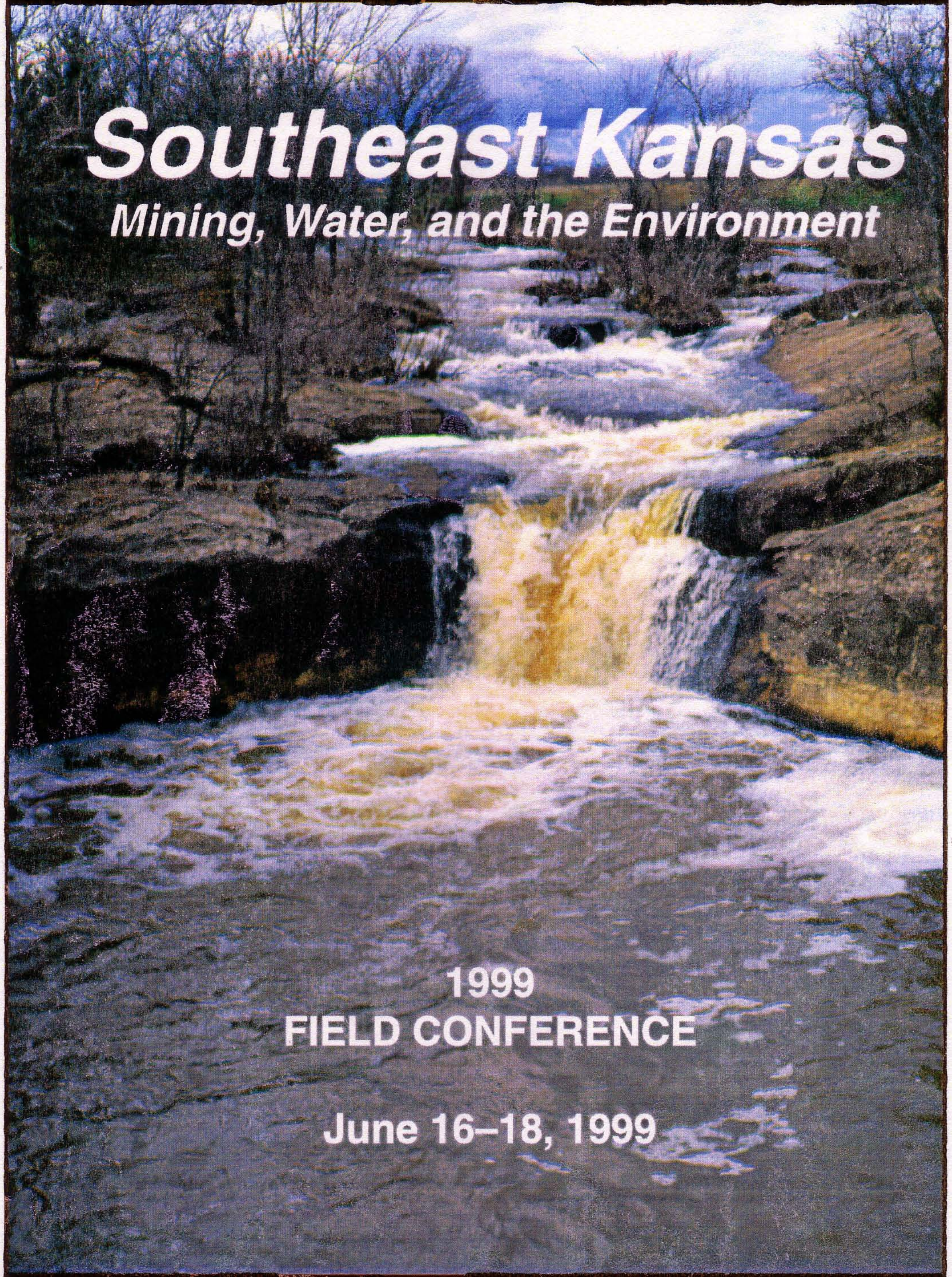
Kansas Earth Resources Field Project

Southeast Kansas

Mining, Water, and the Environment



1999

FIELD CONFERENCE

June 16–18, 1999

Sponsored by Kansas Geological Survey
Kansas Department of Health and Environment and Kansas Water Office

Kansas Earth Resources Field Project

FIELD GUIDE

1999 FIELD CONFERENCE

Southeast Kansas

Mining, Water, and the Environment

June 16-18, 1999

Edited by

Robert S. Sawin

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This project is operated by the Kansas Geological Survey and funded, in part, by the Kansas Water Office and Kansas Department of Health and Environment.

KGS OPEN-FILE
REPORT 99-18

KANSAS GEOLOGICAL SURVEY
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KANSAS EARTH RESOURCES FIELD PROJECT

Southeast Kansas

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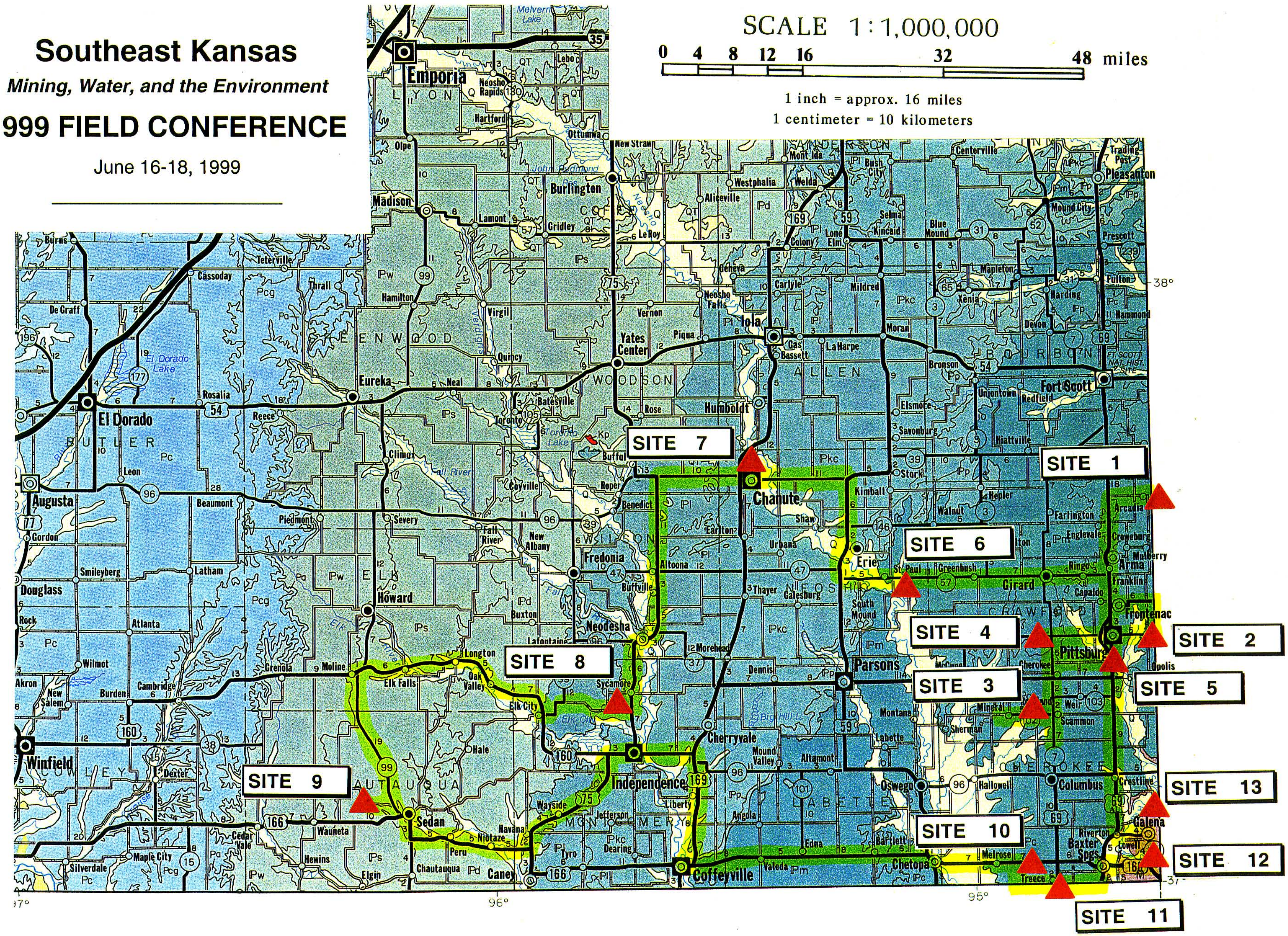

KANSAS EARTH RESOURCES FIELD PROJECT

Southeast Kansas

Mining, Water, and the Environment

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Mining, Water, and the Environment

1999 FIELD CONFERENCE

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PARTICIPANTS LIST

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Jim Barone	Senator 13th District	Kansas Senate	611 W. Leighton Frontenac, KS 66763 316-231-4900
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Tom Collinson	Chairman	Geological Survey Advisory Council	701 N. Locust Pittsburg, KS 66762 316-231-2600
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Janis Lee	Senator 36th District	Kansas Senate	RR 1, Box 145 Kensington, KS 66951 785-476-2294
Bob Love	Coordinator	SEE-KAN Resource Conservation and Development Office	871 S. County Club Rd. Chanute, KS 66720 316-431-6180
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Randy Rose	Science Teacher	Blue Valley North High School/KESTA	Blue Valley North H.S. 12200 Lamar Overland Park, KS 66209 913-345-7300
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John Strickler	Executive Director	KACEE (Kansas Association for Conservation and Environmental Education)	2610 Claflin Road Manhattan, KS 66502-2743 785-532-3314
Mary Torrence	Assistant Revisor of Statutes	Revisor of Statutes Office	300 SW 10th, Ste. 322-S Topeka, KS 6612-1592 785-296-5239
Sid Warner	Member	Kansas Board of Regents	P.O. Box 309 Cimarron, KS 67835-0309 316-855-2282

BIOGRAPHICAL INFORMATION

Ray Aslin
Title
State Forester
Affiliation
Kansas Forest Service
Address and Telephone
2610 Claflin Rd.
Manhattan, KS 66502-2798
Current Responsibilities
State Forester
Experience
23 years with the Kansas Forest Service (District Forester, Fire Control Specialist; State Forester)
Education
University of Missouri - BS, 1972
University of Missouri - MS, 1975

Jim Barone
Title
Senator, 13th District
Affiliation
Kansas Senate
Address and Telephone
611 W. Leighton
Frontenac, KS 66763
Current Responsibilities
State Senator/Business Consultant
Experience
Retired Southwestern Bell Executive
Education
Pittsburg State University - BS, 1962
Various post-graduate

Don Biggs
Title
Senator, 3rd District
Affiliation
Kansas Senate
Address and Telephone
2712 Olde Creek Ct.
Leavenworth, KS 66048
913-682-1802
Current Responsibilities
State Senate
Experience
Mutual Savings Association, retired
Education
Kansas State University - BS, 1952

Cynthia Claus
Title
Commissioner
Affiliation
Kansas Corporation Commission
Address and Telephone
1500 SW Arrowhead Rd.
Topeka, KS 66604-4027
Current Responsibilities
Commissioner, Kansas Corporation Commission
Experience
ARCO Pipeline Co, in-house counsel; private law practice; municipal judge
Education
University of Kansas - BA, 1968
University of Kansas - JD, 1975

Tom Collinson
Title
Chairman
Affiliation
Geological Survey Advisory Council
Address and Telephone
701 N. Locust
Pittsburg, KS 66762
316-231-2600
Current Responsibilities
Publisher, *The Morning Sun*

Margaret Fast
Title
Water Resource Manager
Affiliation
Kansas Water Office
Address and Telephone
109 SW 9th
Topeka, KS 66612
785-296-0865
Current Responsibilities
Manage the unit at KWO responsible for development and implementation of the state water plan
Experience
15 years at the KWO; 7 years at the KS Dept. of Health and Environment
Education
Thomas More College - BA, 1977
University of Kansas - MS, 1985

Joann Flower

Title
Representative, 47th District
Affiliation
Kansas House of Representatives
Address and Telephone
P.O. Box 97
Oskaloosa, KS 66066
785-863-2918
Current Responsibilities
Chair, House Agriculture Committee
Experience
Legislature, 10 years; nursing; small business owner
Education
Johns Hopkins University - BS, 1958

Raney Gilliland

Title
Principal Analyst
Affiliation
Kansas Legislative Research Department
Address and Telephone
Rm 545-N, State Capitol
Topeka, KS 66612
785-296-3181
Current Responsibilities
Staff - House and Senate Agriculture Committees; House Environment Committee; and Senate Energy and Natural Resources for the Kansas Legislature
Experience
Legislative Research, 18 years
Education
Kansas State University - BS, 1975
Kansas State University - MS, 1979

Bob Grant

Title
Representative, 2nd District
Affiliation
Kansas House of Representatives
Address and Telephone
407 W. Magnolia
Cherokee, KS 66724
316-457-8680

Ron Hammerschmidt

Title
Director, Division of Environment
Affiliation
Kansas Department of Health and Environment
Address and Telephone
Forbes Field, Bldg. 740
Topeka, KS 66620
913-296-1535
Current Responsibilities
Responsible for management of interrelated land, air, water, waste, remediation, and district service programs. program and policy development; legislative activities related to environment and natural resources; staff and budget management
Experience
Research Scientist, VA Hospital, Omaha, NE; Director of Agriculture Lab, Harris Labs, Lincoln, NE; Senior Public Health Lab Scientist, KDHE Labs; Director, Bureau of Environment Remediation, KDHE; Dept. Director, Office of Science & Support, KDHE
Education
St. Mary of the Plains College - BA, 1973
University of Nebraska - PhD, 1978

Dave Heinemann

Title
Special Assistant to the Secretary
Affiliation
Kansas Dept. of Revenue
Address and Telephone
915 SW Harrison St.
Topeka, KS 66612
785-296-8458
Current Responsibilities
Special Assistant to the Secretary
Experience
State Representative, 27 years; General Counsel, KCC, 2 years; Executive Director, KCC, 2 years
Education
Augustana College - BA, 1967
University of Kansas - 1967-68
Washburn Law School - JD, 1973

Theresa Hodges

Title
Director
Affiliation
Bureau of Environmental Field Services, Kansas Dept. of Health and Environment
Address and Telephone
Forbes Field
Topeka, KS 66620
785-296-6603
Current Responsibilities
Manage/direct the environmental activities of the 6 district offices and central office support activities for the Division of Environment (ambient water quality monitoring networks and data management units)
Experience
26 years with KDHE—20 years with Div. of Health and Environment (microbiologist) and 6 years with Div. of Environment

Education
Independence Community College - AA, 1959
University of Kansas - BA, 1962
University of Kansas - MA, 1984

Carl Holmes
Title
Representative, 125th District
Affiliation
Kansas House of Representatives
Address and Telephone
Rm 115-S, State Capitol
Topeka, KS 66612
913-296-7670
Current Responsibilities
Chairman, Utilities Committee; Chairman, Fiscal Oversight Committee; Member, Budget Committee, Ag. and Natural Rsources; Member, Information Management Committee
Experience
Chairman, House Energy & Natural Resources Committee; Chairman, Agriculture and Natural Resources Subcommittee Appropriations; President, Kansas League of Municipalities; Mayor, City of Plains
Education
Colorado State University - BS, 1962

Becky Hutchins
Title
Representative, 50th District
Affiliation
Kansas House of Representatives
Address and Telephone
700 Wyoming
Holton, KS 66436
913-364-2612
Current Responsibilities
House Agriculture Committee; Environment Committee
Experience
Second term in Kansas House of Representatives
Education
Washburn University - BA, 1985

Dick Koerth
Title
Assistant Secretary for Administration
Affiliation
Kansas Department of Wildlife and Parks
Address and Telephone
Room 502 N. Landon
State Office Building
900 SW Jackson
Topeka, KS 66612
785/296-2281
Current Responsibilities
Administrative affairs of KDWP (accounting, budgeting, personnel, engineering and licensing)
Experience
Kansas Division of the Budget, 1972–1989
Education
University of Kansas - BA, 1971
University of Kansas - MPA, 1973

Wayne Lebsack
Title
President
Affiliation
Lebsack Oil Production Inc.
Address and Telephone
P.O. Box 489
Hays, KS 67601
316-938-2396
Current Responsibilities
Direct and manage oil and gas exploration and development; Board of Trustees, Kansas Chapter, The Nature Conservancy
Experience
Oil and gas exploration; Ground-water exploration and pollution research
Education
Colorado School of Mines - Geol. Eng., 1949
Colorado School of Mines - Geol. Eng., 1951
Colorado School of Mines - 2 years grad. studies

Al LeDoux
Title
Director
Affiliation
Kansas Water Office
Address and Telephone
109 SW 9th, Suite 300
Topeka, KS 66612-1249
913-296-3185
Current Responsibilities
Plan, market, develop, implement, and evaluate policies/programs for current and future water needs
Experience
Sr. Govt. Affairs Liaison, Gov. Graves; Adm. Assist. to Maj. Leader, KS. Sen., Lt. Gov. Frahm; Legis. Liaison and Ag. Advisor, Gov. Hayden; Admin. Assist. to the Maj. Leader, KS. House; Farmer and Stockman
Education
Baker University - BA, 1969
University of Kansas - Graduate School

Janis Lee
Title
Senator, 36th District
Affiliation
Kansas Senate
Address and Telephone
Rural Route 1, Box 145
Kensington, KS 66951
913-476-2294
Current Responsibilities
Member of Utilities, Public Health and Welfare, and Assessment and Taxation Committees; Assistant Minority Leader
Experience
Involved in family ranching and farming operation; served on USD #238 Board of Ed.
Education
Kansas State University - BS, 1970

Bob Love
Title
Coordinator
Affiliation
SEE-KAN Resource Conservation and Development
Address and Telephone
Rural Route 1, Box 145
Kensington, KS 66951
913-476-2294
Current Responsibilities
Coordinator for SEE-KAN RC&D, a 10-county resource conservation and development organization in southeast Kansas
Experience
Worked for NRCS in Bourbon, Crawford, Labette, and Neosho counties over the past 17 years
Education
Kansas State University - BS, 1966

Laura McClure
Title
Representative, 119th District
Affiliation
Kansas House of Representatives
Address and Telephone
202 South 4th
Osborne, KS 67473
785-296-7680
Current Responsibilities
House Environment Committee
Experience
Owner/operator flower and antiques shop; Nutrition site manager, Beloit Senior Center; Grassroots Lobbyist
Education
Mankato High School - 1968

Gene O'Brien
Title
Representative, 7th District
Affiliation
Kansas House of Representatives
Address and Telephone
State Capital, Rm 284-W
Topeka, KS 66612-7688
785-296-7688
Current Responsibilities
House Environment Committee
Experience
Contractor

Randy Rose
Title
Science Teacher
Affiliation
Blue Valley North High School, Overland Park/ Kansas Earth Science Teachers Association
Address and Telephone
12200 Lamar
Overland Park, KS 66209
913-345-7300
Current Responsibilities
Kansas Earth Science Teachers Association; teach high school Astronomy, Meterorology, and Earth Science
Experience
High school science teacher, 15 years; Junior high science, 2 years
Education
Emporia State University - BS, 1981
Emporia State University - BS, 1989

John Spurling
Title
Member
Affiliation
Kansas Water Authority
Address and Telephone
316-362-4232
Current Responsibilities
Cowherd, farmer, van driver, writer
Experience
Farmer, writer
Education
High School - 1944

Tracy Streeter
Title
Executive Director
Affiliation
State Conservation Commission

Address and Telephone
109 SW 9th, Suite 500
Topeka, KS 66612
913-296-3600
Current Responsibilities
Agency Head
Experience
Employed by SCC from 1985 as field coordinator and assistant director; involved in family farm in Brown County until 1990
Education
Missouri Western State College - BS, 1985
University of Kansas - MPA, 1993

John Strickler
Title
Executive Director
Affiliation
KACEE (Kansas Association for Conservation and Environmental Education)
Address and Telephone
2610 Claflin Rd.
Manhattan, KS 66502
785-532-3314
Current Responsibilities
Executive Director, KACEE
Experience
Special Assistant for Environment and Natural Resources to Governor Mike Hayden, 2 years; Acting Secretary, Kansas Department of Wildlife and Parks, 1987 and 1995; Kansas State and Extension Forestry, Kansas State University, 33 years; U.S. Forest Service, 4 years
Education
University of Missouri - BS, 1957
Kansas State University - MS, 1968

Mary Torrence
Title
Assistant Revisor of Statutes
Affiliation
Revisor of Statutes Office
Address and Telephone
300 SW 10th, Suite 322S
Topeka, KS 66612
785-296-5239
Current Responsibilities
Legislative staff; drafting legislation; and legal advisor
Experience
Revisor of Statutes Office, 22 years
Education
University of Kansas - BA, 1971
University of Kansas - JD, 1974

Sid Warner
Title
Member
Affiliation
Kansas Board of Regents
Address and Telephone
P.O. Box 309
Cimarron, KS 67835
316-855-2282
Current Responsibilities
Managing General Partner of Warner Ranches, L.P., which includes farming and cattle business
Experience
President of Cimarron Investment Co., Cimarron Insurance Co., and Southwest Kansas Television Co.
Education
Kansas State University - BS, 1956

KANSAS GEOLOGICAL SURVEY STAFF

Lee Gerhard
Title
Director and State Geologist
Affiliation
Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785-864-3965
Current Responsibilities
Director of administration and geologic research at the Kansas Geological Survey
Experience
Kansas Geological Survey, 12 years; Colorado School of Mines, 5 years; North Dakota Geological Survey, 6 years; W. Indies Lab., Fairleigh Dickinson Univ., 3 years; Univ. of Southern Colorado, 6 years; Sinclair, 2 years; Consultant and Independent Petroleum Geologist
Education
Syracuse University - BS, 1958
University of Kansas - MS, 1961
University of Kansas - PhD, 1964

Bill Harrison
Title
Deputy Director
Affiliation
Kansas Geological Survey
Address and Telephone
1930 Constant Ave.
Campus West
Lawrence, KS 66049
785-864-3965

Current Responsibilities

Plan and initiate major research programs; assess scientific quality of current programs; Secretary/Treasurer of the Division of Environmental Geosciences of AAPG

Experience

Kansas Geological Survey, 2 years; Lockheed Martin Idaho Technologies; EG&G Idaho, Inc.; ARCO Exploration & Technology; University of Oklahoma/Oklahoma Geological Survey, Faculty/Staff Geologist

Education

Lamar State College of Technology - BS, 1966
University of Oklahoma - MS, 1968
Louisiana State University - PhD, 1976

Lawrence L. Brady

Title

Senior Scientist

Affiliation

Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
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913-864-3965

Current Responsibilities

Geologic research

Experience

Kansas Geological Survey, 29 years; Oklahoma State University, 1 year; U.S. Corps of Engineers, 5 years

Education

Kansas State University - BS, 1958
University of Kansas - MS, 1967
University of Kansas - PhD, 1971

Liz Brosius

Title

Research Assistant

Affiliation

Editing and Geology Extension, Kansas Geological Survey

Address and Telephone

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Campus West
Lawrence, KS 66049
785-864-3965

Current Responsibilities

Edit technical publications and Current Research bulletin; edit and write publications for Geology Extension; responsible for content on GeoKansas, the Survey's educational web site

Experience

Kansas Geological Survey, 4 years; Paleontological Institute, University of Kansas, 10 years

Education

University of Kansas - BA, 1980
University of Kansas - MA, 1985

Rex Buchanan

Title

Associate Director

Affiliation

Public Outreach, Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785-864-3965

Current Responsibilities

Supervise publication and public outreach activities, media relations, and non-technical communications.

Experience

Kansas Geological Survey, 21years; University-Industry Research, University of Wisconsin, 3 years; Salina Journal, 4 years

Education

Kansas Wesleyan University - BA, 1975
University of Wisconsin-Madison - MA, 1978
University of Wisconsin-Madison - MS, 198

Jim McCauley

Title

Assistant Scientist

Affiliation

Geologic Investigations Section, Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785-864-3965

Current Responsibilities

Geologic mapping, remote sensing, and public inquiries

Experience

Kansas Geological Survey, 23 years; KU Remote Sensing Laboratory, 6 years

Education

University of Kansas - BS, 1970
University of Kansas - MS, 1973
University of Kansas - PhD, 1977

Bob Sawin

Title

Research Associate

Affiliation

Geology Extension, Public Outreach, Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-3965

Current Responsibilities

Public outreach activities, Kansas Earth Resources Field Project, and public inquiries

Experience

Kansas Geological Survey, 7 years; Petroleum Geology, 15 years; Engineering Geology, 6 years

Education

Kansas State University - BS, 1972
Kansas State University - MS, 1977

Southeast Kansas

Mining, Water, and the Environment

1999 FIELD CONFERENCE

June 16-18, 1999

Welcome to the 1999 Field Conference, co-sponsored by the Kansas Geological Survey, the Kansas Department of Health and Environment, and the Kansas Water Office. Past field conferences have focused on specific natural-resource issues, such as water or energy. Because of the number and magnitude of the issues facing southeastern Kansas, the theme of this year's Field Conference is *Southeast Kansas: Mining, Water, and the Environment.*

Natural resources have long been an important part of the economy of southeastern Kansas. Coal mining, both underground and surface mining, has taken place here since the mid-1800's. Lead and zinc mining soon followed, beginning in the 1870's and flourishing in the early 20th century. In the late 1800's and early 1900's, natural gas was discovered in abundance and was the basis for many other industries, such as smelting, glass production, brick manufacturing, and cement production. These industries did more than change the land. They brought workers, many from European countries, to southeastern Kansas, giving the area a culture that is unlike the rest of Kansas. That is one reason that this region is known as the Little Balkans.

Today many of these mining industries have played out. Lead and zinc mining ended in 1970 because of environmental issues and depleted mines; coal mining is limited to a few surface mines because of thin coal seams and high-sulfur coal that cannot compete with western coal; and many of the industries associated with natural gas are now gone (though cement continues to be a major product of the area). The legacy of those times, however, remains, much of it in the form of environmental issues. In Cherokee County, for example, old lead and zinc mines pose problems of collapse and must be reclaimed and mining areas made safe. Acid-mine drainage from the old mines poses water-quality problems. Areas that have been surface-mined for coal have been reclaimed since the late 1960's, but earlier mines still dot the landscape. Many of the old brick and glass plants are now deserted and overgrown by vegetation. During the Field Conference, we will visit a coal mine, mined and reclaimed coal and lead and zinc mining areas, and discuss various water-quality and water-supply issues.

The legacy has taken other forms. The ethnic pride of the Little Balkans is still evident in local restaurants, bakeries, churches, and festivals. The mining past is celebrated at museums, such as Big Brutus at West Mineral (Wednesday's lunch stop) and the historical society at Baxter Springs. Many of the old strip mines have been reclaimed and made into productive land. Other mined areas are now used for recreation, fishing, and boating.

Economic issues continue to be important here. With the decline of mining and other natural-resource production, southeastern Kansas has struggled economically. Several of the locations we will visit on the Field Conference show the area's response to economic conditions. Coal-bed methane is a way of producing energy from those deeply buried coal beds that are uneconomic to mine directly. Poultry production is important in parts of the region. Recreation, in the form of hunting, fishing, and other nature-based activities, is increasingly important, as we will see at the Red Buffalo Ranch.

The Field Conference will focus on eight counties in the southeastern corner of the state. The route will take us through four of the state's physiographic provinces, beginning with the Cherokee Lowlands, then moving through the Osage Cuestas, across the Chautauqua Hills, and finally into the Ozark Plateau in the southeastern tip of Kansas. These areas are described in more detail later in the Field Guide.

About the Kansas Field Conference

The 1999 Field Conference is the fifth of the Survey's annual field conferences. These conferences are designed to serve as more than guided tours. Rather, the sites are selected to demonstrate particular perspectives on an issue, and the program is designed to provide first-hand experience. Local and regional experts in resource development will describe each site and the resource issues related to it. In addition, this comprehensive Field Guide provides background on the sites and the issues, serving as a handy reference long after the Field Conference is over.

When possible, participants will interact with county, state, and regional officials, environmental groups, and citizens' organizations. This information base will provide participants with new and broader perspectives useful in formulating policies. During the

Field Conference, participants are expected to be just that—participants. You are encouraged to make contributions to the discussions, ask questions, and otherwise participate in deliberations. The bus microphone is open to everyone, and everyone is encouraged to contribute.

In the course of this Field Conference, we do not seek to resolve policy or regulatory conflicts. Instead, we are trying to provide opportunities to acquaint decision-makers and policy-makers with resource problems and issues. We want to go beyond merely identifying issues; we want to bring together experts who examine the unique technical, geographical, geological, environmental, social, and economic realities of the region. We want this combination of first-hand experience and interaction among participants to result in a new level of understanding of the state's natural resource issues.

The Kansas Field Conference is an education outreach program of the Kansas Geological Survey, administered through its Geology Extension program. The mission of the Field Conference is to provide educational opportunities to individuals who make and influence policy about earth resources and related social, economic, and environmental issues in Kansas. Earth resources are defined as the mineral, energy, water, and oil resources of the earth. The industries that deal with earth resources include energy, mining, quarrying, and agriculture. The Survey's Geology Extension program is designed to develop materials, projects, and services that communicate information about the geology of Kansas, the state's earth resources, and the products of the Kansas Geological Survey to the people of the state.

The Kansas Field Conference is modeled after a similar program of national scope, the Energy and Minerals Field Institute, operated by the Colorado School of Mines. The Kansas Geological Survey appreciates the support of Dr. Erling Brostuen, Director of the Energy and Minerals Field Institute, in helping develop the Kansas project.

Kansas Geological Survey

Since 1889, the Kansas Geological Survey has studied and reported on the state's geologic resources and hazards. Today the Survey's mission is to study and provide information about the state's geologic resources and hazards, particularly ground water, oil, natural gas, and other minerals. In many cases, the Survey's work coincides with the state's most pressing natural-resource issues.

The KGS has no regulatory function. By statutory charge, the Survey's role is strictly one of research and reporting. It is a division of the University of Kansas, part of the University's Research and Public Service division. The KGS employs about 70 full-time staff members and about 80 students and grant-funded staff. It is administratively divided into four research sections—geohydrology, mathematical geology, petroleum research, and geologic investigations—and several other sections that provide research support or deal directly with the public. Survey programs can be divided by subject: water, energy, geology, and information dissemination.

Water issues directly affect the life of every Kansan. Water supplies are crucial for domestic and municipal use, and in much of the state's economic activity. Western Kansas agriculture and industry relies heavily on ground water; in eastern Kansas, growing populations and industry use surface water. The Survey's water research and service includes an annual water-level measurement program (in cooperation with the Kansas Department of Agriculture), studies of mineral intrusion in the Big Bend and Equus Beds areas, nitrates in the Solomon River basin and in central Kansas, and studies of water resources in the Dakota aquifer, the Quivira National Wildlife Refuge, Rattlesnake Creek, the Republican River, and the Arkansas River.

Kansas energy production generates more than $2 billion worth of income each year. Because much of the state has long been explored for oil and gas, maintaining that production takes research and information. The Survey studies the state's coal resources, its petroleum reservoirs, techniques such as high-frequency ground-penetrating radar, and new methods of providing information, such as a digital petroleum atlas. The Survey has recently begun a multi-year study of the resources of the Hugoton Natural Gas Area.

Much of the Survey's work is aimed at producing basic geologic information, which can be applied to a variety of resource and environmental issues. The Survey develops and applies methods to study the subsurface, such as high-resolution seismic reflection, undertakes mapping of the surficial geology of the state's counties, applies statistical analyses to geologic problems and issues, and studies specific resources, such as road and highway materials.

To be useful, geologic information must be disseminated in a form that is most appropriate to the people who need it. The Survey provides information to the general public, to policy makers, to oil and gas explorationists, water specialists, other governmental agencies, and academic specialists. Information is disseminated through a publication sales office, automated mapping, the state's Data Access and Support Center (located at the Survey), a data library, electronic publication, Geology Extension, and the Survey's Wichita Well Sample Library.

Kansas Geological Survey Staff participating in the 1999 Field Conference:

Lee C. Gerhard, Director and State Geologist
William Harrison, Deputy Director
Larry Brady, Senior Scientist, Geologic Investigations
Rex C. Buchanan, Associate Director, Public Outreach
James R. McCauley, Assistant Scientist, Geologic Investigations
Liz Brosius, Research Assistant, Geology Extension/Editing
Robert S. Sawin, Research Associate, Geology Extension

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http://www.kgs.ukans.edu

Kansas Department of Health and Environment

This State agency is composed of two divisions, one responsible for health-related issues, the other for the environment. The Division of Health works with local health departments and other organizations in providing economic public health solutions. The Division conducts surveillance, policy and program development, and statewide assessment functions in order to determine and monitor the health status of Kansans, devise effective interventions, and set accountable measures of progress. The Division is composed of the Bureau for Children, Youth, and Families; Bureau of Consumer Health; Bureau of Epidemology and Disease Prevention; Bureau of Health; Bureau of Health Promotion; and an Office of Local and Rural Health. The Division's acting director is Lorne Phillips.

The Division of Environment's mission is the protection of the public health and environment. The Division conducts regulatory programs involving public water supplies, industrial discharges, wastewater-treatment systems, solid-waste landfills, hazardous waste, air emissions, radioactive materials, asbestos removal, refined petroleum storage tanks, and other sources that impact the environment. In addition, the Division administers other programs to remediate contamination, lessen nonpoint pollution, and evaluate environmental conditions across the state.The Division of Environment is responsible for identifying water-quality and water-pollution problems and recommending remediation; for regulating coal mining and the reclamation of lands that have been mined for coal; for regulating nonpoint-source pollution, such as fertilizer runoff from fields; for regulating runoff from livestock feedlots; for protecting the quality of public water supplies; for cleaning up environmentally contaminated sites; for regulating hazardous-waste storage and remediation; for permitting waste-treatment facilities; and for regulating solid-waste disposal facilities, such as landfills. This agency is also a source of information about water-quality concerns and about water wells drilled in the state.

The Division of Environment is composed of Bureaus of Waste Management, Air and Radiation, Environmental Field Services, Water, and Environmental Remediation. The Director of the Division of Environment is Ronald Hammerschmidt.

Kansas Department of Health and Environment
Division of Environment
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Kansas Water Office

The Kansas Water Office is the water planning, policy, and coordination agency for the state of Kansas. It prepares a state plan of water resources development, management, and conservation, reviews all water laws, and makes recommendations to the Governor and Legislature for new or amendatory legislation.

The Office administers the Kansas Water Plan Storage Act, the Kansas Weather Modification Act, and the Water Assurance Act. It also reviews the plans of any state or local agency for the management of the water and related land resources of the State.

The Kansas Water Authority is within and a part of the Kansas Water Office. It is responsible for advising the Governor, the Legislature, and the Director of the Kansas Water Office on water policy issues, for approving water storage sales, Federal contracts, administrative regulations, and legislation proposed by the Office. The Authority is composed of 13 appointed members who represent the public and a variety of water interests within the state.

Basin Advisory Committees provide the working link between the Kansas Water Authority, Kansas Water Office, and the public in formulating and implementing the Kansas Water Plan. The Basin Advisory Committees 1) identify water-related problems, issues, and concerns within the basin and help identify goals and objectives that can be used to direct subsequent planning efforts, 2) advise and assist the Office in the formulation of revisions to the Kansas Water Plan, 3) serve as a liaison between residents of the basin and the Office by encouraging an awareness of the importance of the basin's water resources, and 4) provide input on water plan implementation priorities and encourage local action necessary to implement the basin plan.

The Director of the Kansas Water Office is Al LeDoux.

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http://www.kwo.org/main.html

SCHEDULE & ITINERARY

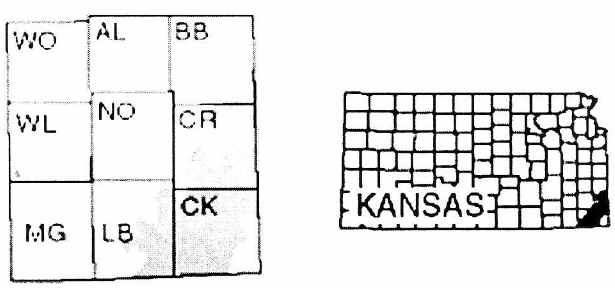
Wednesday June 16, 1999

7:00 am	Breakfast
7:20 am	Conference Overview *Lee Gerhard*, Director, Kansas Geological Survey
7:45 am	**Bus Leaves Holiday Inn Express for Site 1**
8:15 am	**SITE 1** - Blue Mound Coal Mine *Larry Pommier*, Alternate Fuels, Inc. *Larry Brady*, Kansas Geological Survey
9:00 am	Bus to Site 2
9:30 am	**SITE 2** - Coal Mine Reclamation *Murray Balk*, Chief Surface Mining Section, KDHE
10:40 am	Bus to Site 3
11:00 am	**SITE 3** - Mined Land Wildlife Areas *Doug Blex and Rob Riggin*, Kansas Dept. of Wildlife and Parks
12:00 pm	Lunch at Big Brutus
1:00 pm	Bus to Site 4
1:30 pm	**SITE 4** - Poultry Farm - Confined Animal Feeding Operation *Denver Lawson*, Lawson Turkey Farm
2:30 pm	Bus to Site 5
2:45 pm	**SITE 5** - Pittsburg's Wastewater and Water Treatment Facilities *Larry Stevens*, City Manager, Pittsburg *Karl Mueldener*, Director, Bureau of Water, KDHE
5:00 pm	Bus to motel
5:15 pm	Arrive Holiday Inn Express, Pittsburg
6:15 pm	Bus to dinner
7:15 pm	Dinner at Pine Ridge Ranch

Cherokee Lowlands

Occupying roughly 1,000 square miles in Bourbon, Crawford, Cherokee, and Labette counties, the Cherokee Lowlands is a gently rolling plain that developed on easily eroded shales and sandstones of the Cherokee Group. Next to the Mississippian outcrops in the Ozark Plateau, the rocks of the Cherokee Group are the oldest rocks occurring at the surface in Kansas. They were deposited during the early part of the Pennsylvanian Period, approximately 300 million years ago.

The Cherokee Group is rich in coal, and the Cherokee Lowlands is the largest area of coal mining in Kansas. Most coal in Kansas originated during the Pennsylvanian Period, sometimes called the "Great Coal Age." During the Pennsylvanian, the eastern part of Kansas stayed nearly at sea level. Great swamps covered the low-lying areas along the coasts, and primitive plants, including ferns as tall as trees, grew densely. After the plants died and fell into the marsh, they were covered by water and mud and sand. Over time, layers of sediment accumulated, compacting the decaying plant material and eventually producing the sedimentary rock, coal. Geologists estimate that it took about 10 feet of leaves, tree trunks, and other organic matter to produce a one-foot layer of coal.



Extent of Cherokee Lowlands in Kansas.

Coal mining has played an important role in the region's economy. The outcrops of coal from the Cherokee Group extend from Columbus, Kansas, northeasterly into Missouri and Iowa.

The gently sloping landscape is traversed by shallow stream valleys. Isolated sandstone hills offer occasional topographic relief. One of these, Blue Mound, is located just east of Kansas Highway 69 in southern Cherokee County, a half mile north of the Oklahoma border.

The region is characterized by deep, fertile soils, which have eroded from the soft rocks of the Cherokee Group. These soils and the relatively flat and well-drained topography make the region good for farming, except where the surface has been disturbed by mining. Trees generally grow only on the slopes of hills, banks of larger streams, and in abandoned mining areas.

References

Buchanan, Rex C., and McCauley, James R., 1987, Roadside Kansas—A Traveler's Guide to Its Geology and Landmarks: Lawrence, Kansas, University Press of Kansas, 365 p.

Evans, Catherine S., 1988, From Sea to Prairie—A Primer of Kansas Geology, Kansas Geological Survey, Educational Series 6, 60 p.

Schoewe, Walter H., 1949, The Geography of Kansas: Transactions of the Kansas Academy of Science, v. 52, no. 3, p. 261–333.

Wilson, Frank W., Kansas Landscapes—A Geologic Diary: Kansas Geological Survey, Educational Series 5, 50 p.

Coal Mining in Kansas

Coal beds in Kansas with resource potential are found almost entirely in rocks of Pennsylvanian age that were deposited in the bottom of a shallow swampy sea that covered southeast Kansas about 300 million years ago. Nearly 90 percent of all coal mined in Kansas is from the Cherokee Group (fig. 1), mostly from Crawford and Cherokee counties.

Coal deposits in Kansas have been exploited for nearly 145 years, producing about 300 million tons of coal. Two major peaks of production during this period correspond to World War I and World War II. The peak production year was 1918 with 7.3 million tons produced. Production of coal in 1998 was 0.34 million tons; as recently as 1987, production reached 2.0 million tons. During the past 25 years, 25 different coal mines operated in Kansas. All but one of the mines operated in either Crawford, Cherokee, Bourbon, Linn, or Labette counties in southeast Kansas.

The availability and use of natural gas and petroleum in Kansas, and the extraction of most of the important Weir-Pittsburg coal seam reserves, were major factors in the decline of Kansas coal production. Although widespread, Kansas coal has two main drawbacks—it occurs in thin beds (most are less than 2 feet thick) and is high in sulfur content.

Coal mining in Kansas began in the 1850's, with shallow underground mines dug near Fort Leavenworth in Leavenworth County. In the 1850's, Missourians mined coal in Cherokee County near what is now Weir, Kansas, for use by blacksmiths.

Coal production was central to the development of railroading just before and after the Civil War. Because it burned hotter and was less bulky than wood, coal soon became the preferred fuel for the steam locomotives. To meet the demands of the railroads, strip mines were opened during the 1870's in Bourbon, Cherokee, and Crawford counties.

Coal was also mined in Osage County from 1885 to 1892. In 1889, Osage County had 118 coal mines, which employed over 2,200 people and produced almost 400,000 tons of coal. For many years this was the main source of fuel for the Santa Fe railroad, whose main line passes through Osage County.

In 1874 four brothers from Illinois, the Scammon brothers, pioneered new methods of mining coal in southeastern Kansas, digging the first mine shaft in Cherokee County. Although many doubted that their room-and-pillar system would work in such shallow mines, this Cherokee County mine was soon producing 40 carloads of coal a day. Within a few years, underground mining became the principal method of coal mining in southeastern Kansas.

The Scammon brothers mined coal from the Weir-Pittsburg coal bed. Over the years, the Weir-Pittsburg was one of the most extensively mined coal beds in Kansas history, producing over 200 million tons.

In the 1930's, strip mining, which had begun in Kansas in 1876, again became the preferred method of mining coal in southeastern Kansas (though some underground mining continued until 1960). Coal beds too thin to be mined underground were stripped by power shovels, some of which dug to depths of almost 100 feet. One of the world's largest power shovels, Big Brutus, was used in Cherokee County; it is now a museum with exhibits on coal mining and southeastern Kansas.

Strip mining leaves the land marked with deep ditches and high ridges. As the shovels removed the overburden, they created trenches up to 100 feet wide and 50 feet deep. Before widespread land reclamation was required in the 1960's, this land was abandoned and left to grow back to trees and brush while the trenches filled with water.

Gob piles, the mounds of discarded coal waste and fractured rock, are another problem associated with abandoned coal mines. These gob piles contain iron pyrite, sometimes called fool's gold because of its yellow metallic luster. Pyrite is iron sulfide; when exposed to water and oxygen, pyrite undergoes a chemical reaction that produces sulfuric acid, iron oxides, and hydroxides. The iron oxides and hydroxides, similar to common rust, tint these gob piles red. Sulfuric acid, however, pollutes both the water and soil around the mines.

In 1969, the Kansas Legislature passed regulations requiring coal companies to reclaim the land. Subsequently, more stringent federal regulations were enacted. Today strip mines must be converted into useful productive land. Once an area has been mined, companies must smooth out the ditches, replace the topsoil, and plant grass and trees. In theory, once the land is leveled, it can be used for farming or grazing, but pyrite left behind from the coal mining can increase the acidity of the soil, making it hard to cultivate.

Today the only active coal mines in Kansas are located in southern Linn County. Four small strip mines produce coal that is burned at the La Cygne Generating Station near La Cygne, Kansas.

References

Brady, Lawrence L., and Hatch, Joseph R., 1997, Chemical Analysis of Middle and Upper Pennsylvanian Coals from Southeastern Kansas: Kansas Geological Survey, Current Research in Earth Sciences, Bulletin 240, p. 43–59.

Brady, L. L., 1997, Kansas coal resources and their potential for coalbed methane in Transactions of the 1997 AAPG Mid-Continent Section Meeting, September 14–16,1997: Oklahoma City geological Society, Oklahoma City, Oklahoma, p. 150–163.

Buchanan, Rex C., and McCauley, James R., 1987, Roadside Kansas—A Traveler's Guide to Its Geology and Landmarks: Lawrence, Kansas, University Press of Kansas, 365 p.

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Wilson, Frank W., Kansas Landscapes—A Geologic Diary: Kansas Geological Survey, Educational Series 5, 50 p.

Zeller, D. E., (ed.), 1968, The stratigraphic succession in Kansas: Kansas Geological Survey Bulletin 189, 81 p.

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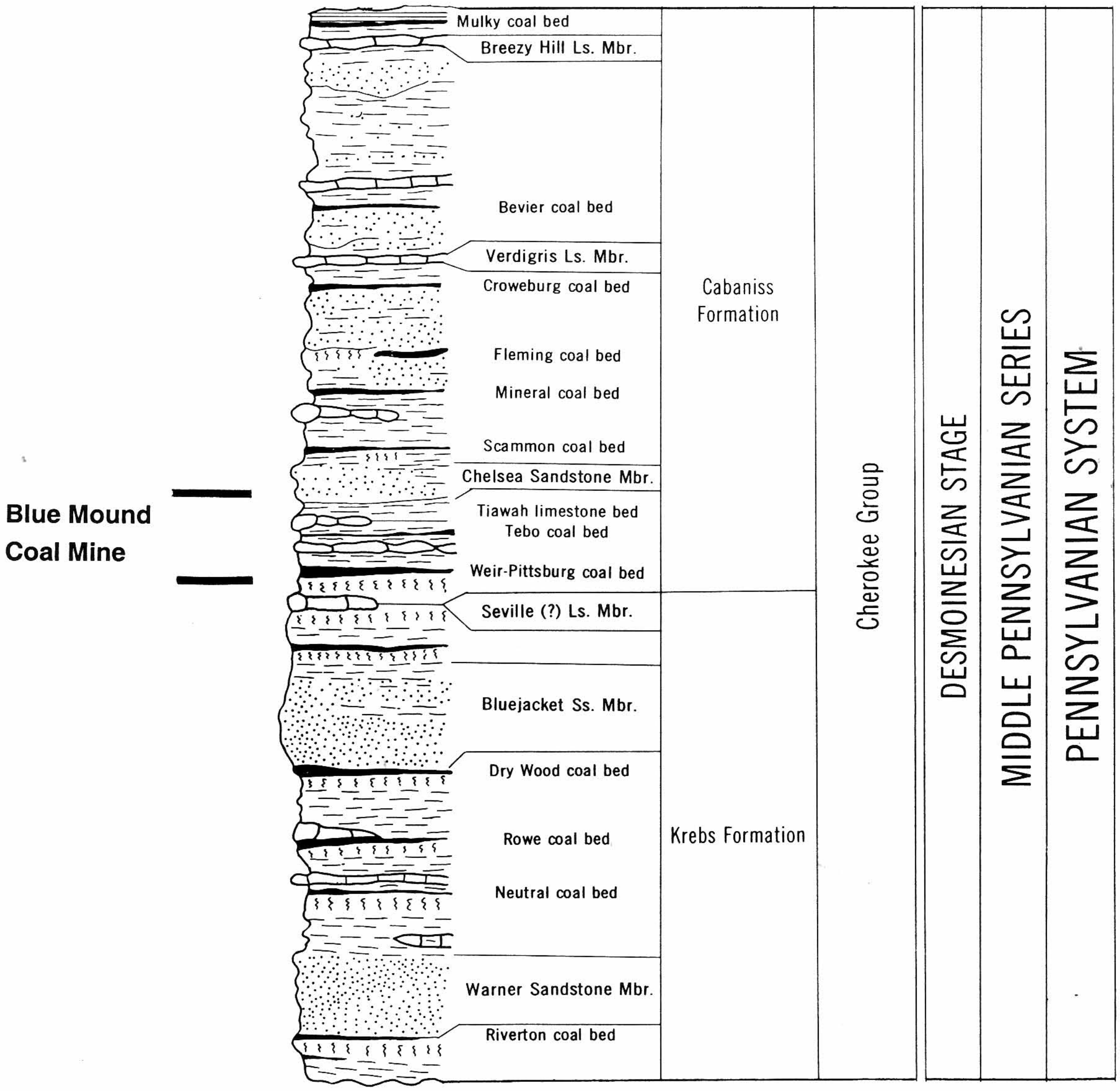

Figure 1. Pennsylvanian rocks of the Cherokee Group in Kansas (from Zeller, 1968). The Tebo and Weir-Pittsburg coal beds are mined at the Blue Mound Mine.

Abandoned Coal Mine Land Reclamation

The Surface Mining Section (SMS), Division of Environment, Kansas Department of Health and Environment, is responsible for the regulation of coal mining and the reclamation of abandoned mine lands in Kansas. Based in Pittsburg, Kansas, the SMS oversees the Administration and Enforcement Program, responsible for all laws and regulations applicable to active coal mining, and the Abandoned Mine Land (AML) Program, responsible for reclamation of priority problem areas associated with historical coal mining.

Administration and Enforcement Program

The Administration and Enforcement Program was established by the Mined Land Conservation and Reclamation Act in 1969. The regulation of coal mining begins with the submission of a detailed permit application. Once the permit application has been approved and a performance bond posted, the operator can begin mining according to the permit document and performance standards. SMS staff inspect the mines at least monthly during the life of the mine. The permit remains bonded until the operator has met the revegetation standards of the regulations. There are currently 13 inspectable sites in Kansas.

Abandoned Mine Land Program

The Kansas Abandoned Mine Land Program was established by Kansas statute in 1979 pursuant to the Surface Mining Control and Reclamation Act of 1977. The purpose of the Kansas Abandoned Mine Land Program is to reclaim and restore land and water resources that have been adversely affected by past coal mining. One of the program's objectives is the protection of public health, safety, general welfare, and property from the extreme danger and/or adverse effects of past coal-mining practices. A secondary objective is the restoration of land and water resources and the environment previously degraded by past coal mining practices. Eligible lands under the program are those lands mined and left abandoned or inadequately reclaimed prior to the enactment of the Surface Mining Control and Reclamation Act on August 3, 1977.

Funding for the Abandoned Mine Land Program is through federal grants from the Office of Surface Mining Reclamation and Enforcement. During the early years of the program (1977–1990), Kansas received about $300,000–500,000 per year for administration of the program and construction projects. Through the efforts of the Mid-Continent Coal Coalition and the Association of Abandoned Mine Land Programs, Congress established a $2 million minimum program funding level for 1991 and beyond. Kansas also operates the Emergency Program, which responds to past coal mining problems that create such an extreme danger to life and/or property that abatement cannot be handled quickly through normal procedures. Coupled with about $460,000 in federal funds for the Emergency Program, about $2.5 million is available for reclamation purposes annually in Kansas.

Kansas currently has over 240 abandoned coal mine sites identified as health, safety, and general welfare problems. Current federal policy is to abate all of these problems (Priority 1 and 2 problems) before environmental restoration projects (Priority 3 problems) are started. The current projected cost to reclaim Priority 1 and 2 problems in Kansas is more than $70 million.

Northeast Frontenac Project Phase I.

The Northeast Frontenac Project remediated an abandoned mine land hazard associated with 3,700 feet of dangerous highwall. This highwall was located within 40 feet of two county roads, one of which was an asphalt road leading to two restaurants. The strip pit at the base of this highwall contained approximately 15 feet of water. Vehicles leaving the road surface would not have time to regain control or stop before entering the pit.

The project was constructed in an area designated as critical habitat for the threatened and endangered (T&E) species of bat, *Myotis grisescens,* commonly known as the Gray Bat. These bats frequent the area during the summer months in a nurse colony below the streets of Pittsburg. The bats have adapted to using the storm sewers in Pittsburg as a nursery for their young. At night, the bats fly over the strip pits and forage for insects. Therefore, great care was taken to construct this project in a manner that would not destroy, but merely limit for a short time, the use of the strip pit by the bats.

As part of the project, a T&E Species permit was obtained from the Kansas Department of Wildlife and Parks. To mitigate for the Gray Bat habitat, the SMS maintained the original linear feet of shoreline and surface area of the strip pit. Trees will be replanted to protect the bats from predators, such as owls and hawks, while flying over the pits to forage.

Mitigation of the hazard on this site involved moving about 508,000 cubic yards of spoil material and constructing a five-cell impoundment. The spoil was moved to fill the highwalls and construct gently sloping terrain so vehicles leaving the road will have time to regain control and miss entering the water-filled impoundment. Forty-eight acres of total disturbance on this project will be left in either water, native grasses, or trees. Drainage improvements will include construction of waterways, culvert extensions, and the reconstruction of the impoundment's outlet structure. Filter fabric and riprap are used to slow down erosion of the disturbed surface. A mixture of lime and old straw (lime/mulch) will be added to help create a suitable growth media for native grasses and trees. After giving the lime time to raise the pH of the spoil and the microorganisms on the straw an opportunity to start making an organic layer, the site will be seeded to native grasses. About 4,500 trees will be planted late next winter or early next spring. Raising an existing water line for Crawford County Water District No. 1 is also included in this project under a separate contract.

Construction began in December 1998 and is about 90 percent complete. The contractor needs to construct the final outlet structure for the five-cell impoundment, install a culvert extension, fertilize, lime, seed, fence, and plant trees to complete the project. The cost of the project will not exceed $468,000.

Koehler Project

The Koehler Project remediated an abandoned mine land hazard associated with 2,600 feet of dangerous highwall, 1,900 feet of priority three highwall, and one acre of industrial/residential waste. The dangerous highwall was located within 40 feet, and in some instances within ten feet, of two county roads, one being a heavily used asphalt road. Water in the strip pit at the base of the highwall was about 15 feet deep. A vehicle leaving the road surface would not have the time or distance necessary to stop or regain control. Illegal trash dumping was also occurring at the site. This project, like the Northeast Frontenac Project, was constructed in Gray Bat habitat and a Kansas Department of Wildlife and Parks T&E Species permit was obtained prior to construction. The water body lost by filling the strip pit was relocated farther east away from the road. Guardrails were placed along the asphalt road on the south side of the project. Drainage altered by coal mining on the north side of the project was filled in and a waterway was constructed to protect the road from erosion that was starting to create stability problems.

During construction, approximately 110,950 cubic yards of spoil was moved in order to fill the highwall and construct a gently sloping terrain. Two large concrete culverts were placed under the gravel road to control water flowing from the watershed west of the project. Guardrails were placed on the south side of the project for a distance of 920 feet. This protects motorists using the asphalt road. Industrial/residential waste was removed from the project site and disposed of in a manner approved by the KDHE's Bureau of Waste Management. Following construction, the site was fertilized, limed and seeded with a native grass mixture. In the early spring of 1996, about 3,000 trees were planted to help protect Gray Bat habitat, and 2,767 feet of fence was installed to help alleviate the problem of illegal trash dumping on the newly reclaimed site.

Construction on this project began in October 1995 and was completed in May 1996 at a cost of $296,569.

North Columbus Reclamation Project Phase II

The North Columbus Reclamation Project alleviated an abandoned mine land hazard associated with 1,080 feet of dangerous highwall and one acre of industrial/residential waste. This project was constructed on land owned by the Kansas Department of Wildlife and Parks. At the north site, a dangerous highwall was located within ten feet of the county road, with a 20-foot drop from the road surface to the strip pit below that was filled with about 12 feet of water. The dangerous highwall on the south site was within 20 feet of the county road and there was approximately 8–10 feet of water in the strip pit. Illegal trash dumping was occurring at the site.

Reclamation at the north site involved filling the north and south ends of two highwalls located on either side of the county road and gently sloping the terrain from the road to the water. Work at the south site consisted of filling in the strip pit, creating a wetland, and covering coarse mining refuse that was creating an acid problem.

During construction about 68,800 cubic yards of spoil was moved to fill the highwall and construct a gently sloping terrain. A rock buttresses was constructed on the north side using 2,356 tons of rock. Two concrete culverts were placed under the county roads to control water flowing through the project. Industrial/residential waste was removed and disposed of in a manner approved by the KDHE's Bureau of Waste Management. A new boat ramp was constructed on the north side of the project to replace an existing ramp whose access was altered by the remediation. Following construction, the site was limed, mulched, fertilized, and seeded with a native grass mixture.

Construction on this project began in January 1998 and was completed in May 1998 at a cost of $207,325.

Reference

Surface Mining Section Employee Manual.

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Mined Land Wildlife Area

The Mined Land Wildlife Area (MLWA), owned and operated by the Kansas Department of Wildlife and Parks, encompasses about 14,500 acres of land and water in 46 scattered tracts across Crawford, Cherokee, and Labette counties. The area has been primarily acquired through donations, with the first donation occurring in 1926. The largest donation took place in 1981 when the Pittsburg and Midway (P&M) Coal Company donated 8,208 acres in Cherokee County. There are over 200 strip-mined lakes on the area totaling about 1,500 acres of water.

Area Management

The primary management goal is to improve wildlife and fisheries habitat and provide quality hunting, fishing, and outdoor recreational opportunities that are compatible with sound natural-resource management, such as wildlife observation, hiking, and primitive camping. A secondary management goal is to correct environmental problems on the area related to the area's surface mining history.

Operational And Maintenance Resources

The area is managed by the Public Lands Section of Fisheries and Wildlife Division. Local personnel consist of one Public Land Manager, and two Conservation Workers. The Main Office, located in MLWA #6 near Pittsburg, also serves as an office for one District Wildlife Biologist and one Fisheries Biologist, who provide management and technical assistance for area functions. Enforcement of Department laws and regulations is primarily the responsibility of a Conservation Officer located in Pittsburg, with assistance from the Public Land Manager. Other wildlife areas managed by the Mined Land Wildlife Area staff include the 424-acre Spring River Wildlife Area located in eastern Cherokee County, the 510-acre Crawford Wildlife Area located north of Pittsburg, and the 102-acre Harmon Wildlife Area located just north of Chetopa in Labette County. The Crawford Wildlife Area is a former county landfill that is being leased from Crawford County. With habitat restoration assistance from Southeast Kansas Quail Unlimited, it is now being managed as a public wildlife area.

MLWA Facilities

Facilities for public use include 21 miles of gravel roads for access to fishing and boat launching. Boat ramps and launching areas are found at about 85 different sites, and shoreline access for fishing exists in many locations. Two handicapped-accessible fishing platforms are located in MLWA #1 and #6 near Pittsburg. A fish feeder is also located directly in front of each of these platforms to attract channel catfish and other fish species to the sites. Parking areas for hunter access and other uses are found along county and state roads and along wildlife area access roads.

Other facilities include two office/shop complexes for operations and maintenance of the area.

Wildlife And Habitat Distribution

The majority of the Mined Land Wildlife Area was once surface (strip) mined for coal. About half the area is unreclaimed mined land and about half was reclaimed under early reclamation laws which required some leveling of the land, but left many steep slopes and rough areas. The vegetation covering the unreclaimed portions ranges from bushy grasslands to woodland. Wildlife include white-tailed deer, wild turkey, fox squirrels, bobcats, and other woodland species.

Areas that received some reclamation are mostly covered in grassland. The Department has converted much of the reclaimed areas into native grasses. These native grasses, such as big bluestem, little bluestem, switchgrass, and Indiangrass, combined with a mixture of native forbs such as Partridge pea, Illinois bundleflower, Maximilian sunflower, and others, provide better wildlife habitat than the fescue and crown vetch that was planted by the coal companies.

About 700 acres of the MLWA is in cropland, which is managed to provide shallow water areas for migrating ducks and geese. Combined with the open water of the strip mined lakes, and a restoration project for Giant Canada Geese, the area provides habitat for many ducks and geese. Most wildlife species found on the area will utilize a variety of habitats throughout the year.

Visitation

Use of the area is increasing at a steady pace, with fishing being the primary use. Because access to private land for hunting is diminishing (due to development, habitat loss, and increasing human population), more hunters are using the wildlife areas each year.

Nongame activities, such as birdwatching, outdoor photography, and primitive camping, are also increasing every year. Other uses, such as sightseeing, are becoming almost as common as the primary uses. Over 200,000 people will visit the Mined Land Wildlife Area in 1999.

Carbon Recovery Project

WATCO, Inc. of Pittsburg, Kansas, has been working for nearly three years with the Kansas Department of Wildlife and Parks and the Surface Mining Section (KDHE) to develop a no-cost abandoned mine land project at two former tipple sites (coal waste sites, or gob piles) located on the Mined Land Wildlife Area.

The tipple sites acted as coal cleaning areas. Large elevated ponds were constructed to receive effluent from the coal cleaning process. These impurities (slurry) also contained large amounts of small coal particles. Once a slurry pond had filled to its capacity with solids, a new pond was constructed.

Two former tipples containing several slurry pond sites exist on the Mined Land Wildlife Area today. Both sites have eroded over the years and have become environmental liabilities. Many of the berms, which are as tall as 25 feet, are eroding, allowing sediment run-off into nearby steams and strip-mine lakes. Due to the acidity, vegetation is sparse to nonexistent at the tipple sites. In some instances the slurry can even act as quicksand. Preliminary cost estimates to reclaim the sites using only a minimal approach exceed $ 2.4 million.

WATCO, Inc. has a contract with the Kansas Department of Wildlife and Parks to remove the coal and reclaim the land. The company trucks the waste coal to power plants where it is burned as fuel. The advent of new technology and a favorable market will now allow the economical recovery of the small wasted coal particles. Not only does the company benefit economically, but so does the environment, and at no cost to the public.

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Lawson Turkey Farm

Poultry farms are more common in southeast Kansas than in other parts of the state. Most poultry operations in southeast Kansas are associated with large corporations. The Lawson Farm has formed a partnership with Butterball Turkey Company in Carthage, Missouri. The company provides the poults, feed, medication, and technical support. The farmer is responsible for providing the land, buildings, equipment, maintenance, labor, and operating expenses.

Poultry farms in Kansas are regulated as Confined Animal Feeding Operations (CAFO) by the Kansas Department of Health and Environment (KDHE). KDHE's main concern is water pollution. Their regional office in Chanute monitors about 25 operators in 16 southeast Kansas counties. All are turkey farms, except for one chicken egg operation.

Operation

The Lawsons have a three-stage, 18,000 bird operation that raises an average of 6.5 flocks per year. The turkeys are raised in three stages of about six weeks each, requiring increasingly larger buildings for each stage. One to two-day-old poults are delivered to the farm and kept in the brooder house where temperature, feed, water, and health conditions are monitored closely. At about five to six weeks of age, the birds are moved to intermediate facilities. At 12 weeks, the turkeys are transferred to the range, or finishing facilities where they remain until shipped to market at 19 weeks of age. When the birds are sent to market, each turkey weights an average of 32 pounds.

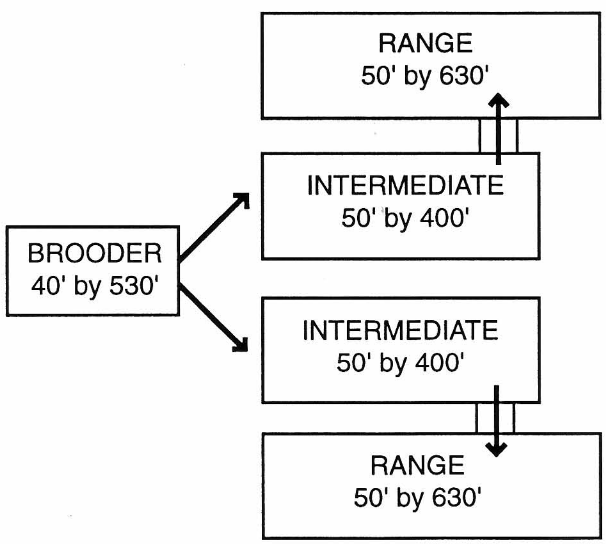

Diagram of facilities at Lawson Poultry Farm.

Natural mortality is about 12 percent, so about 98,500 birds, or approximately 3,150,000 pounds of turkey, are marketed in a year's time.

Waste Disposal

Poultry farms use either a wet or dry method of waste disposal. In the wet method, used at many Missouri operations, the manure falls through a grated floor and is then washed out of the facility with water. Missouri has experienced ground-water problems associated with poultry farms, particularly in the Springfield-Branson areas where the Ozark (Roubidoux) aquifer is close to the surface.

Lawson Farm uses a dry process of waste disposal—in other words, water is not used in the removal or treatment of organic waste. The floors of the rearing facilities are covered with wood shavings and periodically cleaned with a machine called a "housekeeper" that picks up the manure and wood shavings mix, and then separates the two components. The manure is stored in an open-sided shed to keep it dry.

Some of the manure is used to compost dead birds. Dead birds are picked up each day and placed between one foot layers of manure in compost bins. After 30 days in the compost bin, the birds have decomposed (even the bones have broken down) and the mixture is spread on agricultural fields as fertilizer. The odor from the composting facility is slight, and is neither that of manure or dead turkeys, and is not unpleasant.

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Wastewater and Water Treatment Facilities—Pittsburg, Kansas

Wastewater Treatment Plant

The Pittsburg Wastewater Treatment Plant is responsible for the treatment of raw wastewater from residential and commercial users. Waste solids are separated, biologically broken down, dried, and trucked from the plant for land application. Waste liquids are treated and then released into Cow Creek.

The Pittsburg Wastewater Treatment Plant was constructed in 1953, then modified and upgraded in 1978. The latest modification, completed in 1995, more than doubled the hydraulic capacity and added advanced wastewater treatment methods to improve the plant effluent. This treatment plant was designed to meet 1995 Kansas and EPA regulations for water quality standards.

The 1995 modification converted the treatment plant into an activated sludge plant utilizing the extended aeration concept. Extended aeration involves the biological reduction of organic-waste materials while suspended in solution. Extended aeration provides the most flexible and efficient type of treatment for ammonia removal because the conditions for optimum biological treatment are controllable.

Preliminary wastewater treatment begins at the headworks facility where raw sewage enters the plant (see fig. 1). The headworks facility provides screening, flow control, and sampling of the waste stream. Two mechanically cleaned barscreens remove large objects, such as tree branches and trash. Flows of less than 24.0 million gallons per day (MGD) are diverted to the main pump station. Storm flows that exceed 24.0 MGD are sent to the 84-inch diameter screw pump which lifts water 16 feet and has a capacity of 18.0–24.0 MGD. By diverting storm flows in excess of 24.0 MGD around the treatment plant, the aerobic and anaerobic balance of the plant is not upset and can continue to treat the wastewater normally after storm flows subside.

Control Structure No. 2 diverts wastewater flows up to 18.0 MGD to the grit and preaeration structure. When plant flow exceeds 18.0 MGD, the control structure diverts flows directly to the nitrification removal facility. From the grit and preaeration structure, normal flows pass on to the primary clarifiers.

Trickling filters remove organic waste prior to treatment in the aeration basin. By using trickling filters, extended aeration in the basin can be optimized for efficient ammonia removal. Flows in excess of 6.0 MGD are diverted over a control weir to the final clarifiers for storage until peak flows decrease and stored water can be returned to the main pump station.

Chemical feed equipment, designed to maintain alkalinity and pH, is located in the nitrification building. Blowers provide the air needed in the aeration basin-activated sludge process.

In the aeration basin, wastewater is given additional treatment, using the "Schreiber Process," which produces a very high rate of oxygen transfer. This process utilizes a circular concrete basin with a bridge that extends to the center of the basin. The bridge is equipped with piping and diffuser nozzles to deliver air for the nitrification process. The Schreiber system is sized to accommodate a design flow from 6.0 to 8.0 MGD. Excess flows are diverted after secondary treatment by the trickling filters to the final clarifiers to protect the activated sludge process.

The sludge produced in the aeration process is stabilized prior to disposal. The aerobic digester provides a solids retention time of 40 days to produce a stable sludge suitable for land application. The digester consists of two tanks; one tank aerates and mixes the sludge, while the second operates as a sludge thickener.

A computer control system facilitates operation of the plant and stores data for reports, maintenance, and parts inventory. The main computer and data storage are located in the operations building. The computer system allows any pump, blower, or mechanical device to be started, stopped, or taken off line for maintenance. Alarms can be recorded and acknowledged from remote computer stations in each of the main structures. In the event of equipment failure, alarms notify plant operators at home.

The operations building has an area of 2,400 square feet. This building houses meeting rooms for training plant personnel, a state-of-the-art laboratory, office space for record keeping, and provides a computer interface to monitor and control the treatment plant.

Water Treatment Plant

The Pittsburg Water Treatment Plant, located on the east edge of Pittsburg one-half mile south of 4th Street on Free King Highway, was constructed in 1975. The water supply comes from four wells drilled to a depth of 1,050 feet into the Roubidoux Formation (Ozark aquifer). The design capacity of the plant is 5.2 million gallons per day. The wells yield between 1,800 and 2,100 gallons per minute.

Raw water from the aquifer is high in calcium and other minerals. To soften the water, the plant incorporates lime softening, using quicklime and slakers. The pH is adjusted with carbon dioxide and chlorine is used for disinfection. Fluoride is added to achieve a residual of one milligram per liter as recommended by the Kansas Department of Health and Environment.

The plant has one-half million gallons of storage onsite, an additional 1.75 million gallons in overhead tower storage, and 1.5 million gallons of reservoir storage. Peak water production occurred in 1991, when a total of 1.154 billion gallons of raw water was pumped from the wells. In 1998, pumpage was slightly more than 1 billion gallons. The daily average in 1998 was 2.6 million gallons of treated water per day.

References

Pittsburg Wastewater Treatment Plant, Pittsburg, Kansas. Report by Professional Engineering Consultants, P.A., Wichita, Kansas.

Resource Contacts

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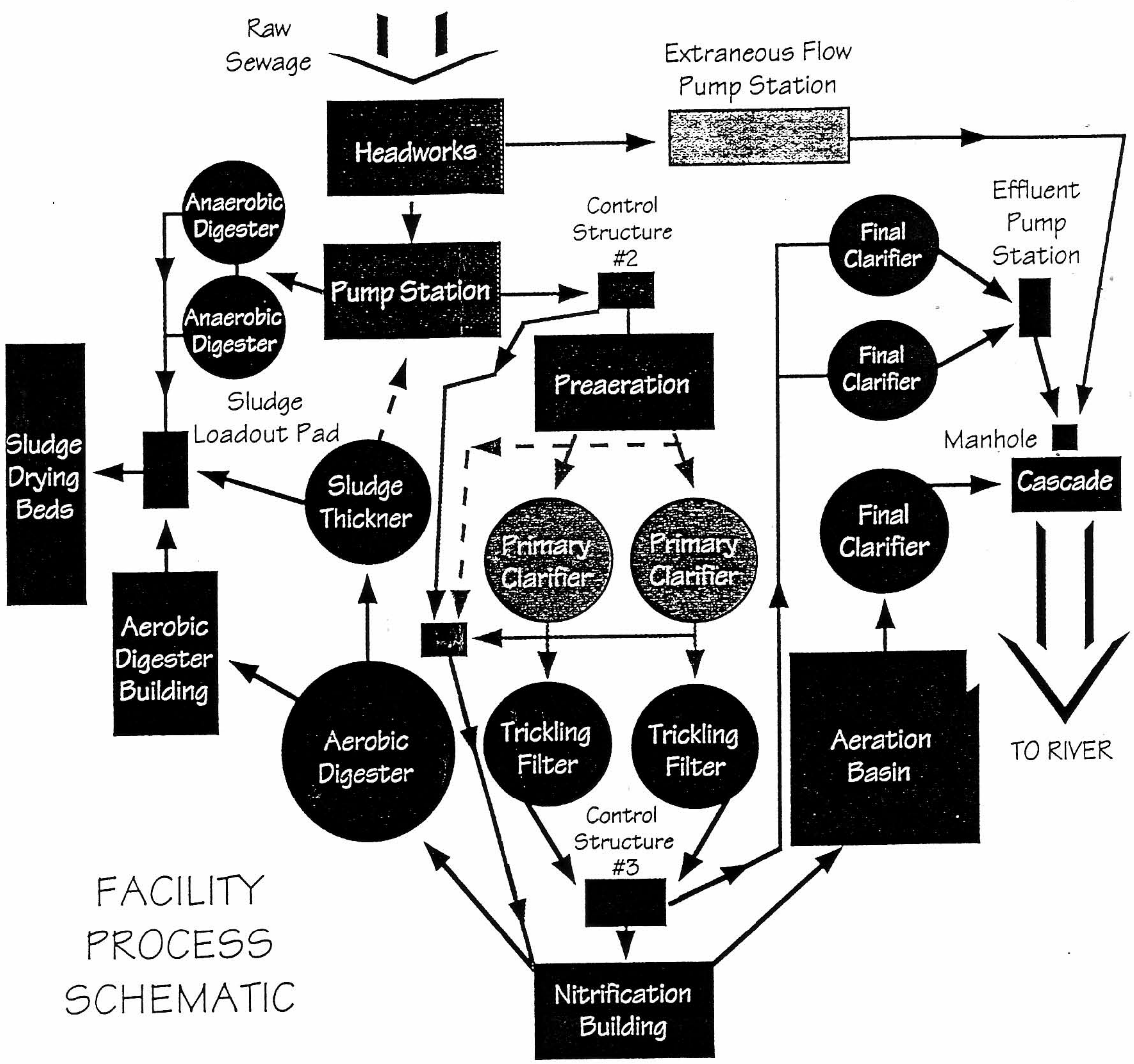


Figure 1. Schematic diagram of the Pittsburg Wastewater Treatment Plant.

SCHEDULE & ITINERARY

Thursday June 17, 1999

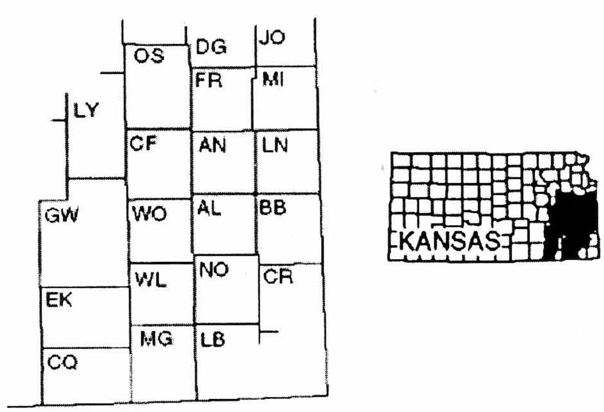
7:00 am	Breakfast
7:50 am	Bus to Site 6
8:30 am	**SITE 6** - Neosho River Watershed - Surface Water Issues *Al LeDoux,* Director, Kansas Water Office *Margaret Fast,* Water Resource Planner, Kansas Water Office *Wakefield Dort, Jr.,* Dept. of Geology, University of Kansas
9:10 am	Bus to Site 7
10:00 am	**SITE 7** - Ash Grove Cement Plant - Chanute, Kansas *Jim Shea,* Plant Manager, Ash Grove Cement Company *Mark Ward,* Production Manager, Ash Grove Cement Company
11:45 am	Bus to Lunch
12:00 pm	Lunch in Chanute
1:00 pm	Bus to Site 8
1:45 pm	**SITE 8** - Coalbed Methane Gas Production - Sycamore Valley Field *George Jones,* President, Stroud Oil Properties, Inc. *Larry Brady*, Kansas Geological Survey
2:30 pm	Bus to Site 9 - Chautauqua Hills
4:00 pm	**SITE 9** - Red Buffalo Ranch *Bill Kurtis,* Owner, Red Buffalo Ranch *Jack Horton,* Manager, Red Buffalo Ranch
6:30 pm	Dinner at Butcher Falls
7:30 pm	Evening Session - An Evening with Bill Kurtis *Bill Kurtis,* Kurtis Productions and the Red Buffalo Ranch
8:45 pm	Bus to motel
9:30 pm	Arrive Apple Tree Inn, Independence

Osage Cuestas

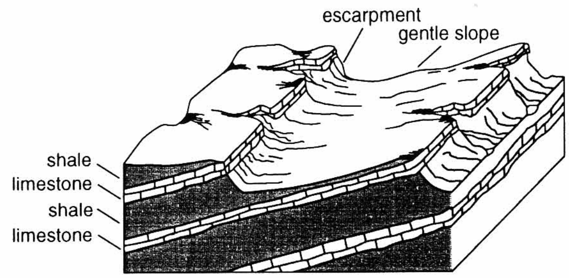
The Osage Cuestas region occupies nearly all of eastern Kansas south of the Kansas River and is characterized by a series of east-facing ridges (or escarpments), between which are flat to gently rolling plains. Cuesta, Spanish for hill or cliff, is the term geologists use to describe ridges with steep, clifflike faces on one side and gentle slopes on the other.

The underlying strata in this region are Pennsylvanian limestones and shales that dip gently to the west and northwest. Each cuesta consists of a striking east-facing ridge or escarpment and a gently inclined surface that slopes in the direction of the dip of the strata. Each escarpment is capped by the more-resistant limestone, while the gentle slopes are underlain by thick layers of shale. The steep faces of the cuestas range in height from approximately 50 feet to 200 feet.

The limestones and shales in the Osage Cuestas were deposited in shallow seas that lapped onto this area during the Pennsylvanian Period, between about 290 and 310 million years ago. The type of rock exposed in a particular outcrop gives geologists information about the environment at that spot millions of years ago. As material was eroded from the land and carried into the sea by streams, the coarsest material was deposited near the shore while finer sediments were carried farther seaward. Although there are exceptions to this general rule, a bed of sandstone usually indicates deposition on or very near shore, and layers of shale (which were once mud) indicate deposition a little farther from shore. Limestone was deposited during periods of decreased erosion or in areas where sandstones and shales were not being deposited. The marine organisms associated with many limestones indicates the environment was tropical and the water was relatively shallow and clear.



Extent of the Osage Cuestas in Kansas.



Cuesta topography developed in gently dipping, alternating hard and soft rock layers.

In eastern Kansas, sandstone is often interbedded with shale and limestone. It also occurs as channel deposits, cutting through older deposits of shale and limestone. The Tonganoxie Sandstone Member of the Stranger Formation, which crops out in Franklin, Douglas, and Leavenworth counties, is an example of a channel deposit. It was deposited in a large river valley about 300 million years ago. Today the Tonganoxie is an important aquifer. Another sandstone in this region, the Bandera Quarry Shale Member, is quarried in Bourbon County, near the town of Redfield. This sandstone, part of the Bandera Shale formation, separates easily along natural bedding planes and is used as flagstone for walkways and veneer.

Coal mining played an important role in this region, particularly in Osage County. Between 1885 and 1892, Osage County had 118 coal mines, which employed more than 2,200 people and produced almost 400,000 tons of coal.

References

Buchanan, Rex C., and McCauley, James R., 1987, Roadside Kansas—A Traveler's Guide to Its Geology and Landmarks: Lawrence, Kansas, University Press of Kansas, 365 p.

Buchanan, Rex C., Tolsted, Laura L., and Swineford, Ada, 1986, Kansas Rocks and Minerals: Kansas Geological Survey, Educational Series 2, 60 p.

Evans, Catherine S., 1988, From Sea to Prairie—A Primer of Kansas Geology, Kansas Geological Survey, Educational Series 6, 60 p.

Schoewe, Walter H., 1949, The Geography of Kansas: Transactions of the Kansas Academy of Science, v. 52, no. 3, p. 261-333.

Wilson, Frank W., Kansas Landscapes—A Geologic Diary: Kansas Geological Survey, Educational Series 5, 50 p.

Neosho River Watershed

The Neosho River gets its start in the Flint Hills of east-central Kansas, where its tributaries form in the pastures of Morris County (fig. 1). From there, the river cuts generally southeast, through the Osage Cuestas of eastern Kansas. In Coffey County, the Neosho is joined by the Cottonwood River. It then continues south-southeast before exiting the state in Cherokee County and continuing on into Oklahoma, where it is joined by another major tributary, the Spring River. From there the Neosho proceeds through a series of reservoirs before dumping into the Arkansas River. In all, the Neosho River drainage basin in Kansas comprises 6,300 square miles and includes all or part of 18 Kansas counties (Kansas Water Office, 1999).

The Army Corps of Engineers operates three reservoirs on the river or its tributaries: Council Grove Reservoir (in Morris County), John Redmond Reservoir (in Coffey County), and Marion Reservoir (on the Cottonwood River in Marion County). The river and its reservoirs are an important source of water for public water supplies in the region. The Wolf Creek Nuclear Generating Plant, located near Burlington in Coffey County, draws water from John Redmond Reservoir and is the largest single water user in the basin. In addition, 15 active watershed districts operate in the basin.

Because the upper reaches of the Neosho River are in the Flint Hills, the river has a gravel-bottom of limestone and flint in many places. In addition, parts of the river drain areas that largely remain in pasture and are not cultivated. These two factors combine to make the Neosho a fairly clear-running stream, especially in comparison to many Kansas Rivers, which are often silt-laden.

As a result, the Neosho can be home to various animal species that are not found in many other river drainages in the state. Certain animals thrive in these clear-running streams; their populations suffer when the stream is changed and the Neosho becomes more silty or the river bottom less gravel-covered. Several species of freshwater mussels, for example, have been completely extirpated from the Neosho River (Collins et al., p. 21–38), probably due to water-quality changes and the construction of impoundments. Today these species are considered threatened or endangered. Better known is the Neosho Madtom (*Noturus placidus*), a small, brown member of the catfish family. A native of Kansas, the Neosho Madtom reaches a maximum length of about 3 inches and lives only in the mainstream of the Neosho, the Cottonwood, and the Spring rivers. Because it occurs especially in areas of riffles and gravel bars, disturbance of the riverbed is a particular problem for this fish. In parts of the lower reach of the Neosho, landowners have dredged the river for river-rounded rock that is used in roads and construction, raising issues of habitat destruction. As a result of this and other river conditions, the Neosho Madtom has been classified a threatened species by both the state and the federal government (Collins et al., 1995, pp. 63–64).

Other issues concerning the Neosho include surface-water quality standards, public water supply, and the impact of dam construction on the river channel. The latter is discussed in more detail in the attached paper by Wakefield Dort.

State Water Planning

The Kansas Water Office, in cooperation with several other agencies that have water-related responsibilities, prepared the state's first comprehensive plan for the management, conservation, and development of Kansas' water and related land resources. The Kansas Water Plan, initially approved in 1984, is updated regularly and provides the framework for addressing the state's water problems, issues, and concerns.

Water Marketing. The State has contracted with the federal government to purchase water-supply storage space in twelve Kansas federal lakes. The water in storage is available to municipal and industrial users by contracting with the Water Office. Money from these contracts is used to repay the cost of purchasing the water-supply storage space. Although 1996 was the 20th anniversary of the first Water Marketing Program contract with a water supply customer, the study, planning, and establishment of the program had spanned the nearly 20 years prior to the signing of that contract.

Water Assurance. This program coordinates operation of a portion of state-owned water-supply storage in twelve federal lakes so that municipal and industrial water right holders are assured water during a drought. During periods of drought, natural streamflow on regulated streams (streams with reservoirs) may be significantly reduced. Municipal and industrial water rights holders may find their ability to use the stream is severely limited, at a time when their demand for water is at its highest. The water assurance program allows for coordinated operation of state-owned or controlled water storage space in federal reservoirs. Because the state operates all reservoirs within a basin as a system, increased efficiency in water delivery assures enhanced flow during times of drought.

Kansas has the distinction of having established the first water assurance district in the nation. We now have three districts:

Kansas River Water Assurance District No. 1: City of Junction City, City of Manhattan, Western Resources (3 locations), City of Topeka, S.E. Public Service, Hill's, UCB Cello, Inc, City of Lawrence, Sunflower Ordinance Plant, City of Olathe, City of Bonner Springs, Johnson Co. Water Dist. No. 1, Proctor and Gamble, Midwest Cold Storage, K.C. Board of Public Utilities.

Marais des Cygnes River Assurance District No. 2: City of Melvern, City of Ottawa, Franklin Co. RWD No. 6, City of Osawatomie, City of Paola, City of La Cygne, Kansas City Power and Light.

Cottonwood and Neosho River Basins Water Assurance District No. 3: City of Council Grove, City of Cottonwood Falls, City of Emporia, City of Hartford, City of Burlington, City of Leroy, Woodson Co. RWD No. 01, Public Wholesale Water Supply District No. 5, City of Iola, City of Humboldt, Monarch Cement, Ash Grove Cement, City of Chanute, City of Erie, City of St. Paul, City of Parsons, Crawford Co. RWD No. 6, KS Army Ammunition, KG&E, City of Oswego, City of Chetopa.

References

Collins, J.T., S.L. Collins, J. Horak, D. Mulhern, W. Busby, C.C. Freeman, and G. Wallace, 1995, An Illustrated Guide to the Endangered or Threatened Species in Kansas, University Press of Kansas, 140 p.

Kansas Water Office, 1999, The Neosho Basin, http://www.kwo.org/bac/basins/neosho.html (June 1999).

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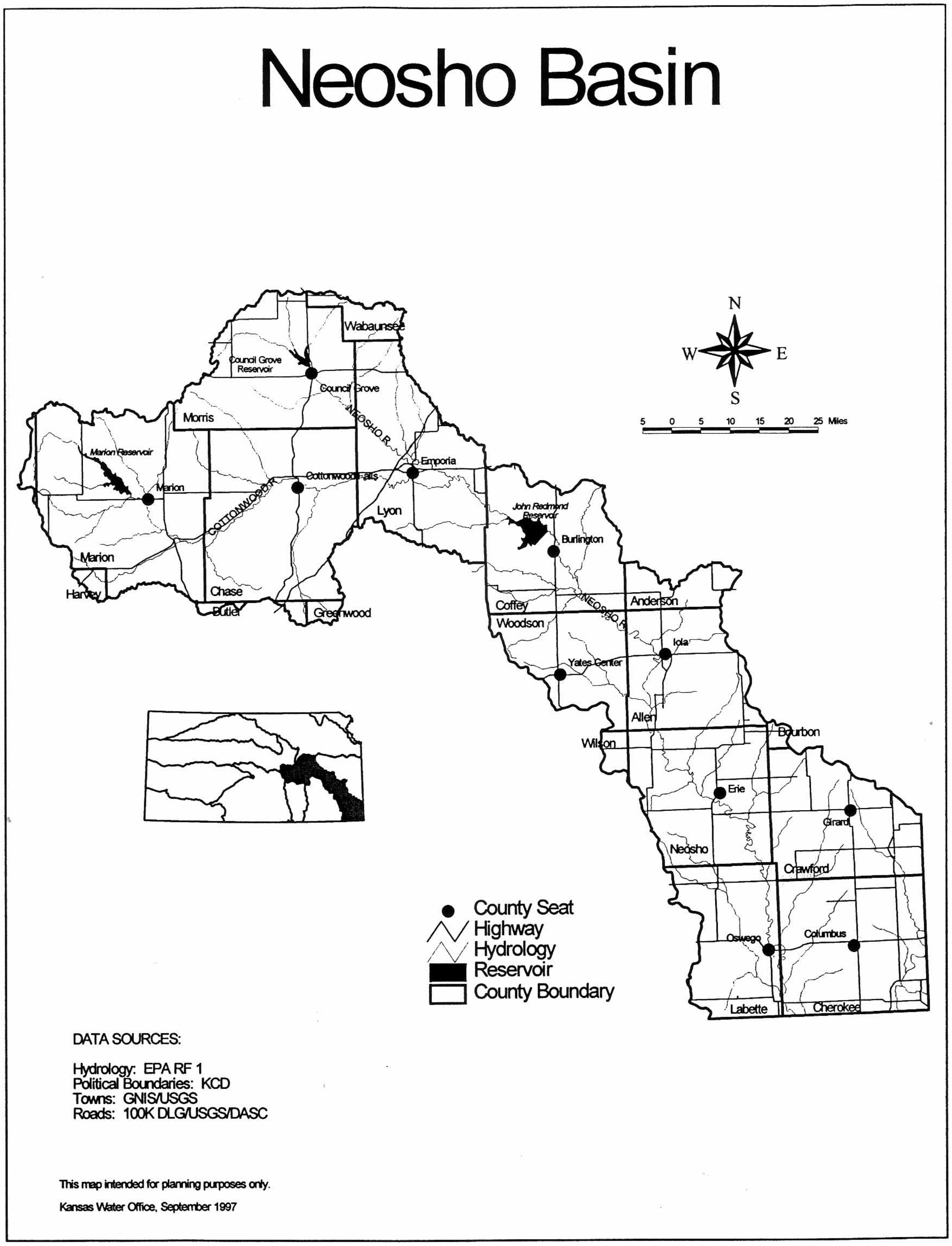
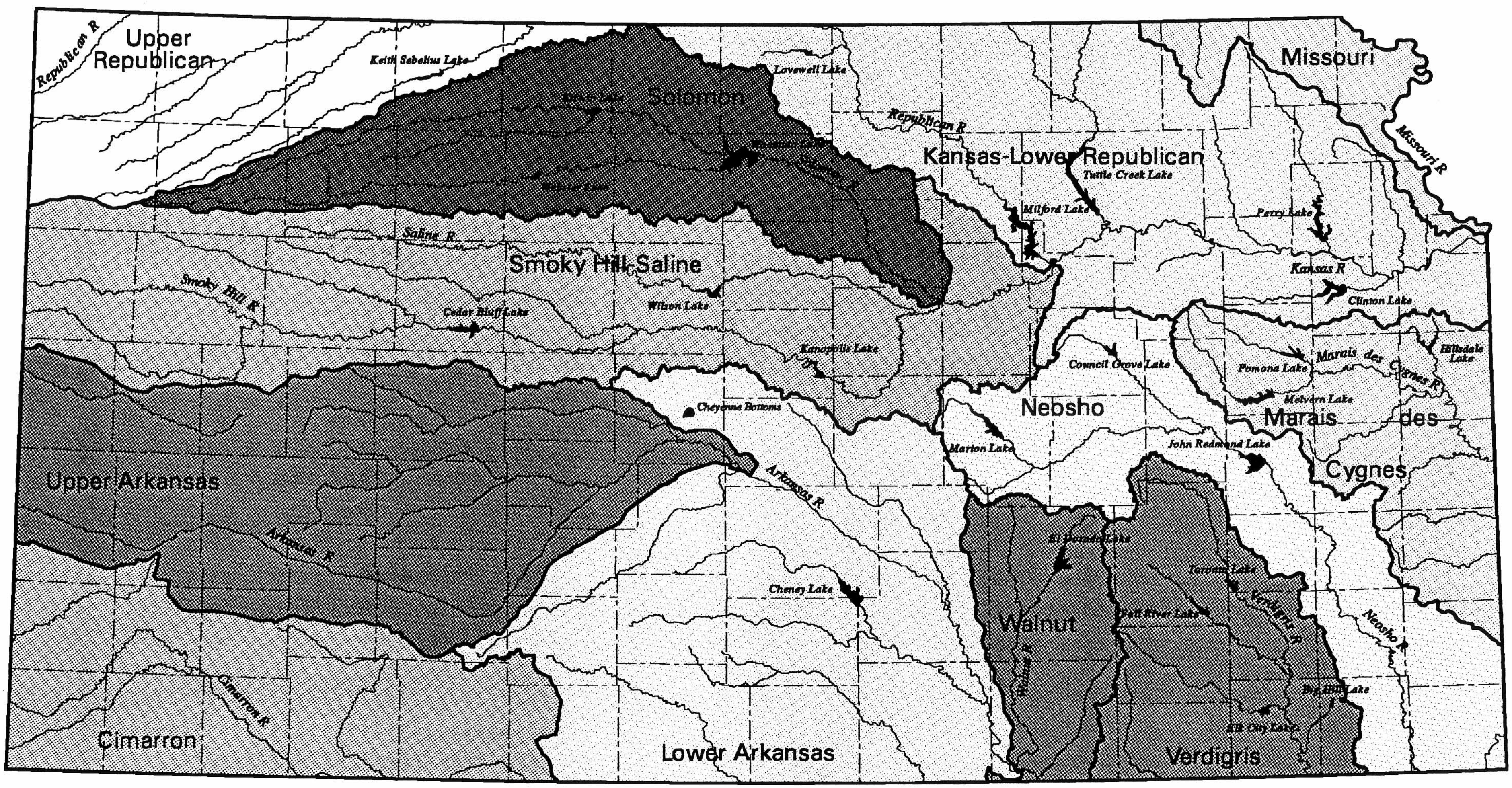


Figure 1. Neosho River Watershed.

Kansas River Basins and Federal Lakes



Kansas Water Office

May 1996

Neosho Wildlife Area

Located on the broad, flat flood plain below the junction of Flat Rock Creek and the Neosho River, the Neosho Wildlife Area is a human-made marsh developed by the Kansas Department of Wildlife and Parks. The area is designed and managed to furnish a resting and feeding place for migratory waterfowl and to provide more public hunting opportunities for Kansans. Covering 3,246 acres in Neosho County, the wildlife area is more than half under water, with 1,748 acres contained in 14 human-made pools.

Construction of the area began in the fall of 1960, and by early 1961 three pools were completed. Waterfowl hunting was first permitted in 1962. In the fall of 1988, 270 acres were added to the area through a cost-sharing agreement with Ducks Unlimited, Inc.

The original area was constructed with the aid of Pittman-Robertson Federal Aid funds at a cost-share rate of three federal dollars to one state dollar. The funds come from an 11 percent excise tax on sporting arms and ammunition. Lands used for production of agricultural crops as part of the management program remain on county tax rolls.

Fishing is normally allowed from early March to near the beginning of the waterfowl season. Pool 3 has permanent water capability for supporting excellent seasonal fishing for crappie and fair to good angling for channel catfish and bullhead. Fishing for flathead and channel catfish on the Neosho River, which forms the west boundary of the area, can be seasonally good to excellent. Bowfishing for carp on mudflats in spring and summer is also popular locally.

During spring and fall, impressive numbers of ducks visit the area, sometimes as many as 100,000 birds. More than 60,000 ducks, primarily mallards, normally spend the winter on the area.

Prior to the hunting seasons, the waterfowl hunting area is flooded with approximately two feet of water. Pool 3, located in the refuge area, remains flooded throughout the year. Three of the 14 pools are managed in a moist soil environment through an annual water-level manipulation plan. Four green-tree marshes ranging in size from five to 15 acres offer a different type of hunting opportunity. Approximately 250 acres of corn, milo, and millet are planted in the pools by area personnel.

In addition to waterfowl, other game may be hunted in season. The area affords good hunting for deer, turkey, quail, rabbit, and squirrel.

Reference

Neosho Wildlife Area brochure. Kansas Department of Wildlife and Parks.

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Instability of the Lower Neosho River

Wakefield Dort, Jr., Department of Geology, University of Kansas

Some landowners along the Lower Neosho River have complained that since impoundment of John Redmond Reservoir in 1964, variations in outflow from the dam have caused increased erosion of their waterfront property. In 1965, the Kansas Water Office requested a study of channel stability and activity along the 177-mile-long reach from John Redmond Dam to the Oklahoma border. In brief, evidence was not found to support the contention that significant erosion has occurred because of John Redmond.

In order to evaluate the record of channel change since 1964, it is necessary to determine the pattern and magnitude of changes that were ongoing under prior natural conditions. Following the example of the study of channel changes of the Kansas River and its major tributaries that was published in atlas form for the Corps of Engineers in 1980, the former positions of the Lower Neosho River were obtained by studying all published U.S. Geological Survey and County Atlas maps of the area. Compilation of data showed that the Neosho channel has been migrating across its floodplain since the 1880's. Indications of channel movements during the preceding several hundred years are also visible on aerial photographs. It is clear that the Lower Neosho has been a meandering stream throughout this long interval, though the rate of change has not been the same at all localities. Some reaches have wandered rapidly, cutting off oxbow lakes, then forming new bends. Other reaches have not changed appreciably during the same interval. Nevertheless, it can be stated categorically that the Lower Neosho River has been an unstable, actively migrating river for at least the last few hundred years.

The Kansas Water Office mandated a full scientific study of the river within limitations of time (equals money). This well-advised decision resulted in acquisition of information about several unsuspected aspects of river behavior and history. Study of aerial photographs led to subdivision of the Lower Neosho into 15 segments of contrasting intensities of channel activity. These were subjectively designated high, medium, or low. Two reaches display a remarkable split into two channels for distances of several miles, a phenomenon not known in other streams (see fig. 1, which illustrates the dual channels near St. Paul, Kansas). It was also discovered that the level of channel activity correlates with the nature of the underlying bedrock, which directly influences the gradient of each reach.

In places the channel is floored by bedrock. Numerous oil-well logs show that between LeRoy and Neosho Falls the entire valley, locally more than five miles wide, is underlain by a layer of chert-pebble gravel averaging 8 feet in thickness. This gravel rests on a nearly flat bedrock surface. Above the gravel are three sand-silt units. Soil developed in the upper part of each unit during pauses in accumulation of sediment. Radiocarbon analysis of organic material in these soils clearly shows that the lowest unit was deposited between 6,500 and 4,500 years ago. The upper units are even younger. This chronology indicates that the Lower Neosho River has undergone profound changes, both laterally and vertically, in the past few thousand years.

Much has been discovered about the history of the Lower Neosho River, events and sequences that must have been very strongly influenced by happenings farther upstream in the drainage basin. This, therefore, is an area that merits further study. Additionally, lessons learned from the Neosho can certainly be transferred profitably to other streams in Kansas.

Reference

Dort, W., Jr., 1998, Instability and Channel Migration, Lower Neosho River: Hydrogram, Autumn 1998, p. 21–24.

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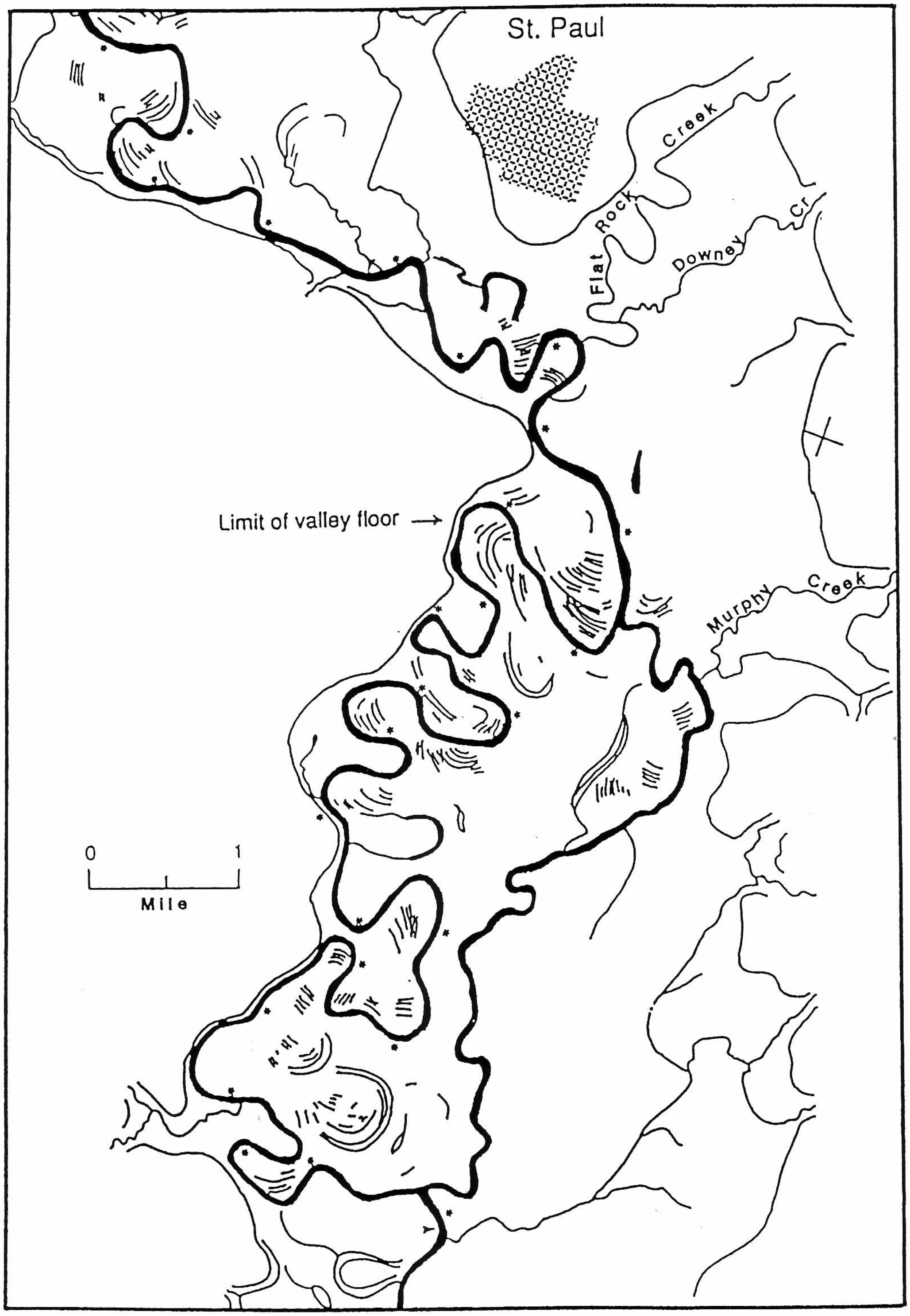


Figure 1. Active dual channels of the Lower Neosho River downstream from St. Paul. Short curved lines indicate the former locations of outwardly migrating meanders during the past few hundred years.

Prepared in cooperation with the KANSAS WATER OFFICE

Channel Stability of the Neosho River Downstream From John Redmond Dam, Kansas

—Kyle E. Juracek

The stability of the Neosho River channel downstream from John Redmond Dam, in southeast Kansas, was investigated using multi-date aerial photographs and stream-gage information. Bankfull channel width was used as the primary indicator variable to assess pre- and post-dam channel change. Five 6-mile river reaches and four stream gages were used in the analysis. Results indicated that the overall channel response to the altered streamflow regime and sediment load introduced by the dam has been minor. Aside from some localized channel widening, there was little post-dam change in bankfull channel width. The lack of a pronounced post-dam channel response may be attributable to a substantial reduction in the magnitude of the post-dam annual peak flows in combination with the resistance to erosion of the bed and bank materials. Also, the channel may have been overwidened by a series of large floods that predated construction of the dam.

Introduction

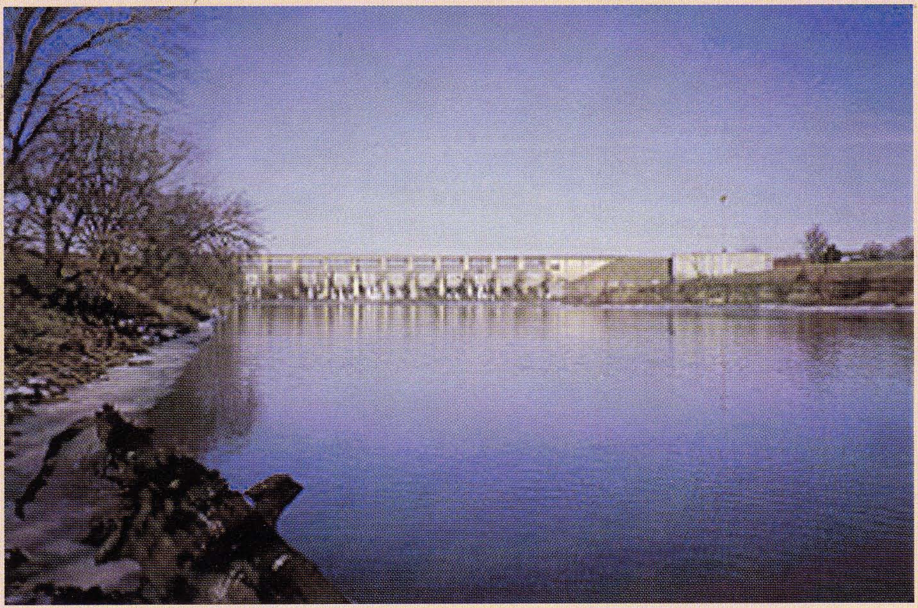
The construction and operation of a reservoir can have a substantial effect on the stability of the river channel downstream from the dam. Since its completion in 1964, the downstream effect of John Redmond Dam on the Neosho River in southeast Kansas (fig. 1) has been much debated. Previous studies by the U.S. Army Corps of Engineers (COE) (1972) and the U.S. Geological Survey (USGS) (Studley, 1996) have indicated the possibility of channel widening. Also, anecdotal evidence of perceived channel widening has been provided by residents living along the Neosho River as far as 165 mi downstream from the dam. The available evidence, however, is not sufficient to conclude that John Redmond Dam has caused the Neosho River channel to change more than it otherwise would have changed without the dam.

To determine the effect of John Redmond Dam, a study of the Neosho River that compares the channel before, during, and after completion of the dam was undertaken by the USGS in cooperation with the Kansas Water Office. The objective of this study was to determine whether or not the Neosho River channel has widened in response to the changes in flow regime and sediment load introduced by the dam. Pre- and post-dam channel stability was assessed using multi-date aerial photographs and streamgage information.

Important issues related to the stability of the Neosho River channel include protection of riparian resources, protection of habitat for threatened and endangered species (for example, the Neosho Madtom, *Noturus placidus*), and bank stabilization as related to loss of property, general aesthetics, and recreation. The knowledge provided by this study will provide some of the information needed to best manage the Neosho River system.

Description of Study Area

The focus of this study was the middle 180-mile reach of the Neosho River between John Redmond Dam and the Kansas-Oklahoma State line (fig. 1). Throughout this reach the Neosho River is characterized by a meandering, gravel-bed channel. The channel slope averages about 1.2 feet per mile. Riverbank height varies from about 15 to 30 feet. The channel bed frequently is situated on bedrock. Alluvium in the Neosho River Valley averages about 25 feet in thickness and is typified by silt with a basal layer of sand and gravel that averages about 3 feet in thickness. The channel-bank materials consist mostly of cohesive silt and clay and are relatively resistant to erosion compared to sand banks. Also,



John Redmond Dam on the Neosho River near Burlington, southeast Kansas.

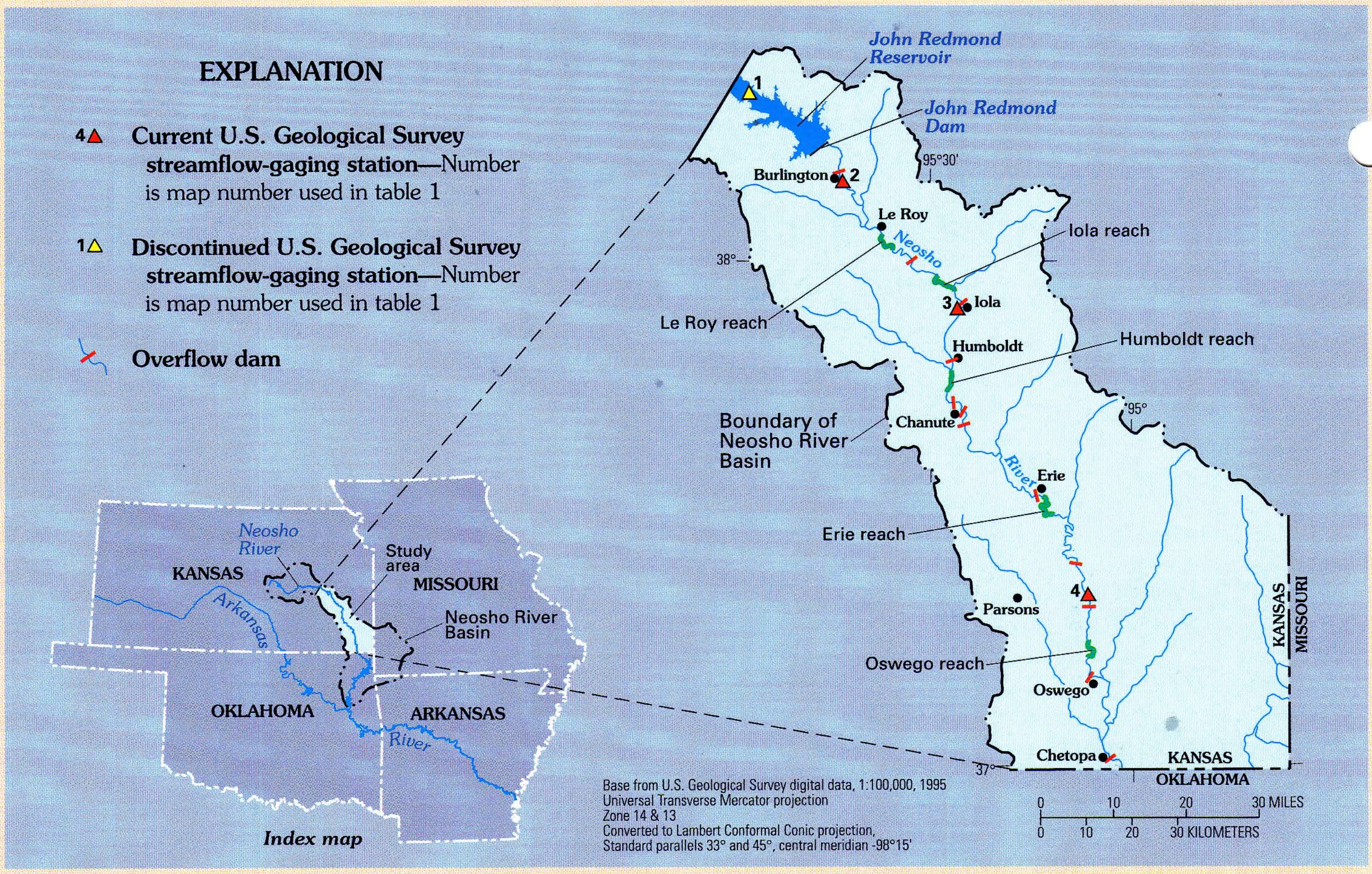


Figure 1. Location of Neosho River Basin, study area, river reaches, and streamflow-gaging stations.

the channel banks are typically covered by partial to complete mature tree cover which may enhance bank stability at some locations.

Several tributaries contribute unregulated flow to the Neosho River downstream from John Redmond Dam. Also noteworthy are 12 overflow dams (fig. 1) that were constructed within the main-stem channel mostly in the 1930's or 1950's. Changes in the streamflow regime attributable to the operation of John Redmond Dam have included a decrease in the magnitudes of peak discharges (flows) and an increase in the magnitudes of low discharges (fig. 2) (Studley, 1996). Post-dam suspended-sediment concentrations are substantially reduced immediately downstream from the dam.

Methods

A stable river channel naturally meanders across its river valley over time while maintaining approximately the same cross-sectional shape. Therefore, changes in channel geometry may be used to infer channel instability. In this study, bankfull channel width was used as the primary indicator variable to assess channel change after the completion of the dam.

Five 6-mile river reaches were selected for use in this study (fig. 1) with the objective being to obtain a spatially representative sample while avoiding, to the extent possible, localized human-caused or natural conditions that might obscure channel adjustment. Human-caused conditions include overflow dams (fig. 1), bridges, and channel modifications (for example, riprap). Natural conditions include split-channel locations and hard points (that is, locations where the channel is situated along the valley wall). Additional factors considered in the selection of the reaches included proximity to John Redmond Dam and the availability and usability of aerial photographs.

For each reach, aerial photographs were obtained for three time periods—pre-dam (late 1930's), construction (early 1960's), and post-dam (early 1990's). The bankfull channel area was interpreted from the aerial photographs for each time period and traced on a scale-stable mylar overlay. Primary indicators used in the delineation of the bankfull channel included breaks in slope, the tops of point bars, and changes in vegetation. The channel centerline was added, and all information was digitized. Mean bankfull channel width then was estimated for all reaches and dates as channel area divided by channel centerline length.

To compare pre- and post-dam channel stability, the mean bankfull channel widths for all reaches and dates were tabulated, and pre- and post-dam differences were evaluated. For each reach, pre-dam change was computed as the percentage difference in mean bankfull channel width between the pre-dam and construction time periods. Similarly, post-dam change was computed for each reach as the percentage difference in mean bankfull channel width between the construction and post-dam time periods. The magnitude and direction of the changes were used to assess pre- and post-dam channel stability for the individual reaches as well as the entire system. Due to various potential sources of error in the use of aerial photographs to measure bankfull channel widths, only a change in bankfull width of 10 percent or more was considered significant.

Information from USGS streamflow-gaging stations (fig. 1, table 1) was also analyzed to assess pre- and post-dam channel stability downstream from the dam. A comparison of pre- and post-dam conditions included an assessment of stage-discharge, discharge-width, discharge-area, and discharge-velocity relations. The Parsons gaging station was excluded from all analyses due to back-water effects from an overflow dam located 2.7 miles downstream from the gage (fig. 1, map number 4). The gaging stations provide site-specific information at locations separate from the river reaches analyzed in this study.

Results and Discussion

The aerial-photograph analyses indicate that the construction and operation of John Redmond Dam has not resulted in a substantial and pervasive downstream widening of the Neosho River channel. The mean bankfull channel widths (table 2) show that, with the exception of the Iola reach (10-percent increase in width), post-dam changes have been minor (and may be attributable in part to measurement error). In comparison, relatively large pre-dam channel-width changes had occurred at the Le Roy, Humboldt, and Oswego reaches with respective increases of 15, 14, and 10 percent. The fact that three of the four largest increases in mean bankfull channel width predate the dam may be indicative of a predam period of channel widening possibly associated with one or more large floods.

In many river systems 90 to 99 percent of significant bank erosion occurs during large floods. A large flood occurred in July 1951 when the Neosho River had a flow with an estimated 500-year recurrence interval. The peak discharge during this flood at Strawn (fig. 1) was 400,000 cubic feet per second (The mean annual peak discharge for the period of record at Strawn is about 43,000 cubic feet per second). Interestingly, the three reaches that had the largest pre-dam increases in bankfull channel width also had the smallest post-dam changes in bankfull

Downstream Effects of Dams on River Channels

Primary changes introduced by a dam include a reduction in the river's sediment load as well as an alteration of the flow regime. Typical changes in the flow regime include a reduction in the magnitude of peak flows and a possible increase in the magnitude of low flows. Such artificially introduced changes may trigger an adjustment by the river as it attempts to re-establish an approximate equilibrium between the channel and the discharge and sediment load being transported.

In general, rivers downstream from dams initially adjust by channel degradation. Typically, a river will scour, and thus lower, its channel bed as the sediment-depleted water emerging from the dam attempts to replenish its sediment load. Concurrently, the reduced magnitude of peak flows emerging from the dam eventually may result in channel narrowing as vegetation encroaches. An exception is the case where the channel bed is armored or situated on bedrock. Unable to effectively scour the resistent channel bed, the river may instead erode laterally and thus widen its channel. Typically, channel degradation initiates near the dam following closure and eventually may migrate a considerable distance downstream (Williams and Wolman, 1984).

The type, rate, duration, and downstream extent of channel degradation downstream from dams are controlled by a number of factors, including discharge, sediment load, bed and bank material composition, local bed-elevation control (for example, bedrock, armoring), channel geometry, climate, tributary inflow, and vegetation. Considerable variation in the type and rate of channel degradation may occur even between sites located close together due to the variability of the controlling factors.

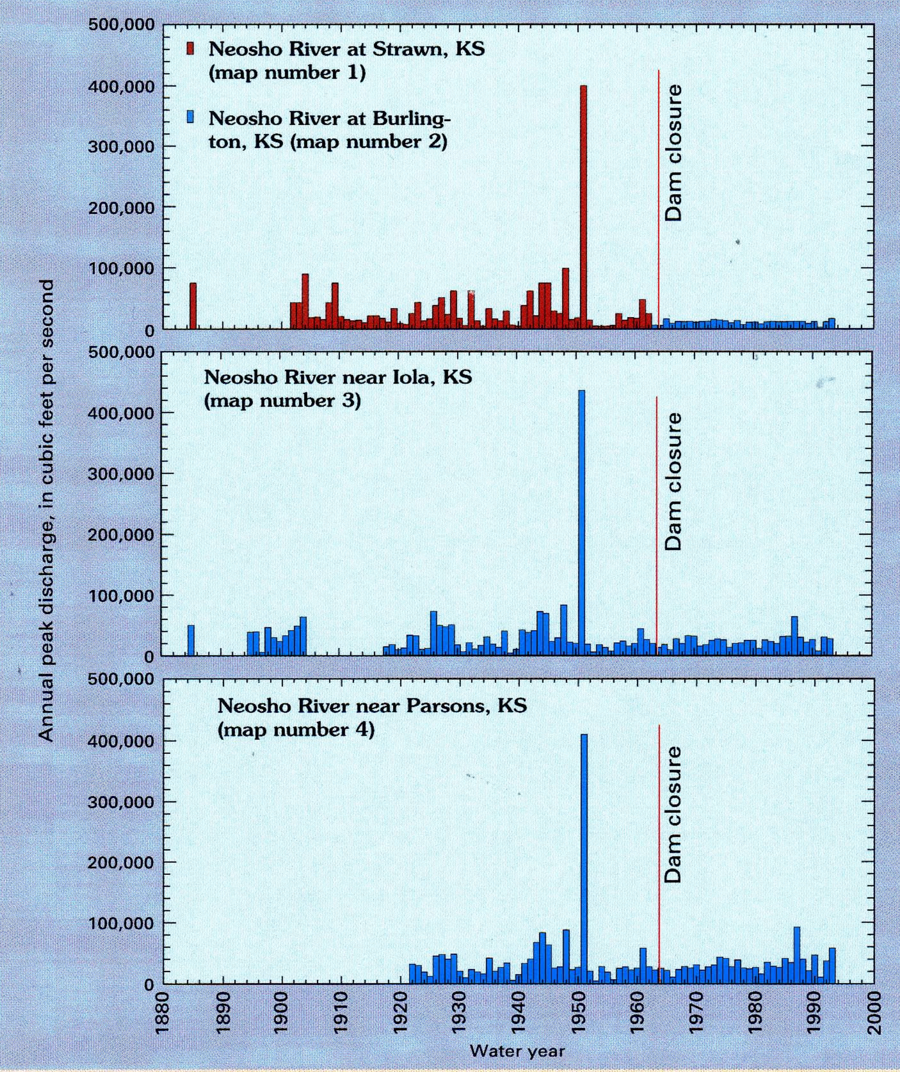


Figure 2. Annual peak discharges for U.S. Geological Survey streamflow-gaging stations downstream from John Redmond Dam. Location of stations shown in figure 1.

Table 1. U.S. Geological Survey (USGS) streamflow-gaging stations used in this study

Map number (fig. 1)	USGS station number	USGS station name	Distance downstream from John Redmond Dam (miles)	Drainage area (square miles)	Period of continuous record (water year)
1	07182400	Neosho River at Strawn, KS	--	3,015	1949–63
2	07182510	Neosho River at Burlington, KS	5.3	3,042	1963–present
3	07183000	Neosho River near Iola, KS	56.3	3,818	1918–present
4	07183500	Neosho River near Parsons, KS	139.6	4,905	1922–present

Table 2. River-reach locations and mean bankfull channel widths

River reach (fig. 1)	Distance downstream from dam (miles)	Mean bankfull channel width (feet) (percent change from previous time period)		
		Pre-dam	Construction	Post-dam
Le Roy	23–29	197	226 (+15)	233 (+3)
Iola	42–49	240	236 (-2)	259 (+10)
Humboldt	63–69	243	276 (+14)	266 (-4)
Erie	102–108	246	253 (+3)	269 (+6)
Oswego	146–152	233	256 (+10)	256 (0)

channel width. This may be due to the overwidened condition of the channel at these locations in response to the 1951 and other pre-dam floods.

The gaging-station analyses provided some indication of channel widening at Burlington in the years immediately following completion of John Redmond Dam in 1964. Results indicated an initial increase in channel width of about 10 to 20 feet, followed by apparent stabilization at this location. At Iola, channel width has not changed. However, an increase in flow velocity was indicated. The increase in velocity may be due to an increase in channel slope and (or) a decrease in channel roughness.

Together, the aerial-photograph and gaging-station analyses indicate that the overall downstream response of the Neosho River channel to John Redmond Dam has been minor. With one exception, the five river reaches indicated little if any post-dam change in channel width. However, the apparent initial widening of the channel at the Burlington gage shows that localized widening has occurred. Such localized widening is also evident in a series of six COE cross sections located successively at intervals of about 1 mile immediately downstream from the dam. The cross sections, surveyed in 1963, 1974, and 1983, indicate minor widening at one site (10 to 20 feet), moderate widening at one site (30 to 40 feet), and little if any change at the remaining four sites (Harry Hartwell, U.S. Army Corps of Engineers, written commun., 1995). Localized widening may or may not be directly related to the operation of John Redmond Dam.

The overall lack of a pronounced post-dam channel response may be attributable to several factors. First, there has been a substantial post-dam reduction in the magnitude of the annual peak discharges. A second factor is the strength of the bed and bank materials. Degradation of the channel bed has been limited due to the presence of bedrock and (or) coarse gravel, the latter of which would require large flows to transport. The channel banks consist mostly of cohesive silt and clay and are relatively resistant to erosion. Moreover, bank stability may be enhanced at some locations by partial to complete mature tree cover. Therefore, significant bank erosion (beyond site-specific occurrences) may only occur during large flows which have mostly been eliminated by the dam.

A third factor is the pre-dam condition of the channel. As indicated by the five river reaches, there is some indication of a pre-dam widening of the channel, possibly due in part to the 1951 flood. Thus, it is possible that the channel, at least in places, may have been in an overwidened condition at the time of dam construction. Thus, additional widening at such locations may be unlikely. In fact, there is some field evidence to indicate that a new lower flood plain may be forming within the confines of the original channel. Eventually, this may result in a narrowing of the channel.

The findings of this study suggest two possibilities. First, the Neosho River is a relatively stable system that may only change significantly in response to extreme events. Second, it may be that insufficient time has transpired for pronounced channel changes to become manifest. Local residents' perception of channel widening may be correct at specific locations. However, also likely are instances where normal channel migration has been mistaken for channel widening, especially where property (for example, cropland and structures) has been lost or is threatened.

Acknowledgments

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Ash Grove Cement Plant—Chanute, Kansas

The Ash Grove Cement Company is headquartered in Overland Park, Kansas, and operates 10 cement and lime plants in 9 states. The company has an annual production capacity of more than 4.6 million tons, making it the fourth largest cement manufacturer in the U.S. The cement plant in Chanute was erected in 1907 and had an annual production of 164,500 tons. Today the plant has an annual production capacity of 574,000 tons, accounting for just over one-fourth of the state's total production (in 1997, Kansas produced 1.9 million tons of cement).

Although Ash Grove's Chanute plant prodcues as many as eight types of cement, most of its production is Portland cement. Portland cement is the basic ingredient of concrete. It was first made early in the 19th century by Joseph Aspdin, an English bricklayer, who burned powdered limestone and clay in his kitchen stove. Portland cement is a predetermined and carefully proportioned combination of calcium, silicon, iron, and aluminum.

Making Portland Cement

At Chanute's Ash Grove Cement Plant, most of the chemical ingredients used in manufacturing the cement (such as calcium, silica, aluminum, and iron) are quarried on plant property. Rock, containing the chemicals, is blasted from the quarry face into loose piles and loaded by power shovels and front end loaders into 50 ton capacity dump trucks that transport the material over all-weather roads to the primary crusher (fig. 1).

The quarried stone, some larger than 3 feet in diameter, is fed through the huge gyratory crusher that extends 60 feet below ground level. The first crushing reduces the rock to a maximun size of about 6 inches. Then it is conveyed to the surface where a secondary impactor crusher reduces the size to about 3 inches or smaller. It is then conveyed to the giant storage building that contains separate bins for each raw material.

The next step in the process is proportioning the raw materials. Girder cranes with 5-cubic-yard buckets transfer raw materials from storage bins to proportioning bins where the limestone, shale, and sandstone are proportioned by weight. The raw materials, properly proportioned, are then fed onto a conveyor that carries them to a 2,000-horsepower ball mill. There the rock is pulverized and mixed with 33% water to form a slurry of thick cream consistency.

The slurry is pumped to one of eight blending tanks where it is kept homogenous by air and mechanical stirring. The chemical composition of each tank is recorded. By interblending the tanks, the precise chemical composition of the kiln-feed slurry can be established. Accurate formulating of the kiln-feed slurry is essential to maintaining cement uniformity.

The slurry is fed at a controlled rate into the upper end of two rotating kilns that are 450 feet long and 12 feet in diameter. The temperature inside the kilns reaches 2800° F. As the slurry moves down the slightly inclined kiln, certain elements are driven off in the form of gases. The remaining elements form a substance called clinker, which is discharged from the low end of the kilns on to horizontal grate coolers that cool it quickly to 150° F.

In the final step, clinker is conveyed (along with 4% gypsum) to finish mills for finish grinding. The gypsum is added to regulate the setting time of cement. The cement then passes through water-tube heat exchangers that reduce the heat generated during grinding. After cooling, the cement is air separated into desired fineness and pumped to storage.

Fuel Sources

A typical U.S. cement kiln needs the equivalent of 425 pounds of coal to make one ton of cement.In the past, Ash Grove relied on traditional fossil fuels like coal, coke, and natural gas. In recent years, the company has begun using flammable waste materials as a fuel. The Chanute plant has been using these waste-derived fuels under interim authority since 1986. In 1996, state and federal regulators issued a permanent permit to the Chanute plant. It was the first plant in the nation to receive such a permit.

Waste-burning kilns burn commercial and industrial wastes—such as printing ink, paint residues, cleaning solvents, industrial sludges—in addition to coal, oil, or natural gas. Many of these wastes are banned from landfills and must be incinerated anyway. Other cement plants in Kansas used waste-derived fuels in 1997: the Lafarge Corporation in Fredonia, and the RC Cement Company in Independence.

In fall 1999 Ash Grove Cement Co. will begin constructing a $158 million replacement for the Chanute plant. The new facility will triple current production (to 1.5 million tons), making it one of the nation's largest producers. Despite tripling the production capacity of the plant, Ash Grove will not increased the use of waste-derived fuel, partly because of a switch to a "dry" manufacturing process (versus the "wet" one outlined above), which burns fuel more efficiently.

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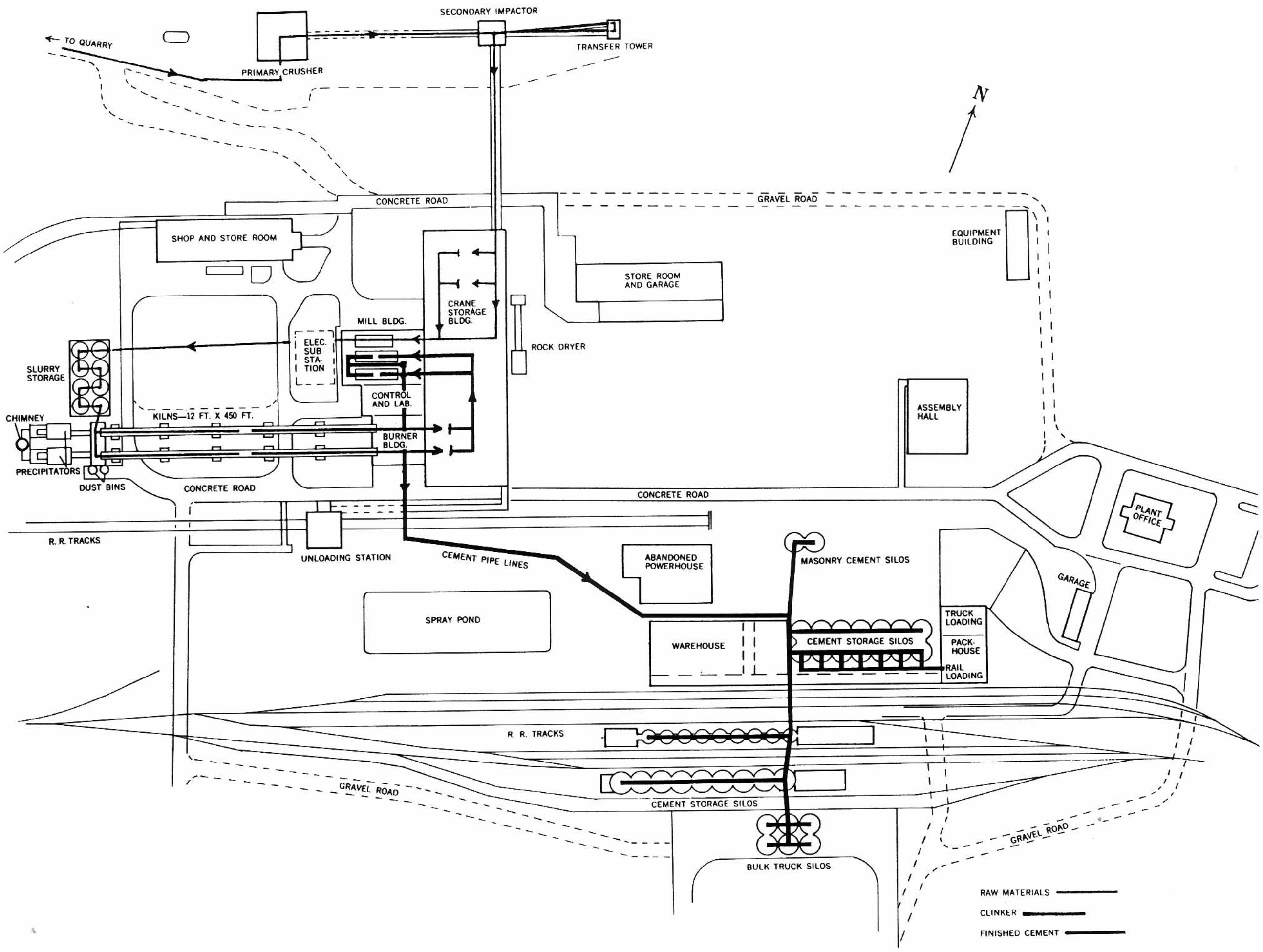
Chanute, Kansas Plant Plan and Material Flow



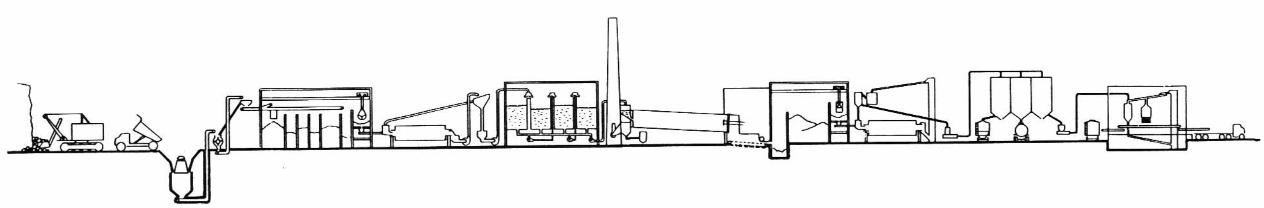


Figure 1. Schematic diagram of the Ash Grove Cement Plant, Chanute, Kansas.

Methane from Coal

Methane can be present in large amounts in certain coals. For years, methane has been considered a major problem in deep coal mines because of the potential for explosions. In recent years, utilization of the methane from coal has become important as a commercial gas source. In areas of the San Juan basin in New Mexico and Colorado and parts of the Warrior basin in Alabama, large amounts of methane are being developed from deep coal beds. Coal gas is now being exploited in other areas of thick coal-bearing rocks such as the Powder River basin in Wyoming and Montana. Kansas also has potential for additional production of gas from coal.

Coal contains gas in its matrix. Once the confining pressure on the coal is relieved (for example, by drilling), the gas is released from the coal, or desorbed. Coals begin to give up gas as soon as the confining pressure is lowered to a point equal to the hydrostatic pressure of the formation. Development of methane from coal can take several months because of the large quantities of water that need to be pumped from the coal bed to allow the methane to be desorbed from the coal. Gas migrates from the coal to the well bore along fractures, which provide the only permeability in coal.

Medium-volatile bituminous coal is the ideal rank for methane to be present in large quantities. High-volatile A bituminous coal that is present in southeastern Kansas and adjacent areas is slightly lower in rank, but has potential to release large quantities of methane. If sufficient overburden and a seal are present, such as a thick shale overlying the coal bed to prevent the gas from escaping, then methane of possible economic quantities may be present and potentially developed.

In areas where the coal is deeper than 500 feet, the coals probably retain a large amount of methane. Drilling and artificial fracturing of the thicker coal beds or multiple coal beds could produce significant amounts of the gas.

Methane from coal beds also exists in northeast Kansas where numerous coal beds are present.

By January 1993, at least 232 wells were completed for coalbed methane in Kansas (Stevens and Sheehy, 1993). Total completions to 1997 have more than doubled that figure. Most of the activity has been in southeastern Kansas, primarily Montgomery, Wilson, western Labette, and eastern Chautauqua counties. Good potential for economic development exists in these areas. Important coals for methane in these counties include the Weir-Pittsburg, Riverton, and Mulky coals.

Important to early coalbed methane development in Kansas was a federal tax credit for developing this unconventional gas source.

Stroud Oil Properties, Inc.

One of the best documented coal gas projects is Stroud Oil Properties' Sycamore Valley field, which began producing methane from the Riverton and Weir-Pittsburg coal seams in October 1989. Stroud's leases and wells are located two miles southwest of Sycamore, Kansas, which is six miles north of Independence, Kansas. Most of the wells are about 1,100 feet deep. As of February 1993, the field was producing nearly 800 thousand cubic feet of gas per day (MCFGD) from 13 wells, for an average rate of 65 MCFGD per well. Today, 15 wells produce about 330 MCFGD, and there is one water disposal well.

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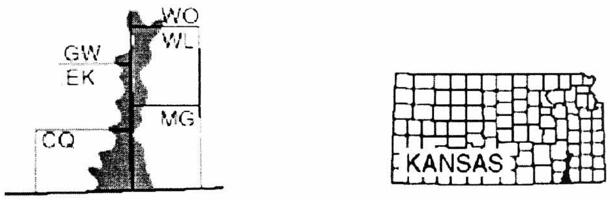
Chautauqua Hills

The Chautauqua Hills are a sandstone-capped rolling upland that extends into the Osage Cuestas from the southern Kansas border. Approximately 10 miles wide, these hills extend as far north as Yates Center in Woodson County. Small patches of similar terrain can be found as far north as Leavenworth County.



Extent of the Chautauqua Hills in Kansas.

The Chautauqua Hills are characterized by thick sandstone units. During the Pennsylvanian Period, about 290 million to 320 million years ago, rivers and streams flowed into the sea in this area. These rivers and streams carried sand and other sediments that collected in the estuaries and at the mouths of the rivers in deltas. Eventually the seas dried up and the sediments were buried and compacted—the sands became sandstone and the muds became shale. Over millions of years, uplift and erosion exposed the sandstone and shale at the earth's surface. Further erosion has dissected the area into a series of low hills, capped by more resistant sandstone.

The sandstones capping the Chautauqua Hills are the Tonganoxie Sandstone Member of the Stranger Formation and Ireland Sandstone Member of the Lawrence Formation. Both are thick rock formations—the Tonganoxie is more than 140 feet and the Ireland as much as 160 feet thick.

The Ireland is an important aquifer in Elk County, where many rural areas rely on ground water. Although apparently solid, sandstone has abundant microscopic pore space between the rock particles. This makes it a good medium for the accumulation and pumping of water. Near Busby in northeastern Elk County (which lies near the boundary between the Chautauqua Hills and the Osage Cuestas), the Ireland is sandwiched between two layers of impervious shale, increasing the pressure in the aquifer. In some places, the water is forced to the surface in artesian wells.

Because of rock outcrops in this region, the hills are generally not cultivated but are used instead for pasture. The Verdigris, Fall, and Elk rivers cross the area in narrow valleys walled by sandstone bluffs. Topographic relief in the region is never more than 250 feet.

Many of the hills are covered by stands of black jack oaks, scrub oaks, and other hardwood species. This mix of medium-tall grasslands and scattered stands of deciduous trees is called the Cross Timbers by scientists who map vegetation. In Kansas, the extent of the Cross Timbers is almost identical to the extent of the Chautauqua Hills physiographic region.

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SCHEDULE & ITINERARY

Friday June 18, 1999

7:00 am	Breakfast
8:00 am	Bus to Site 10
9:15 am	**SITE 10** - Tar Creek Collapse - near Treece, Kansas *Jim McCauley*, Kansas Geological Survey
9:45 am	Bus to Site 11
10:00 am	**SITE 11** - Lead and Zinc Mining - Treece, KS and Pitcher, OK
10:05 am	Bus to Site 12
10:30 am	**SITE 12** - Schermerhorn Cave and Park - Ozark Plateau
11:00 am	Bus to Site 13
11:15 am	**SITE 13** - Hell's Half Acre - Galena, Kansas *Larry Knoche,* Director, Bureau of Environmental Remediation, KDHE *Dave Drake,* U.S. Environmental Protection Agency
12:00 pm	Bus to Pittsburg
12:35 pm	**Arrive Holiday Inn Express, Pittsburg**

Lead and Zinc Mining in Kansas

The discovery of blackjack (a dark variety of the mineral sphalerite) on the Cook Forty in Galena in 1870 marked the beginning of a century of lead and zinc mining in the Kansas part of the Tri-State mining district. The Tri-State mining district of southwestern Missouri, southeastern Kansas, and northeastern Oklahoma was one of the major lead and zinc mining areas in the world (fig. 1). For one hundred years (1850–1950), the district produced 50 percent of the zinc and ten percent of the lead in the United States.

The first commercial ore discovery in the district was made in southwest Missouri around 1838. Production from the Tri-State district peaked between 1918 and 1941. During the 1920's more than 11,000 miners worked in the area, and perhaps three times as many were involved in support work and industries.

During the life of the district, more than 4,000 mines produced 23 million tons of zinc concentrates and four million tons of lead concentrates. The Kansas part of the Tri-State district produced more than 2.9 million tons of zinc, with an estimated value of 436 million dollars, and 650,000 tons of lead worth nearly 91 million dollars.

In general, mining was done underground, using room-and-pillar methods. However, because ore bodies occurred near the surface in the eastern part of the district, some mining companies tried open-cut mining methods, especially in the Galena area and in Missouri. Many of the rock layers that were mined for ore were also aquifers, or water-bearing formations. Thus, water often came into the mines through these rock layers. To keep the mines from filling with water, as many as 63 pumping plants operated 24 hours a day to remove huge amounts of water. For example, in 1947, more than 36 million gallons of water were pumped from the mines every day (this is enough to cover one acre of ground with water 110 feet deep).

After World War II, production in the Tri-State mining district gradually declined. In 1970 the last active mine, the Swalley Mine located two miles west of Baxter Springs, Kansas, shut down due to environmental and economic problems.

Lead and zinc mining left behind a number of physical hazards. In the early 1980's, the U.S. Bureau of Mines, in cooperation with state geological surveys, conducted detailed studies of the physical hazards

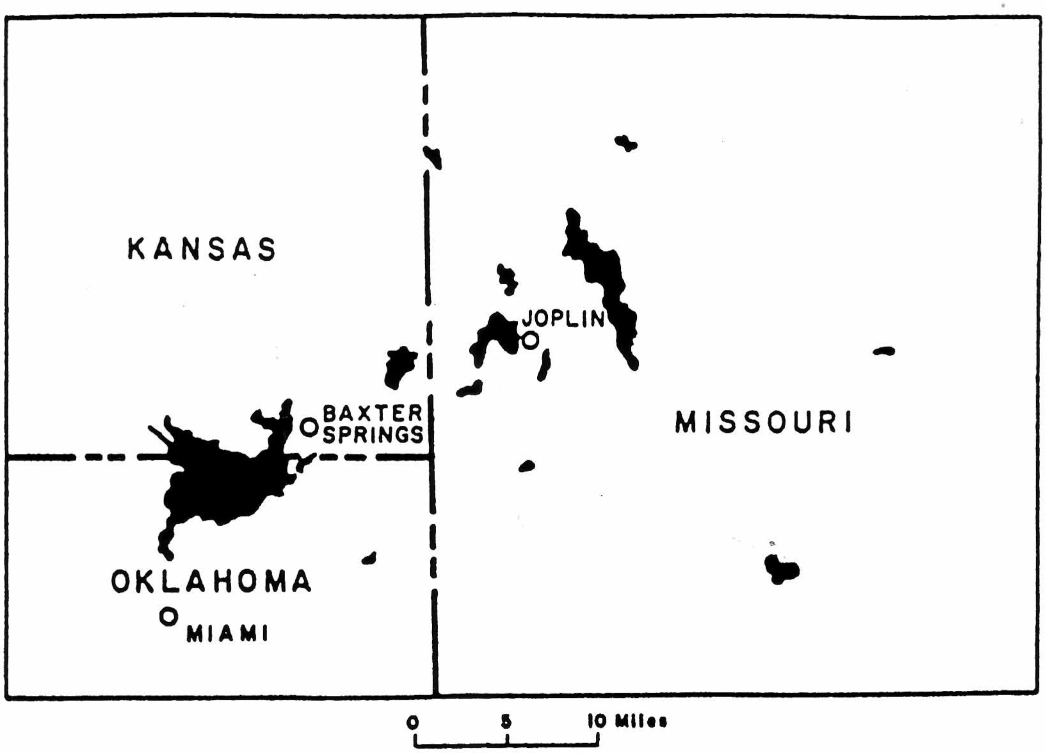

Figure 1. Major lead and zinc mines of the Tri-State mining district (from Brockie et al., 1968).

associated with the old mining areas. These studies identified more than 1,500 open mine shafts and nearly 500 subsidence collapse features in the Tri-State.

The hundred years of mining also left the region with serious environmental problems. When the mines closed, the pumping stopped, and the abandoned tunnels filled with water. The water in these tunnels became contaminated by iron sulfide (or pyrite) that remained in the mine walls or was left behind by the miners, as well as by other metallic sulfides found in the mines. In addition to becoming very acidic, the water contained dissolved metals, some of which are very toxic. This water in turn contaminated local ground water, springs, and surface water.

Then there were the mine tailings and chat that covered 4,000 acres in Cherokee County alone. Ore production consisted of crushing and grinding the rock to standard sizes and separating the ore. Depending on the separation process used, wastes were either the size of fine gravel (chat) or the size of sand and silt (tailings). These wastes contaminated more than the soil around them. Lead, zinc, and cadmium from the mine tailings also leached into the shallow ground water, contaminating local wells. Runoff from the waste piles also moved contaminants into nearby streams and rivers. Radon gas from the mining operations was detected in the air around Galena. During the 1980's, this area was considered one of the most environmentally blighted in the nation.

Some of the cleanup efforts are funded by the U.S. Environmental Protection Agency's Superfund. The EPA has divided the Cherokee County Site into six subsites that correspond to six general mining locations, including the areas around Treece, Baxter Springs, and Galena.

Treece Area and Tar Creek

In the Treece area, a total of 97 mine hazards were found, 79 of which were open shafts. The largest collapse in this area occurs along the course of Tar Creek. This collapse is 230 feet by 430 feet and is about 60 feet deep. To reduce contamination of Tar Creek with acid mine wastes, levees were constructed to divert the creek away from this collapse. Across the state line, near Picher, Oklahoma, iron sulfide-contaminated waters pour into Tar Creek, leaving a rust-colored stain.

The EPA started investigating soil and water pollution in the Treece area in 1988. The investigation was completed in 1994, and a remedy was selected in August 1997. Remedy implementation is estimated to begin later in 1999.

Galena Subsite

Cleanup work is further along at Galena than at other sites. In 1989 the EPA, with the agreement of the State of Kansas, outlined a series of remedies to reduce ground- and surface-water contamination. These included (1) selectively moving and placing mine wastes in areas away from surface water bodies, (2) capping wastes with less impacted materials followed by revegetation, (3) diverting surface streams away from the contaminants, (4) recontouring the land surface to control runoff and erosion, and (5) investigating deep aquifer wells. These remedies were completed in late 1994. The EPA has also taken action to clean up contaminated soil in Galena by excavation and disposal of contaminated soils followed by replacement with clean backfill and grass sod or seed. Nearly 700 residences were remediated by December 1998.

A total of 599 mine hazards were found in the Galena area. An area in Galena known as "Hell's Half Acre" was a moonscape of rubble piles, collapsed mines, and open mine shafts. In 1994 and 1995, the EPA and local citizens filled in all the mine collapses and shafts in the town of Galena. New top soil was hauled in to cover the chat and boulders in the area.

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Ozark Plateau

As its name suggests, this corner of southeastern Kansas is part of the Ozarks of Missouri, Oklahoma, and Arkansas. Bounded by the Spring River on the west, the Ozark Plateau covers about 55 square miles and includes the towns of Baxter Springs and Galena. This region contains the oldest surface rocks in the state, limestones that formed about 345 million years ago during the later part of the Mississippian Period.

These rocks show that during the late Mississippian, the land was alternately above and below sea level. When the sea advanced, limestones (and occasionally shales) were deposited. When the sea retreated, erosion set in.

The Mississipian limestones contain chert (or flint). Because chert is much harder and more resistant to weathering than limestone, erosion of the softer limestone has left a thick blanket of chert gravel on the hilltops and ridges. Economically, these Mississippian limestones were very important because they contained valuable lead and zinc ores.

The thin and rocky soil of the region, combined with steep slopes, makes most of the region unsuitable for farming. Cropland is restricted to the valley floors of Shoal Creek and Spring River. Many of the hillsides are covered with hardwood forests, predominantly oaks and hickories, along with other trees, shrubs, and vines. Some of the vegetation, such as sassafras trees and mistletoe, is not found anywhere else in the state.

Like the rest of southeast Kansas, the Ozark Plateau averages more than 40 inches of precipitation a year, making it one of the wettest places in the state. Water also affects the landscape of the reigon. Percolating through the joints and fractures of the Mississipian limestones, water creates caves and feeds seeps and springs, which in turn drain into clear streams that flow over gravel-beds in steep-walled valleys. These stream valleys produce the region's topographic relief. The region's highest point (with an elevation of 1,040 ft) is located just a few miles east of one of the lowest points along the Spring River (elevation 770 ft).

Schermerhorn Park

Probably the best place to see the Mississippian limestones of the Ozark Plateau is Schermerhorn Park, located about one mile south of Galena on the east side of Kansas Highway 26. Shoal Creek, one of the major tributaries to the Spring River, flows through the park. This spring-fed, Ozarkian stream has been the major force shaping the basin, producing the physiographic features so common to the Ozark region—rolling hills and steep river bluffs. The park sits at the west end of a tall limestone bluff on the north side of the river.

Throughout the history of the region, Schermerhorn has been a popular gathering place for picnicking, swimming, and fishing. At various times during its history, particularly during active lead and zinc mining, the park would receive heavy use and attract people from all around the Tri-State area. Still evident are many structures built during the first part of this century by the Civilian Conservation Corps (CCC). Picnic shelters, rest rooms, and a dance pavilion are reminders of past popularity. The park is now managed by the City of Galena.

Among the numerous caves carved into the region's Mississippian limestone is Schermerhorn Cave, located within the park. The spring that issues from the cave is home to the Dark-sided Salamander (*Eurycea longicauda melanopleura*), Cave Salamander (*Eurycea lucifiga*), Graybelly Salamander (*Eurycea multiplicata griseogaster*), and the Grotto Salamander (*Typhlotriton spelaeus*).

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