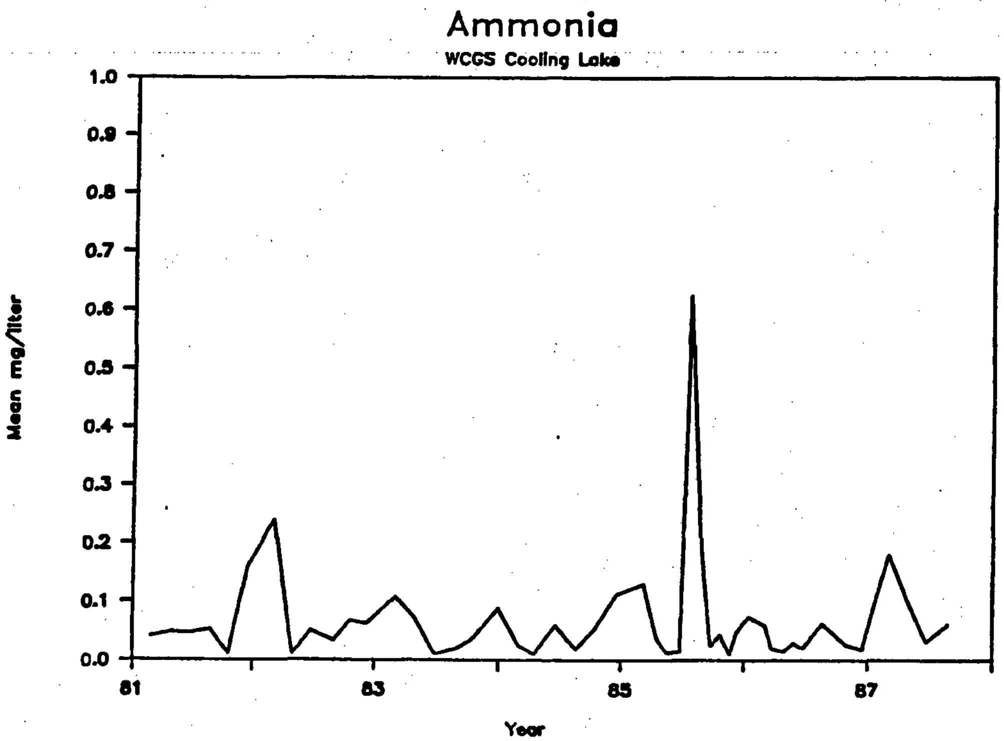
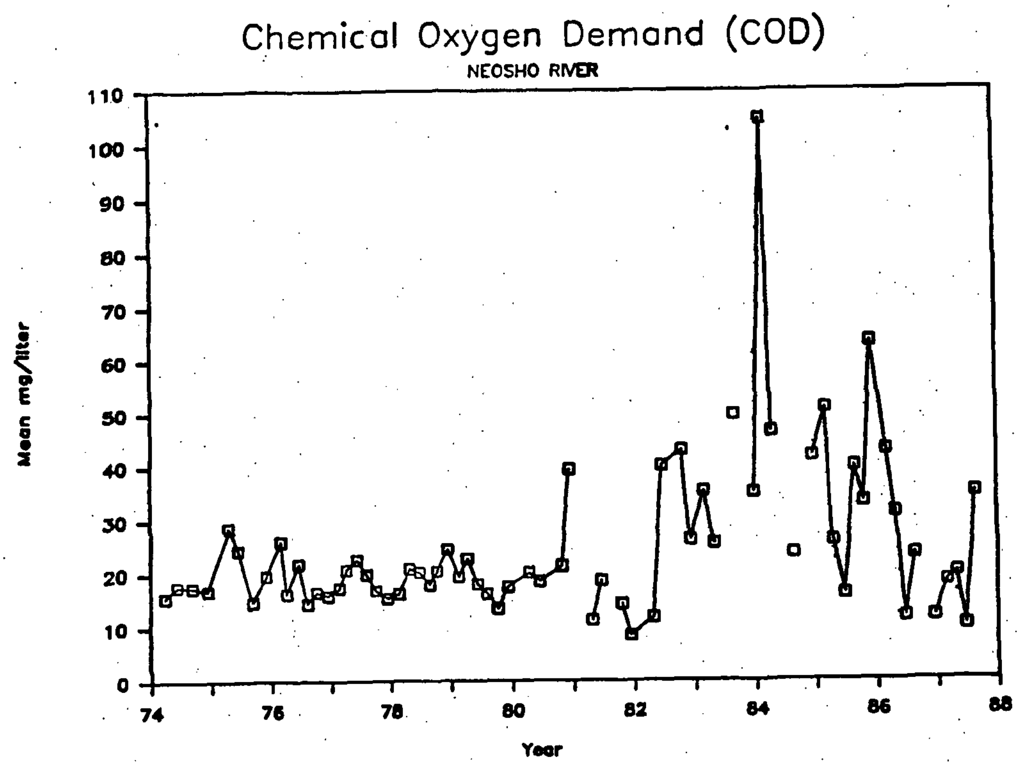


Figure A-12. Temporal variations in ammonia concentrations for the Neosho River and WCGS Cooling Lake, 1974-1987.



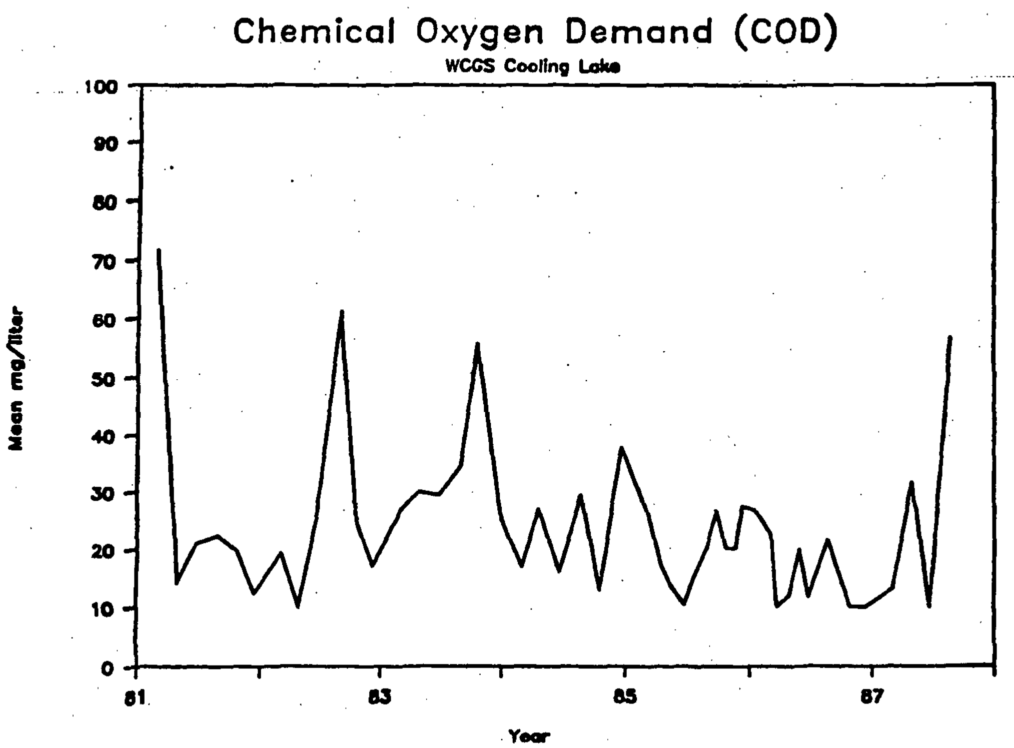
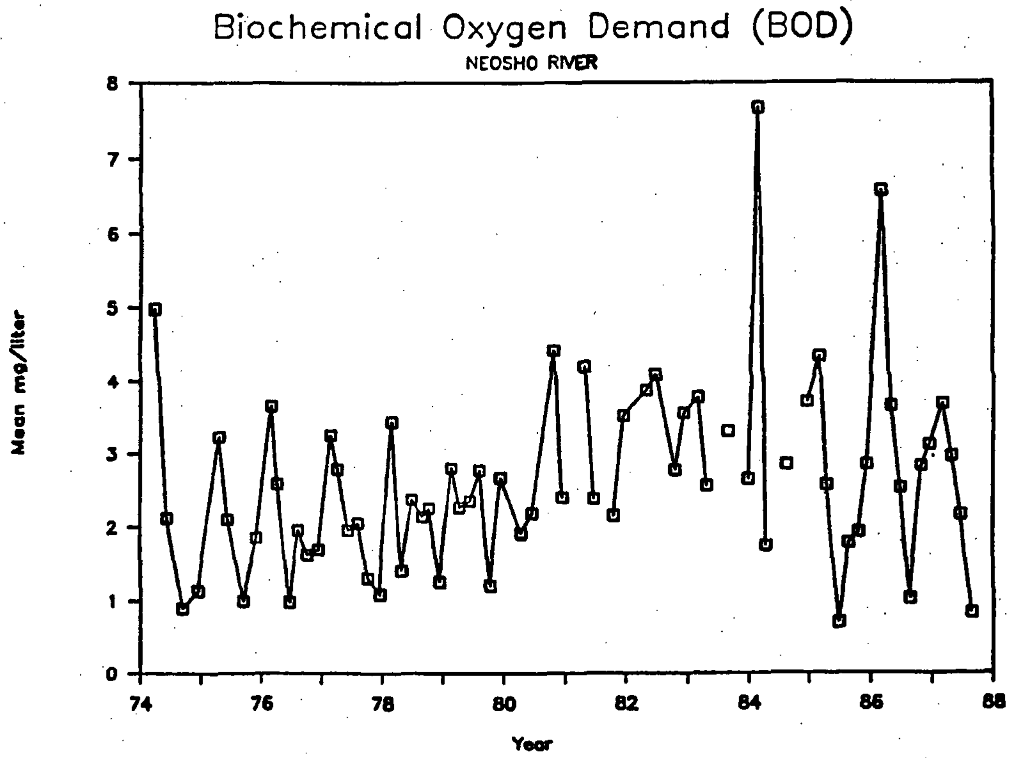


Figure A-13. Temporal variations in chemical oxygen demand (COD) for the Neosho River and WCGS Cooling Lake, 1974-1987.



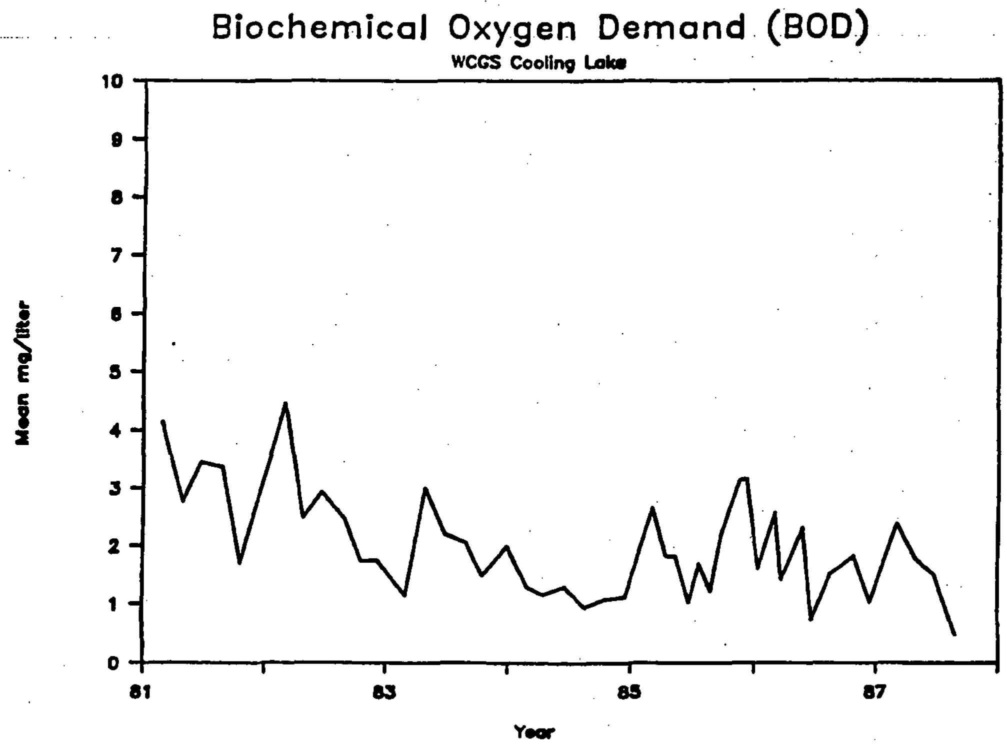
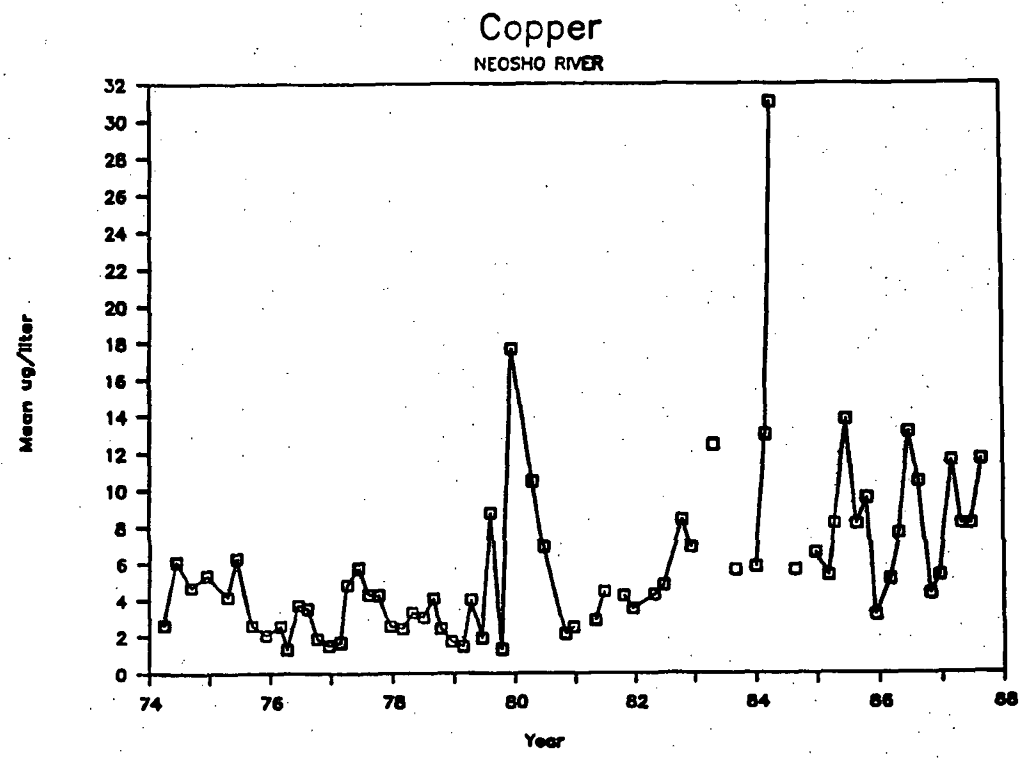


Figure A-14. Temporal variations in biochemical oxygen demand (BOD) for the Neosho River and WCGS Cooling Lake, 1974-1987.



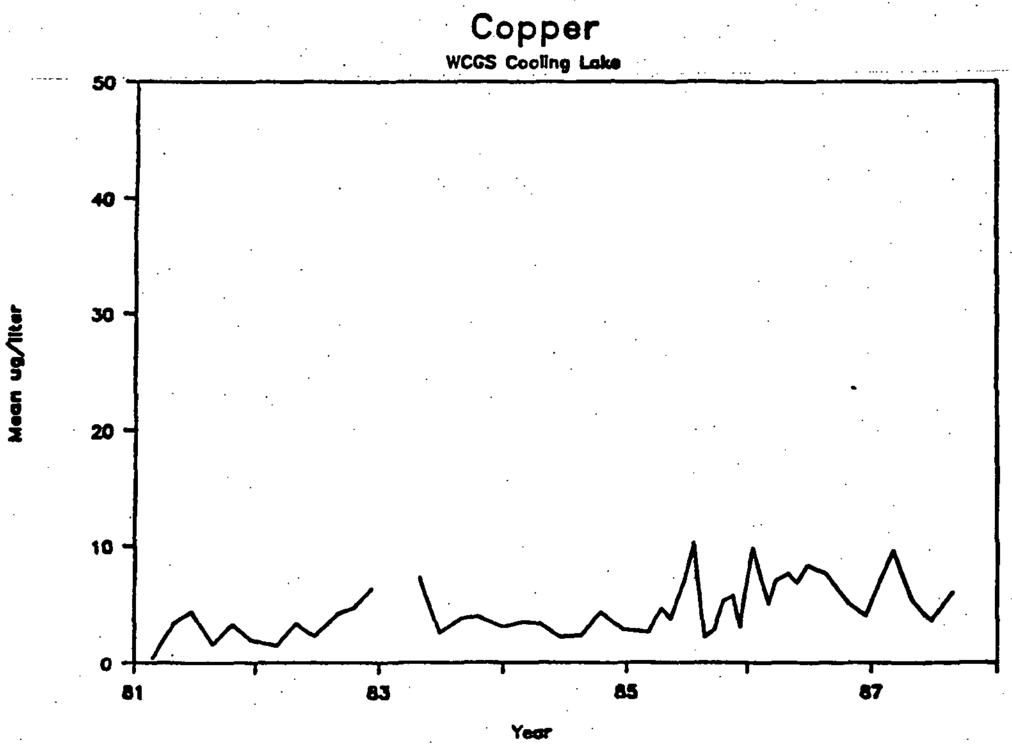
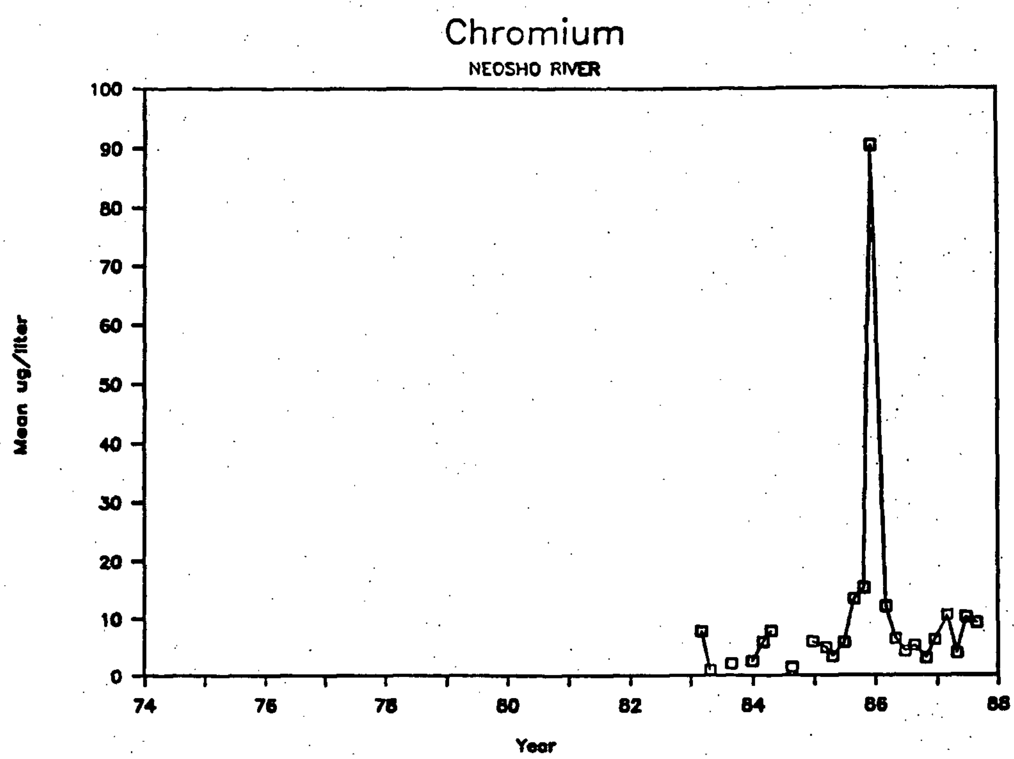


Figure A-15. Temporal variations in copper concentrations for the Neosho River and WCGS Cooling Lake, 1974-1987.



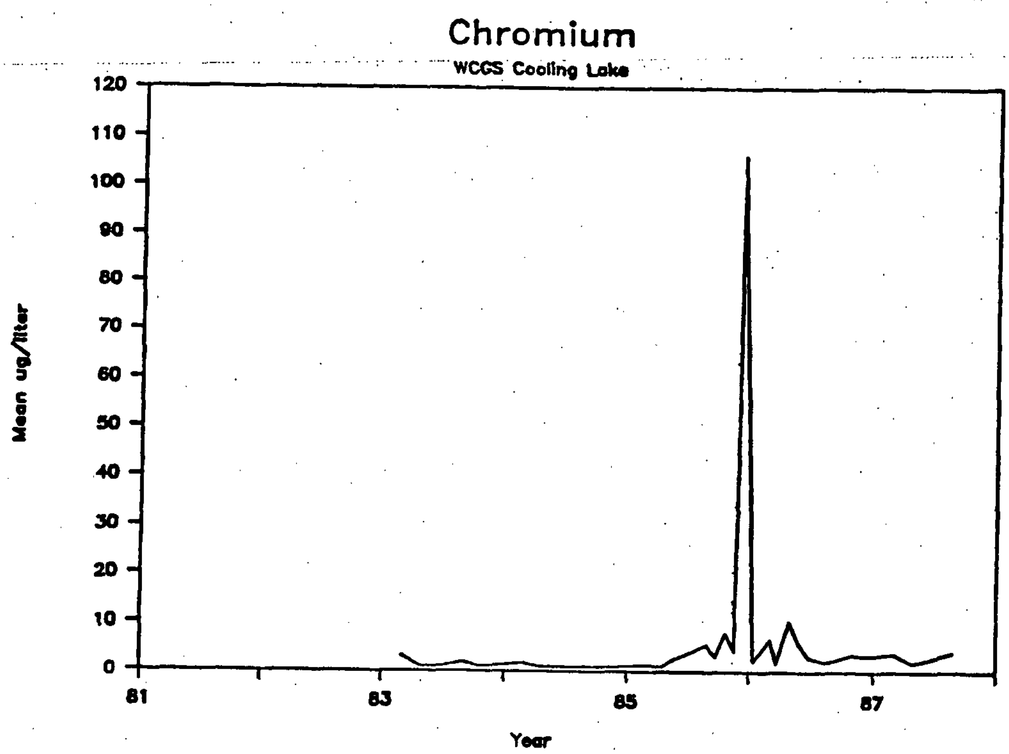


Figure A-16. Temporal variations in chromium concentrations for the Neosho River and WCGS Cooling Lake, 1983-1987.

APPENDIX B
1987 DATA TABLES

Contents

TABLE B-1 REPLICATE WATER CHEMISTRY DATA FOR SAMPLES COLLECTED FROM THE NEOSHO RIVER AND THE COOLING LAKE FOR WOLF CREEK GENERATING STATION, 2 MARCH 1987

Parameter	Units	1A	1B	10A	10B	4A	4B	2A	2B	6A	6B	8A	8B
Water Temperature	C	7.0	-	8.0	-	8.0	-	12.5	-	-	-	6.0	-
Dissolved Oxygen	mg/l	13.7	13.8	13.2	13.4	12.3	12.7	12.0	-	10.4	-	13.6	-
pH	units	8.0	8.1	7.2	7.4	7.1	7.2	7.9	7.9	7.9	7.9	7.9	7.9
Conductivity	µmhos/cm	420	420	440	440	410	410	320	320	320	320	320	320
Total Alkalinity	mg/l	310	380	310	300	320	290	250	243	251	256	260	230
Turbidity	NTU	48	50	58	52	88	90	17	18	5	5	11	9
Residue (TDS)	mg/l	298	258	304	284	624	628	164	232	272	146	216	128
(TSS)	mg/l	76	82	100	86	52	44	4	4	8	4	12	12
Biochemical Oxygen Demand	mg/l	4.0	3.45	1.0	1.34	3.56	5.41	2.0	2.3	2.9	2.6	2.2	2.3
Oil and Grease	mg/l	-	3.1	<3	<3	<3	<3	<3	<3	<3	<3	<3	-
Bacteria, Fecal Coliform	No./100 ml	19	17	88	94	56	38	55	38	0	0	1	4
Calcium	mg/l	53.2	56.0	<0.1	<0.1	61.1	56.2	33.5	32.7	36.8	40.1	38.4	39.0
Total Chromium	µg/l	0.006	0.006	0.025	0.010	0.007	0.009	0.006	0.004	0.003	0.004	0.003	0.003
Copper	µg/l	0.045	0.010	0.013	0.009	0.010	0.016	0.010	0.004	0.008	0.008	0.029	0.018
Total Iron	mg/l	2.7	2.4	3.1	3.7	3.2	5.2	0.77	0.73	0.15	0.19	0.34	0.35
Soluble Iron	mg/l	0.02	0.10	0.6	0.21	0.06	0.10	1.60	0.06	<0.02	<0.102	0.02	0.02
Magnesium	mg/l	19.2	15.6	15.6	15.4	18.6	17.6	12.1	12.5	14.9	15.6	15.2	16.2
Nickel	µg/l	0.001	0.017	0.006	0.004	0.006	0.011	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Chemical Oxygen Demand	mg/l	20	<10	30	<10	30	<10	20	20	<10	10	<10	10
Chloride	mg/l	12	11	12	10	10	10	15	15	16	16	15	16
Ammonia-Nitrogen	mg/l	0.24	0.23	0.32	0.30	0.36	0.36	0.12	0.14	0.19	0.16	0.23	0.24
Nitrite-Nitrogen	mg/l	0.04	0.04	0.06	0.06	0.06	0.07	0.02	0.02	<0.01	<0.01	<0.01	<0.01
Nitrate-Nitrogen	mg/l	0.45	0.44	0.77	0.55	0.43	0.46	0.14	0.22	0.17	0.21	0.15	0.13
Orthophosphate	mg/l	0.02	0.02	0.06	0.06	0.06	0.06	0.02	0.03	0.01	0.03	0.03	0.04
Sulfate	mg/l	58	58	55	56	54	53	49	48	50	50	49	49

TABLE B-2 REPLICATE WATER CHEMISTRY DATA FOR SAMPLES COLLECTED FROM THE NEOSHO RIVER AND THE COOLING LAKE FOR WOLF CREEK GENERATING STATION, 28 APRIL 1987

Parameter	Units	1A	1B	10A	10B	4A	4B	2A	2B	6A	6B	8A	8B
Water Temperature	C	20.0	-	20.5	-	20.5	-	22.0	-	20.0	-	18.5	-
Dissolved Oxygen	mg/l	9.5	9.6	9.2	9.3	-	9.7	8.0	-	8.6	-	8.6	-
pH	units	7.4	7.7	8.1	8.3	8.1	8.1	8.0	8.1	8.0	8.2	8.0	8.2
Conductivity	µmhos/cm	370	380	420	420	420	430	300	310	300	320	380	325
Total Alkalinity	mg/l	392	354	385	383	378	376	305	296	291	294	292	295
Turbidity	NTU	42	42	39	37	37	37	2.8	2.8	2.5	2.0	2.5	2.2
Residue (TDS)	mg/l	306	326	266	224	352	326	250	224	136	198	112	214
(TSS)	mg/l	42	28	76	146	44	60	1	1	8	16	16	2
Biochemical Oxygen Demand	mg/l	3.0	3.3	2.6	2.1	3.7	3.1	1.7	2.3	1.6	1.5	1.4	2.2
Oil and Grease	mg/l	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Bacteria, Fecal Coliform	No./100 ml	23	23	10	46	36	10	0	0	0	0	0	0
Calcium	mg/l	50.4	53.7	66.0	62.2	63.5	54.7	38.8	37.0	42.6	38.0	40.0	40.3
Total Chromium	µg/l	0.006	0.002	0.003	0.003	0.005	0.004	0.001	0.002	0.002	0.002	0.002	0.002
Copper	µg/l	0.007	0.007	0.006	0.015	0.009	0.005	0.006	0.005	0.005	0.004	0.003	0.009
Total Iron	mg/l	3.70	0.45	2.14	1.80	3.42	2.64	0.15	0.15	0.15	0.15	0.26	0.26
Soluble Iron	mg/l	0.06	0.06	0.19	0.06	0.06	0.06	0.08	0.15	0.06	0.08	0.06	0.10
Magnesium	mg/l	10.0	5.0	11.2	11.0	11.2	10.8	9.0	8.3	9.4	9.2	9.1	9.2
Nickel	µg/l	0.002	0.001	0.001	0.002	0.002	0.001	0.001	<0.001	<0.001	<0.001	0.007	0.002
Chemical Oxygen Demand	mg/l	20	10	20	40	20	10	30	20	30	40	30	40
Chloride	mg/l	10	10	11	11	11	11	15	15	15	15	15	15
Ammonia-Nitrogen	mg/l	0.06	0.06	0.04	0.03	0.13	0.04	0.11	0.11	0.09	0.09	0.10	0.10
Organic Nitrogen	mg/l	0.3	0.4	0.4	0.5	0.2	0.5	0.9	0.6	0.7	0.4	0.6	0.9
Nitrite-Nitrogen	mg/l	0.07	0.07	0.06	0.06	0.05	0.05	<0.01	0.01	0.01	0.01	<0.01	<0.01
Nitrate-Nitrogen	mg/l	1.83	0.87	0.88	1.01	0.79	0.99	0.77	0.22	0.03	0.02	0.08	0.03
Orthophosphate	mg/l	0.03	0.03	0.03	0.03	0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	mg/l	50	49	51	50	52	52	50	50	50	51	49	50

TABLE B-3 REPLICATE WATER CHEMISTRY DATA FOR SAMPLES COLLECTED FROM THE NEOSHO RIVER AND THE COOLING LAKE FOR WOLF CREEK GENERATING STATION, 23 JUNE 1987

Parameter	Units	1A	1B	10A	10B	4A	4B	2A	2B	6A	6B	8A	8B
Water Temperature	C	30.5	-	30.0	-	29.0	-	33.0	-	27.5	-	27.5	-
Dissolved Oxygen	mg/l	7.9	7.6	7.5	7.4	7.8	7.7	7.0	-	8.2	-	8.2	-
pH	units	8.3	8.3	8.1	8.3	7.8	7.9	8.4	8.5	8.0	8.1	8.6	8.5
Conductivity	µmhos/cm	450	460	460	440	470	470	400	400	400	400	400	400
Total Alkalinity	mg/l	170	174	174	176	181	178	142	142	138	139	140	142
Turbidity	NTU	38	33	47	30	34	35	5	3	2	3	3	5
Residue (TDS)	mg/l	204	180	216	238	194	186	186	164	160	168	148	176
(TSS)	mg/l	50	50	64	66	70	66	2	4	10	4	14	2
Biochemical Oxygen Demand	mg/l	3.2	3.1	1.6	1.7	1.9	1.5	2.6	1.5	1.1	1.0	1.6	1.2
Oil and Grease	mg/l	<3	<3	<3	<3	<3	<3	-	<3	<3	<3	<3	<3
Bacteria, Fecal Coliform	No./100 ml	124	37	31	35	32	37	1	1	0	1	0	0
Calcium	mg/l	52.4	46.7	52.8	53.0	51.6	56.7	40.3	40.6	42.2	40.0	40.5	37.3
Total Chromium	µg/l	0.018	0.006	0.008	0.007	0.012	0.010	0.003	0.002	0.003	0.003	0.003	0.003
Copper	µg/l	0.012	0.008	0.004	0.006	0.013	0.006	0.005	0.001	0.007	0.003	0.003	0.002
Total Iron	mg/l	2.27	1.90	3.02	2.04	2.18	2.48	0.11	0.10	0.10	0.04	0.12	0.12
Soluble Iron	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Magnesium	mg/l	12.5	13.6	15.4	15.3	13.5	15.5	13.4	13.2	13.8	13.2	13.7	13.0
Nickel	µg/l	0.006	0.005	0.006	0.005	0.005	0.011	0.005	0.002	0.003	0.002	0.002	0.002
Chemical Oxygen Demand	mg/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloride	mg/l	10	10	10	10	11	10	15	15	14	15	14	13
Ammonia-Nitrogen	mg/l	0.06	0.10	<0.03	0.06	<0.03	0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Organic Nitrogen	mg/l	1.5	1.4	1.2	1.0	1.2	1.0	0.7	0.9	0.5	0.8	0.7	0.7
Nitrite-Nitrogen	mg/l	0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate-Nitrogen	mg/l	0.82	0.82	1.14	1.04	1.04	1.08	0.03	0.12	<0.01	0.02	0.04	0.06
Orthophosphate	mg/l	0.02	0.02	0.05	0.03	0.03	0.05	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	mg/l	66	66	66	66	66	66	62	62	63	62	62	62

TABLE B-4 REPLICATE WATER CHEMISTRY DATA FOR SAMPLES COLLECTED FROM THE NEOSHO RIVER AND THE COOLING LAKE FOR WOLF CREEK GENERATING STATION, 24 AUGUST 1987

Parameter	Units	1A	1B	10A	10B	4A	4B	2A	2B	6A	6B	8A	8B
Water Temperature	C	-	-	-	-	-	-	26.0	-	26.0	-	27.0	-
Dissolved Oxygen	mg/l	8.8	9.0	8.9	8.8	7.9	7.8	7.4	-	7.7	-	7.6	-
pH	units	7.6	7.3	7.5	7.4	7.4	7.4	7.9	7.4	7.6	7.7	7.5	7.5
Conductivity	µmhos/cm	380	380	375	380	380	375	400	400	360	360	360	360
Total Alkalinity	mg/l	125	136	126	130	129	132	120	125	115	115	115	118
Turbidity	NTU	33	33	33	30	35	38	4.0	3.5	3.7	3.2	6.3	5.0
Residue (TDS)	mg/l	280	272	288	266	274	270	244	244	238	246	256	244
(TSS)	mg/l	40	50	400	60	52	50	6	6	2	8	6	4
Biochemical Oxygen Demand	mg/l	1.0	1.0	0.6	0.8	0.8	0.8	1.1	0.4	0.2	-	0.4	0.3
Oil and Grease	mg/l	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Bacteria, Fecal Coliform	No./100 ml	102	86	54	62	22	34	1	2	0	0	0	2
Calcium	mg/l	43.9	42.6	36.1	36.4	44.3	41.4	29.9	31.2	36.1	35.7	38.3	36.4
Total Chromium	µg/l	0.005	0.005	0.008	0.008	0.48	0.020	0.006	0.006	<0.003	<0.003	0.003	0.004
Copper	µg/l	0.005	0.003	0.007	0.007	0.036	0.012	0.051	0.018	<0.003	<0.003	0.003	<0.003
Total Iron	mg/l	2.6	3.7	3.4	2.9	5.9	5.8	2.6	2.5	0.21	0.13	0.46	0.36
Soluble Iron	mg/l	0.03	0.02	0.03	0.02	0.02	0.02	<0.03	0.02	0.02	0.02	0.02	0.01
Magnesium	mg/l	9.45	11.8	10.3	10.5	11.0	9.72	10.8	5.84	12.4	11.6	12.5	12.6
Nickel	µg/l	0.006	0.003	0.011	0.009	0.014	0.005	0.029	0.013	<0.001	0.001	<0.001	<0.001
Chemical Oxygen Demand	mg/l	30	30	30	60	30	30	40	70	70	30	70	60
Chloride	mg/l	14	14	14	14	15	13	19	19	19	19	19	18
Ammonia-Nitrogen	mg/l	0.04	0.05	0.04	0.04	0.04	0.05	0.06	0.06	0.06	0.04	0.09	0.05
Nitrite-Nitrogen	mg/l	0.10	0.10	0.06	0.06	0.06	0.06	0.01	0.01	0.01	0.01	<0.01	<0.01
Nitrate-Nitrogen	mg/l	0.42	0.43	0.59	0.54	0.55	0.55	0.02	0.02	0.03	0.02	0.01	<0.01
Orthophosphate	mg/l	0.06	0.07	<0.01	<0.01	0.07	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	mg/l	37	36	33	35	34	33	44	45	45	45	45	45

TABLE B-5 WATER QUALITY DATA FROM GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1987

Parameter	Units	MARCH				APRIL			
		B12	C20	C49	D65	B12	C20	C49	D65
Temperature	C	-[a]	-	-	-	16.5	14.5	19.0	14.5
pH	units	7.2	7.3	7.0	7.4	8.2	7.3	7.3	6.9
Alkalinity	mg/l	310	881	523	515	1,057	592	740	296
Conductivity	µmhos/cm	3,400	1,000	1,100	1,100	1,100	1,100	1,000	2,600
Hardness - Total	mg/l	929	613	532	608	528	659	490	1,010
Residue (TDS)	mg/l	2,490	836	1,090	1,922	802	1,040	610	2,454
Calcium	mg/l	227	213	135	209	155	240	130	317
Chloride	mg/l	800	360	56	310	67	200	55	400
Magnesium	mg/l	88	19.8	47.4	21.0	34	14.5	40.1	53
Sulfate	mg/l	70	58	20	58	19	50	90	42
Nitrate (as N)	mg/l	290	61	7.4	54	0.52	42.3	5.11	220
Iron - Total	mg/l	10.5	1.82	0.06	5.34	3.76	1.76	0.13	0.54
Iron - Soluble	mg/l	0.17	0.04	0.10	0.04	0.15	0.11	0.21	0.10

Parameter	Units	AUGUST			
		B12	C20	C49	D65
Temperature	C	-	-	-	-
pH	units	7.0	7.4	7.0	6.9
Alkalinity	mg/l	200	265	360	148
Conductivity	µmhos/cm	2,00	1,220	1,000	2,400
Hardness - Total	mg/l	572	608	408	996
Residue (TDS)	mg/l	1,144	1,080	824	2,310
Calcium	mg/l	205	214	111	286
Chloride	mg/l	160	170	46	420
Magnesium	mg/l	15.6	17.9	31.8	68.4
Sulfate	mg/l	54	52	29	77
Nitrate (as N)	mg/l	52	47	0.84	240
Iron - Total	mg/l	2.1	3.7	<.01	21
Iron - Soluble	mg/l	0.03	0.06	0.55	0.05

(a) No data available.

TABLE B-6 PHYTOPLANKTON AND ZOOPLANKTON PRODUCTION IN THE COOLING LAKE OF WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1987

Date	Location	Phytoplankton: Chlorophyll a Concentration (mg/m3)	Phytoplankton: Carbon Fixation Rate (mg C/m3/hr)	Zooplankton: Dry Weight (mg/m3)	Zooplankton: Ash-Free Dry Weight (mg/m3)
2,3 MAR					
	2	10.4	6.5	301	61
	6	8.4	8.7	43	24
	8	7.5	7.0	79	40
	Mean	8.8	7.4	141	42
27,28 APR					
	2	4.5	14.6	93	66
	6	3.8	12.9	93	71
	8	4.5	11.2	265	187
	Mean	4.3	12.9	150	108
22 JUN					
	2	7.4	4.0	200	23
	6	6.0	4.0	95	28
	8	7.5	5.8	65	25
	Mean	7.0	4.6	120	25
24 AUG					
	2	7.6	10.6	83	23
	6	7.3	9.9	76	32
	8	11.1	13.6	79	57
	Mean	8.6	11.4	79	37
23 NOV					
	2	4.9	-	-	-
	6	4.8	-	-	-
	8	3.4	-	-	-
	Mean	4.4	-	-	-
28 DEC					
	2	3.5	-	-	-
	6	4.9	-	-	-
	8	5.3	-	-	-
	Mean	4.6	-	-	-
Annual Average	2	6.4	8.9	169	43
	6	5.9	9.1	77	39
	8	6.6	9.4	97	77
	Mean	6.3	9.1	114	53

Note: Dash (-) indicates location not sampled.

TABLE B-7

WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR SPECIES

DATE: 02MAR87
AND LOCATION: 2

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Dero digitata	1	0	9.4	3.85
Coenagrionidae n.	1	0	9.4	3.85
Leptoceridae l.	1	0	9.4	3.85
Chaoborus punctipennis l.	0	1	9.4	3.85
Coelotanypus l.	5	2	66.0	26.92
Chironomus l.	2	7	84.9	34.62
Glyptotendipes l.	6	0	56.6	23.08
TOTAL BENTHOS	16	10	245.3	100.00

DATE: 02MAR87
AND LOCATION: 4

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Branchiura sowerbyi	8	23	292.5	22.30
Limno. claparedianus	1	0	9.4	0.72
Limnodrilus hoffmeisteri	1	2	28.3	2.16
Imm. tub. w/o cap. chaet.	2	0	18.9	1.44
Isonychia n.	2	0	18.9	1.44
Stenonema n.	0	2	18.9	1.44
Cheumatopsyche l.	1	0	9.4	0.72
Potamyia flava l.	2	5	66.0	5.04
Stenelmis l.	7	5	113.2	8.63
Chironomidae p.	7	0	66.0	5.04
Orthocladiinae l.	9	5	132.1	10.07
Cricot. tremulus grp. l.	0	1	9.4	0.72
Eukiefferiella l.	13	2	141.5	10.79
Hydrobaenus l.	21	3	226.4	17.27
Orthocladius l.	4	0	37.7	2.88
Chironominae l.	2	1	28.3	2.16
Cryptochironomus l.	1	0	9.4	0.72
Polypedilum scalaenum l.	3	0	28.3	2.16
Corbicula	2	4	56.6	4.32
TOTAL BENTHOS	86	53	1311.3	100.00

TABLE B-7 (Cont.)

DATE: 02MAR87
AND LOCATION: 6

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Dero	1	0	9.4	3.45
Dero digitata	10	0	94.3	34.48
Aulodrilus pigueti	3	0	28.3	10.34
Chaoborus punctipennis l.	2	5	66.0	24.14
Chironomidae p.	1	0	9.4	3.45
Tanypodinae l.	2	0	18.9	6.90
Procladius l.	1	0	9.4	3.45
Coelotanypus l.	2	0	18.9	6.90
Chironomus l.	2	0	18.9	6.90
TOTAL BENTHOS	24	5	273.6	100.00

DATE: 02MAR87
AND LOCATION: 8

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Aulodrilus pigueti	1	0	9.4	11.11
Ilyodrilus templetoni	0	2	18.9	22.22
Imm. tub. w/ cap. chaet.	1	1	18.9	22.22
Coelotanypus l.	0	3	28.3	33.33
Chironomus l.	1	0	9.4	11.11
TOTAL BENTHOS	3	6	84.9	100.00

DATE: 02MAR87
AND LOCATION: 10

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Pristina	0	1	9.4	0.53
Imm. tub. w/o cap. chaet.	0	1	9.4	0.53
Enchytraeidae	1	0	9.4	0.53
Stenonema n.	6	3	84.9	4.76
Stenonema pulchellum n.	2	0	18.9	1.06
Perlidae n.	4	0	37.7	2.12
Neoperla n.	4	0	37.7	2.12
Cheumatopsyche l.	16	1	160.4	8.99
Potamyia flava l.	46	9	518.9	29.10
Stenelmis l.	24	1	235.8	13.23
Chironomidae p.	4	4	75.5	4.23
Orthocladiinae l.	1	2	28.3	1.59
Cricot. tremulus grp. l.	0	1	9.4	0.53
Eukiefferiella l.	25	25	471.7	26.46
Orthocladius l.	1	2	28.3	1.59
Hexatoma l.	2	1	28.3	1.59
Corbicula	2	0	18.9	1.06
TOTAL BENTHOS	138	51	1783.0	100.00

TABLE B-8 WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR SPECIES

DATE: 27APR87
AND LOCATION: 2

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Chaoborus punctipennis l.	0	1	9.4	7.14
Coelotanypus l.	4	5	84.9	64.29
Chironomus l.	1	3	37.7	28.57
TOTAL BENTHOS	5	9	132.1	100.00

DATE: 27APR87
AND LOCATION: 6

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Dero digitata	3	4	66.0	6.25
Aulodrilus pigueti	15	3	169.8	16.07
Ilyodrilus templetoni	8	2	94.3	8.93
Limno. claparedianus	1	0	9.4	0.89
Imm. tub. w/o cap. chaet.	5	9	132.1	12.50
Imm. tub. w/ cap. chaet.	48	7	518.9	49.11
Chaoborus punctipennis l.	1	0	9.4	0.89
Chironomidae p.	0	1	9.4	0.89
Coelotanypus l.	0	2	18.9	1.79
Chironominae l.	1	0	9.4	0.89
Chironomus l.	2	0	18.9	1.79
TOTAL BENTHOS	84	28	1056.6	100.00

DATE: 27APR87
AND LOCATION: 8

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Ilyodrilus templetoni	2	0	18.9	33.33
Coelotanypus l.	2	0	18.9	33.33
Chironomus l.	2	0	18.9	33.33
TOTAL BENTHOS	6	0	56.6	100.00

DATE: 28APR87
AND LOCATION: 4

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Hydra	13	4	160.4	77.27
Imm. tub. w/o cap. chaet.	1	0	9.4	4.55
Hydropsychidae l.	0	1	9.4	4.55
Potamyia flava l.	0	1	9.4	4.55
Cryptochironomus l.	1	0	9.4	4.55
Corbicula	1	0	9.4	4.55
TOTAL BENTHOS	16	6	207.5	100.00

TABLE B-8 (Cont.)

DATE: 28APR87
AND LOCATION: 10

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Hydra	12	4	150.9	66.67
Imm. tub. w/o cap. chaet.	0	1	9.4	4.17
Stenonema n.	0	1	9.4	4.17
Perlidae n.	1	0	9.4	4.17
Potamyia flava l.	0	2	18.9	8.33
Elmidae l.	0	1	9.4	4.17
Hexatoma l.	1	0	9.4	4.17
Corbicula	0	1	9.4	4.17
TOTAL BENTHOS	14	10	226.4	100.00

TABLE B-9 WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR SPECIES

DATE: 22JUN87
AND LOCATION: 2

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Hexagenia n.	0	1	9.4	25.00
Thienemannimyia ser. l.	0	1	9.4	25.00
Chironomus l.	2	0	18.9	50.00
TOTAL BENTHOS	2	2	37.7	100.00

DATE: 22JUN87
AND LOCATION: 4

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Ephoron album n.	1	2	28.3	18.75
Neoperla n.	1	1	18.9	12.50
Hydropsychidae p.	1	0	9.4	6.25
Potamyia flava l.	7	3	94.3	62.50
TOTAL BENTHOS	10	6	150.9	100.00

DATE: 22JUN87
AND LOCATION: 6

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Aulodrilus pigueti	1	3	37.7	66.67
Chironomus l.	2	0	18.9	33.33
TOTAL BENTHOS	3	3	56.6	100.00

DATE: 22JUN87
AND LOCATION: 8

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Chaoborus punctipennis l.	1	0	9.4	100.00
TOTAL BENTHOS	1	0	9.4	100.00

TABLE B-9 (Cont.)

DATE: 22JUN87
AND LOCATION: 10

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Baetidae n.	0	1	9.4	2.33
Ephoron album n.	2	0	18.9	4.65
Neoperla n.	0	1	9.4	2.33
Hydropsychidae p.	3	0	28.3	6.98
Potamyia flava l.	21	13	320.8	79.07
Stenelmis l.	1	0	9.4	2.33
Corbicula	0	1	9.4	2.33
TOTAL BENTHOS	27	16	405.7	100.00

TABLE B-10 WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR SPECIES

DATE: 24AUG87
AND LOCATION: 2

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Procladius l.	1	1	18.9	28.57
Coelotanypus l.	1	3	37.7	57.14
Chironomus l.	1	0	9.4	14.29
TOTAL BENTHOS	3	4	66.0	100.00

DATE: 24AUG87
AND LOCATION: 4

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Glossiphoniidae	1	0	9.4	3.85
Neoperla n.	1	0	9.4	3.85
Potamyia flava l.	2	2	37.7	15.38
Stenelmis l.	1	0	9.4	3.85
Hexatoma l.	0	1	9.4	3.85
Gastropoda	0	1	9.4	3.85
Corbicula	3	14	160.4	65.38
TOTAL BENTHOS	8	18	245.3	100.00

DATE: 24AUG87
AND LOCATION: 6

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Coelotanypus l.	1	0	9.4	50.00
Chironomus l.	0	1	9.4	50.00
TOTAL BENTHOS	1	1	18.9	100.00

DATE: 24AUG87
AND LOCATION: 8

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
No Organisms Collected	0	0	0.0	.
TOTAL BENTHOS	0	0	0.0	.

TABLE B-10 (Cont.)

DATE: 24AUG87
AND LOCATION: 10

SPECIES	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Perlidae n.	0	1	9.4	7.69
Hydropsychidae p.	2	3	47.2	38.46
Potamyia flava l.	0	5	47.2	38.46
Cryptochironomus l.	0	1	9.4	7.69
Corbicula	0	1	9.4	7.69
TOTAL BENTHOS	2	11	122.6	100.00

TABLE B-11 WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR FAMILIES

DATE: 02MAR87
AND LOCATION: 2

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Naididae	1	0	9.4	3.85
Coenagrionidae	1	0	9.4	3.85
Leptoceridae	1	0	9.4	3.85
Chaoboridae	0	1	9.4	3.85
Chironomidae	13	9	207.5	84.62
TOTAL BENTHOS	16	10	245.3	100.00

DATE: 02MAR87
AND LOCATION: 4

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Tubificidae	12	25	349.1	26.62
Siphlonuridae	2	0	18.9	1.44
Heptageniidae	0	2	18.9	1.44
Hydropsychidae	3	5	75.5	5.76
Elmidae	7	5	113.2	8.63
Chironomidae	60	12	679.2	51.80
Corbiculidae	2	4	56.6	4.32
TOTAL BENTHOS	86	53	1311.3	100.00

DATE: 02MAR87
AND LOCATION: 6

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Naididae	11	0	103.8	37.93
Tubificidae	3	0	28.3	10.34
Chaoboridae	2	5	66.0	24.14
Chironomidae	8	0	75.5	27.59
TOTAL BENTHOS	24	5	273.6	100.00

DATE: 02MAR87
AND LOCATION: 8

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Tubificidae	2	3	47.2	55.56
Chironomidae	1	3	37.7	44.44
TOTAL BENTHOS	3	6	84.9	100.00

TABLE B-11 (Cont.)

DATE: 02MAR87
AND LOCATION: 10

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Naididae	0	1	9.4	0.53
Tubificidae	0	1	9.4	0.53
Enchytraediae	1	0	9.4	0.53
Heptageniidae	8	3	103.8	5.82
Perlidae	8	0	75.5	4.23
Hydropsychidae	62	10	679.2	38.10
Elmidae	24	1	235.8	13.23
Chironomidae	31	34	613.2	34.39
Simulidae	2	1	28.3	1.59
Corbiculidae	2	0	18.9	1.06
TOTAL BENTHOS	138	51	1783.0	100.00

TABLE B-12

WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR FAMILIES

DATE: 27APR87
AND LOCATION: 2

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Chaoboridae	0	1	9.4	7.14
Chironomidae	5	8	122.6	92.86
TOTAL BENTHOS	5	9	132.1	100.00

DATE: 27APR87
AND LOCATION: 6

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Naididae	3	4	66.0	6.25
Tubificidae	77	21	924.5	87.50
Chaoboridae	1	0	9.4	0.89
Chironomidae	3	3	56.6	5.36
TOTAL BENTHOS	84	28	1056.6	100.00

DATE: 27APR87
AND LOCATION: 8

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Tubificidae	2	0	18.9	33.33
Chironomidae	4	0	37.7	66.67
TOTAL BENTHOS	6	0	56.6	100.00

DATE: 28APR87
AND LOCATION: 4

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Hydridae	13	4	160.4	77.27
Tubificidae	1	0	9.4	4.55
Hydropsychidae	0	2	18.9	9.09
Chironomidae	1	0	9.4	4.55
Corbiculidae	1	0	9.4	4.55
TOTAL BENTHOS	16	6	207.5	100.00

TABLE B-12 (Cont.)

DATE: 28APR87
AND LOCATION: 10

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Hydridae	12	4	150.9	66.67
Tubificidae	0	1	9.4	4.17
Heptageniidae	0	1	9.4	4.17
Perlidae	1	0	9.4	4.17
Hydropsychidae	0	2	18.9	8.33
Elmidae	0	1	9.4	4.17
Simulidae	1	0	9.4	4.17
Corbiculidae	0	1	9.4	4.17
TOTAL BENTHOS	14	10	226.4	100.00

TABLE B-13 WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR FAMILIES

DATE: 22JUN87
AND LOCATION: 2

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Ephemeridae	0	1	9.4	25.00
Chironomidae	2	1	28.3	75.00
TOTAL BENTHOS	2	2	37.7	100.00

DATE: 22JUN87
AND LOCATION: 4

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Polymitarcyidae	1	2	28.3	18.75
Perlidae	1	1	18.9	12.50
Hydropsychidae	8	3	103.8	68.75
TOTAL BENTHOS	10	6	150.9	100.00

DATE: 22JUN87
AND LOCATION: 6

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Tubificidae	1	3	37.7	66.67
Chironomidae	2	0	18.9	33.33
TOTAL BENTHOS	3	3	56.6	100.00

DATE: 22JUN87
AND LOCATION: 8

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Chaoboridae	1	0	9.4	100.00
TOTAL BENTHOS	1	0	9.4	100.00

DATE: 22JUN87
AND LOCATION: 10

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Baetidae	0	1	9.4	2.33
Polymitarcyidae	2	0	18.9	4.65
Perlidae	0	1	9.4	2.33
Hydropsychidae	24	13	349.1	86.05
Elmidae	1	0	9.4	2.33
Corbiculidae	0	1	9.4	2.33
TOTAL BENTHOS	27	16	405.7	100.00

TABLE B-14

WOLF CREEK GENERATING STATION - 1987 MACROINVERTEBRATE STUDY
PONAR RESULTS: REPLICATE COUNTS AND MEAN DENSITIES FOR FAMILIES

DATE: 24AUG87
AND LOCATION: 2

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Chironomidae	3	4	66.0	100.00
TOTAL BENTHOS	3	4	66.0	100.00

DATE: 24AUG87
AND LOCATION: 4

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Glossiphonidae	1	0	9.4	3.85
Perlidae	1	0	9.4	3.85
Hydropsychidae	2	2	37.7	15.38
Elmidae	1	0	9.4	3.85
Simulidae	0	1	9.4	3.85
Corbiculidae	3	14	160.4	65.38
Other Groups	0	1	9.4	3.85
TOTAL BENTHOS	8	18	245.3	100.00

DATE: 24AUG87
AND LOCATION: 6

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Chironomidae	1	1	18.9	100.00
TOTAL BENTHOS	1	1	18.9	100.00

DATE: 24AUG87
AND LOCATION: 8

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Hydridae	0	0	0.0	.
TOTAL BENTHOS	0	0	0.0	.

DATE: 24AUG87
AND LOCATION: 10

FAMILY	REP A COUNT	REP B COUNT	MEAN (#/sq m)	(%)
Perlidae	0	1	9.4	7.69
Hydropsychidae	2	8	94.3	76.92
Chironomidae	0	1	9.4	7.69
Corbiculidae	0	1	9.4	7.69
TOTAL BENTHOS	2	11	122.6	100.00

TABLE B-15 PHYSICAL MEASUREMENTS RECORDED DURING FISH SURVEYS IN THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION BURLINGTON, KANSAS, 1987

Date	Gear[a]	Reservoir Discharge (cfs)	Water Temp (C)			Conductivity (μmhos/cm)			Turbidity (N.T.U.)		
			1	10	4	1	10	4	1	10	4
2 MAR	EF	411	6.5	8.0	8.0	420	440	410	49	58	89
	S		6.5	8.0	8.0	420	440	410	49	58	89
27 APR	EF	554	21.5	22.0	22.0	375	420	425	42	38	37
	S		21.5	22.0	22.0	375	420	425	42	38	37
22 JUN	EF	316	29.0	29.0	29.0	455	450	470	36	39	35
	S		29.0	29.0	29.0	455	450	470	36	39	35
24 AUG	EF	752	22.0	23.0	23.0	380	378	378	33	32	37
	S		22.0	23.0	23.0	380	378	378	33	32	37

(a) EF = electrofishing; S = seining.

TABLE B-16 SUMMARY OF ELECTROSHOCKING CATCH DATA FROM THE NEOSHO RIVER AND WOLF CREEK NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1987

Date/Location		Species	Number	CPE[a]	Total Length (mm)		Total Weight (g)	
					Mean	Range	Mean	Range
2 MAR	1	Gizzard shad	3	3.0	144	80-250	-	<10-145
		Carp	2	2.0	513	408-617	1900	800-3000
		Red shiner	1	1.0	55	-	<10	-
		River carpsucker	2	2.0	373	362-384	550	520-580
		Smallmouth buffalo	1	1.0	425	-	1130	-
		Black bullhead	2	2.0	149	133-165	45	30-60
		White crappie	1	1.0	256	-	250	-
		Total	12	12.0				
	10	Gizzard shad	8	8.0	97	85-108	<10	<10
		Carp	6	6.0	498	415-568	1397	1000-2100
		Smallmouth buffalo	8	8.0	497	373-780	1849	670-5600
		Bigmouth buffalo	1	1.0	470	-	1790	-
		Shorthead redhorse	1	1.0	384	-	640	-
		Channel catfish	1	1.0	362	-	350	-
		Freshwater drum	1	1.0	367	-	580	-
		Total	26	26.0				
	4	Shortnose gar	1	1.0	635	-	660	-
		Carp	1	1.0	455	-	1100	-
		Smallmouth buffalo	4	4.0	410	348-475	1050	500-1950
		Channel catfish	1	1.0	490	-	1070	-
		Flathead catfish	1	1.0	72	-	<10	-
		White crappie	1	1.0	190	-	70	-
		Freshwater drum	3	3.0	266	123-373	284	18-500
		Total	12	12.0				
27 APR	1	Gizzard shad	2	2.0	237	217-257	103	70-135
		Carp	3	3.0	407	357-492	860	260-1650
		River carpsucker	10	10.0	324	226-365	526	355-870
		Smallmouth buffalo	3	3.0	461	388-510	1503	960-1870
		Bigmouth buffalo	2	2.0	528	470-585	-	-
		Channel catfish	1	1.0	338	-	310	-
		Flathead catfish	1	1.0	228	-	120	-
		White bass	3	3.0	234	162-344	275	56-700
		White crappie	1	1.0	244	-	120	-
		Total	26	26.0				
	10	Longnose gar	1	1.0	514	-	315	-
		Shortnose gar	1	1.0	590	-	800	-
		River carpsucker	2	2.0	378	375-381	755	730-780
		Smallmouth buffalo	4	4.0	402	310-448	1133	420-1660
		Longear sunfish	1	1.0	117	-	40	-
		Freshwater drum	1	1.0	115	-	10	-
		Total	10	10.0				
	4	Longnose gar	2	2.0	660	570-750	675	400-950
		Carp	1	1.0	418	-	1040	-
		River carpsucker	3	3.0	301	256-332	355	205-460
		Total	6	6.0				

TABLE B-16 (CONT)

Date/Location		Species	Number	CPE	Total Length (mm) Mean	Total Length (mm) Range	Total Weight (g) Mean	Total Weight (g) Range
22 JUN	1	Gizzard shad	255	25.0	49	42-60	<10	-
		Carp	4	4.0	310	227-357	425	150-600
		Ghost shiner	1	1.0	42	-	<10	-
		River carpsucker	5	5.0	265	228-350	280	170-580
		Smallmouth buffalo	6	6.0	382	250-502	980	330-1710
		Bigmouth buffalo	5	5.0	559	520-585	2814	1600-3940
		Blue sucker	1	1.0	590	-	1940	-
		Flathead catfish	3	3.0	217	140-302	140	30-290
		White bass	3	3.0	246	27-357	<463	<10-730
		Spotted bass	1	1.0	251	-	225	-
		Freshwater drum	2	2.0	220	61-378	<400	<10-790
		Total	286	286.0				
	10	River carpsucker	1	1.0	347	-	630	-
		Bigmouth buffalo	1	1.0	475	-	1240	-
		Channel catfish	1	1.0	665	-	3540	-
		Flathead catfish	2	2.0	269	234-303	220	160-280
		Total	5	5.0				
	4	Longnose gar	1	1.0	605	-	455	-
		Gizzard shad	3	3.0	339	60-770	<68	<10-150
		Fathead minnow	1	1.0	73	-	<10	-
		River carpsucker	3	3.0	296	142-379	458	35-700
		Smallmouth buffalo	1	1.0	332	-	510	-
		Flathead catfish	12	12.0	193	133-251	75	20-160
		Longear sunfish	3	3.0	86	72-105	<15	<10-25
		Spotted bass	1	1.0	137	-	30	-
		White crappie	1	1.0	261	-	250	-
		Total	26	26.0				
24 AUG	1	Carp	4	4.0	363	312-445	650	450-1050
		River carpsucker	2	2.0	297	273-320	324	248-400
		Smallmouth buffalo	3	3.0	393	325-511	1073	520-2050
		Bigmouth buffalo	1	1.0	585	-	3400	-
		Blue sucker	1	1.0	670	-	2960	-
		Channel catfish	1	1.0	408	-	530	-
		Flathead catfish	2	2.0	228	225-230	116	108-123
		Green sunfish	2	2.0	58	52-63	<10	-
		Orangespotted sunfish	1	1.0	63	-	<10	-
		Spotted bass	1	1.0	225	-	136	-
		White crappie	1	1.0	94	-	<10	-
		Freshwater drum	5	5.0	185	78-424	<283	<10-1270
		Total	24	24.0				
	10	Longnose gar	1	1.0	602	-	570	-
		Channel catfish	1	1.0	320	-	270	-
		Green sunfish	1	1.0	89	-	10	-
		Longear sunfish	2	2.0	82	76-88	<12	<10-13
		Freshwater drum	7	7.0	156	87-255	<71	<10-220
		Total	12	12.0				

TABLE B-16 (CONT)

Date/Location	Species	Number	CPE	Total Length (mm) Mean	Total Length (mm) Range	Total Weight (g) Mean	Total Weight (g) Range
4	Gizzard shad	5	5.0	90	87-91	<10	-
	River carpsucker	3	3.0	352	301-391	600	350-750
	Smallmouth buffalo	1	1.0	418	-	-	-
	Flathead catfish	2	2.0	241	222-260	140	100-180
	Longear sunfish	1	1.0	83	-	11	-
	White crappie	1	1.0	281	-	330	-
	Freshwater drum	4	4.0	165	103-344	140	<10-530
	Total	17	17.0				

(a) CPE represents number of fish collected per 30-minute effort.

TABLE B-17 SUMMARY OF SEINE DATA FROM THE NEOSHO RIVER NEAR WOLF CREEK GENERATING STATION, BURLINGTON, KANSAS, 1987

Date/Location		Species	Number	Total Length (mm) Mean	Total Length (mm) Range	Total Weight (g) Mean	Total Weight (g) Range
2 MAR	1	Gizzard Shad	1	88	-	-	<10
		Ghost shiner	3	35	32-40	-	<10
		Total	4				
	10	Ghost shiner	94	28	19-39	-	<10
		Red Shiner	34	35	21-51	-	<10
		Mosquitofish	2	33	23-42	-	<10
		Total	130				
	4	Sample Not Preserved	30-40 Minnows				
	11	No Neosho madtoms					
27 APR	1	Ghost shiner	7	33	26-37	-	<10
		Red shiner	30	41	29-55	-	<10
		Brook silverside	1	73	-	-	<10
		White crappie	2	107	102-112	13	12-14
		Total	40				
	10	Ghost shiner	39	31	20-41	-	<10
		Red shiner	345	39	22-63	-	<10
		Slim minnow	1	27	-	-	<10
		Mosquitofish	5	32	27-38	-	<10
		Brook silverside	1	43	-	-	<10
		Total	391				
	4	Ghost shiner	173	34	22-44	-	<10
		Red shiner	31	32	21-49	-	<10
		Slim minnow	2	32	27-37	-	<10
		Channel catfish	2	68	58-77	-	<10
		Green sunfish	1	63	-	-	<10
		Total	209				
	11	No Neosho madtoms					
22 JUN	1	Gizzard shad	74	51	25-75	-	<10
		Carpiodes sp.	10	48	44-53	-	<10
		Ghost shiner	1	46	-	-	<10
		Mosquitofish	5	44	38-52	-	<10
		Brook silverside	1	23	-	-	<10
		White bass	6	53	43-67	-	<10
		Spotted bass	1	54	-	-	<10
		White crappie	17	46	36-59	-	<10
		Total	115				
	10	Gizzard shad	5	68	64-73	-	<10
		Red shiner	25	39	42-60	-	<10
		Suckermouth minnow	2	47	45-48	-	<10

TABLE B-17 (CONT)

Date/Location		Species	Number	Total Length (mm) Mean	Total Length (mm) Range	Total Weight (g) Mean	Total Weight (g) Range
10 (Cont.)		Slim minnow	2	50	47-52	-	<10
		Channel catfish	1	132	-	25	-
		Black-striped topminnow	2	28	23-33	-	<10
		Mosquitofish	14	26	21-32	-	<10
		White bass	4	47	36-58	-	<10
		Freshwater drum	1	58	-	-	<10
		Total	56				
	11	Neosho madtom	1	27	-	-	<10
	4	Gizzard shad	69	46	35-72	-	<10
		Ghost shiner	167	39	17-48	-	<10
		Red shiner	15	48	34-68	-	<10
		Suckermouth minnow	2	37	36-37	-	<10
		Slim minnow	1	22	-	-	<10
		Mosquitofish	17	27	23-44	-	<10
		White bass	8	42	35-48	-	<10
		Spotted bass	1	56	-	-	<10
		White crappie	6	36	27-41	-	<10
		Orangethroated darter	1	25	-	-	<10
		Total	287				
24 AUG	1	Gizzard shad	3	89	87-91	-	<10
		Ghost shiner	19	22	20-26	-	<10
		Carpiodes sp.	1	78	-	-	<10
		Mosquitofish	1	47	-	-	<10
		Brook silverside	2	36	25-36	-	<10
		Green sunfish	2	25	23-26	-	<10
		Orangespotted sunfish	1	42	-	-	<10
		White crappie	10	86	77-91	-	<10
		Total	39				
	10	Red shiner	60	36	20-54	-	<10
		Suckermouth minnow	3	60	52-71	-	<10
		Bluntnose minnow	5	46	39-57	-	<10
		Bullhead minnow	2	35	31-39	-	<10
		Channel catfish	2	66	61-70	-	<10
		Noturus sp.	1	18	-	-	<10
		Mosquitofish	122	27	16-48	-	<10
		Orangethroated darter	4	46	37-65	-	<10
		Total	199				
	4	Ghost shiner	162	32	18-50	-	<10
		Red shiner	62	32	23-50	-	<10
		Notropis sp.	1	<20	-	-	<10
		Bluntnose minnow	8	42	35-51	-	<10
		Bullhead minnow	11	41	30-50	-	<10
		Pimephales sp.	42	41	-	-	<10
		Mosquitofish	151	25	16-42	-	<10

TABLE B-17 (CONT)

Date/Location	Species	Number	Total Length (mm) Mean	Range	Total Weight (g) Mean	Range
4 (Cont.)	Orangespotted sunfish	4	45	44-47	-	<10
	Lepomis sp.	16	22	18-24	-	<10
	White crappie	1	64	-	-	<10
	Total	458				
11	No Neosho Madtom					