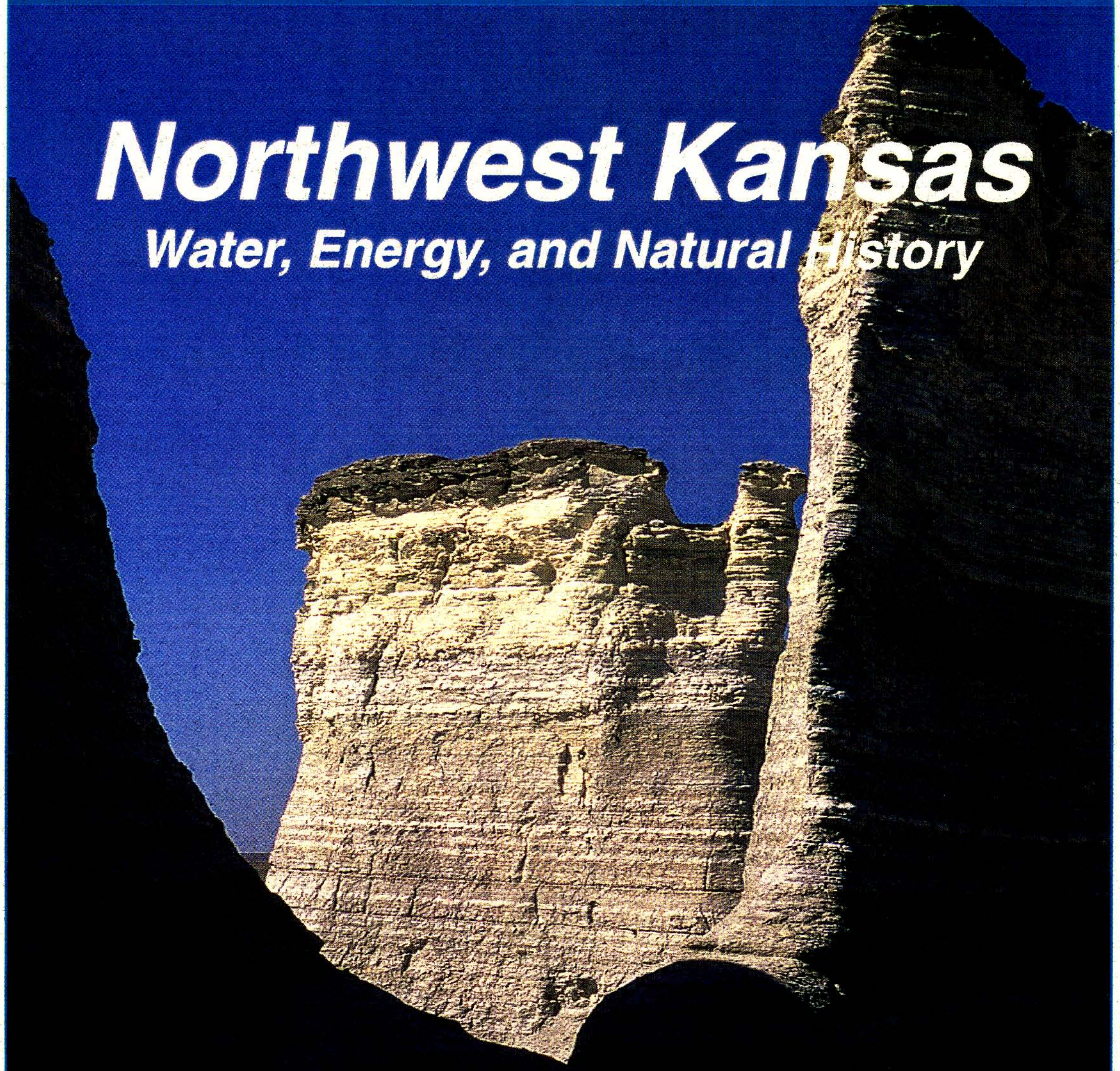
Kansas Field Conference

Northwest Kansas

Water, Energy, and Natural History



2001
FIELD CONFERENCE

June 13–15, 2001

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

KANSAS FIELD CONFERENCE

FIELD GUIDE

2001 FIELD CONFERENCE

Northwest Kansas

Water, Energy, and Natural History

June 13-15, 2001

Edited by

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KANSAS FIELD CONFERENCE

Northwest Kansas

Water, Energy, and Natural History

2001 FIELD CONFERENCE

June 13-15, 2001

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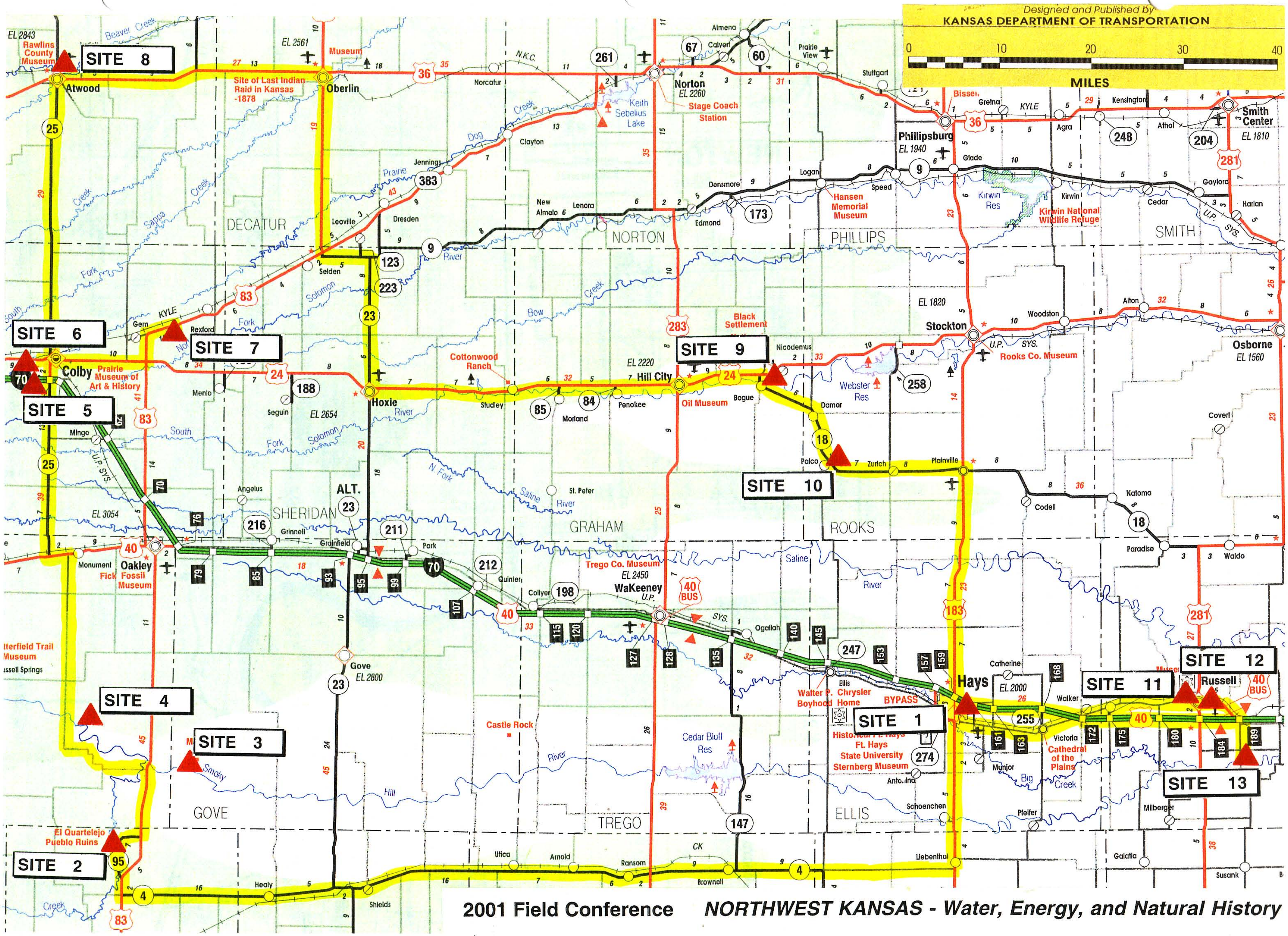

2001 Field Conference NORTHWEST KANSAS - Water, Energy, and Natural History

Northwest Kansas

Water, Energy, and Natural History

2001 FIELD CONFERENCE

June 13–15, 2001

PARTICIPANTS LIST

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Jack Walker	Northwest Kansas Regional Representative	KESTA (Kansas Earth Science Teachers Association)	1785 Rd. 69 Goodland, KS 67735 785/899-3890

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Shari Weber	Representative 68th District	Kansas House of Representatives, House Majority Leader	934 Union Road Herington, KS 67449 785/258-3526

BIOGRAPHICAL INFORMATION

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Affiliation
Kansas Department of Agriculture
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Current Responsibilities
Secretary of Agriculture.
Experience
Appointed Secretary in August 1999; 3 years as Legislative Liaison for agriculture, environment, natural resource and water issues; Vice-President for Government Affairs, Kansas Grain & Feed Association and the Kansas Fertilizer & Chemical Asssociation; Director of Environmental & Labor Affairs, American Feed Industry Association; research analyst at U.S. Chamber of Commerce, natural resource policy section.
Education
University of Michigan – BGS, 1985
Georgetown University – MPP, 1992

Joseph Aistrup
Title
Director
Affiliation
Docking Institute of Public Affairs, Fort Hays State University
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Current Responsibilities
Director of Docking Institute, Professor of Political Science, FHSU.
Education
Indiana University – Ph.D. 1989

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Northwest Kansas Groundwater Management District 4
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Current Responsibilities
Manager, Northwest Kansas GMD 4.
Experience
Oklahoma Water Resources Board, Groundwater Division.
Education
Oklahoma University – BS, 1975

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Kansas Department of Health & Environment
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Current Responsibilities
Manage environmnetal staff and resources for KDHE Northwest District Office in Hays.
Experience
Oil & gas exploration and production; Environmental consulting; Solid waste management.
Education
University of Kansas – BS, 1975
University of Wyoming – MS, 1977

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Assistant Director
Affiliation
State Conservation Commission
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Current Responsibilities
Assist in policy development for the agency's conservation programs and establish priorities for expenditure of conservation program funds.
Experience
NPS Program Manger; Conservation District Program Coordinator; former rancher.

Education

Fort Hays State University – BS, 1979
University of Kansas – MPA, 2001

Stan Clark

Title

Senator, 40^{th} District

Affiliation

Kansas Senate

Address and Telephone

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Current Responsibilities

Chair, Kansas Senate Utilities Committee; Member, Assessment & Taxation, Rules & Regulation, and Elections & Local Government Committees.

Experience

Photographer; farmer.

Education

Oakley High School - 1973
Colby Community College – AA, 1975

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Title

Chair

Affiliation

Kansas Geological Survey Advisory Council

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Current Responsibilities

Farming.

Experience

Publisher, Pittsburg Morning Sun, 23 years.

Education

University of Kansas – BS, 1964

Mary Compton

Title

Representative, 13^{th} District

Affiliation

Kansas House of Representatives

Address and Telephone

Route 3, Box 242
Fredonia, KS 66736
620/633-5364

Current Responsibilities

Utilities, Agriculture, Transportation, and New Economy Committees.

Experience

Retired Paraprofessional, Fredonia Elementary School (USD 484).

Education

Fredonia High School – 1951

Eric Depperschmidt

Title

Constituent Representative

Affiliation

Congressman Jerry Moran

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Current Responsibilities

Constituent Representative, Congressman Jerry Moran.

Christine Downey

Title

Senator

Affiliation

Kansas Senate

Address and Telephone

10320 N. Wheat State
Inman, KS 67546

Current Responsibilities

Ranking Minority Member, Education and Agriculture Committees; Member, Ways & Means and Natural Resources Committees.

Experience

Elementary School Teacher, 20 years; Adjunct Professor, Department of Education, Bethel College.

Education

Wichita State University – BS, 1980
Wichita State University – M.Ed., 1986

Hank Ernst

Title

Environmental Scientist IV

Affiliation

Kansas Water Office

Address and Telephone

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hernst@kwo.state.ks.us

Current Responsibilities

Information and Education Coordinator, State Water Plan; Editor of HydroGram; Basin Planner, Upper Republican River Basin.

Experience

Editor, Kansas Farmer magazine (1982–1999); Managing Editor, Missouri Ruralist (1978–1982); Associate Editor, Missouri Ruralist (1970–1978); Reporter, Booneville Daily News.

Education

University of Missouri – BS, 1968

Vaughn L. Flora

Title

Representative, 57th District

Affiliation

Kansas House of Representatives

Address and Telephone

431 SE Woodland Ave.
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Current Responsibilities

Agriculture, Environment, Taxation Committees.

Experience

President, Non-profit Affordable Housing Corp.; CEO Topeka City Homes; Farmer.

Education

Kansas State University – BS, 1963

Raney Gilliland

Title

Principal Analyst

Affiliation

Kansas Legislative Research Department

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Current Responsibilities

Staff for Legislative Committees: House and Senate Agriculture Committees; House Environment Committee; and Senate Natural Resources, Utilities, and Rules & Regulations Committees.

Experience

Legislative Research, 20 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
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Current Responsibilities

State Representative

Education

Labette Community College – AA, 1971
Pittsburg State University

John Harsch

Title

Section Chief

Affiliation

Kansas Department of Health & Environment

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Current Responsibilities

Section Chief for the Livestock Waste Management Section, KDHE.

Experience

KDHE, 3 years; Osage County Conservation District, 5 years; Farmer.

Education

Emporia State University – 1993

David Heinemann

Title

Special Assistant to the Secretary

Affiliation

Kansas Department of Revenue

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915 SW Harrison
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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 – 1967–1968
Washburn Law School – JD, 1973

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Representative, 125th District
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Current Responsibilities
Chairman, Utilities and Fiscal Oversight Committees; Member, Agriculture, Natural Resources, and Rules & Regulations Committees; Farm/Ranch owner and manager.
Experience
Chairman, House Energy & Natural Resources Committee; President, Kansas League of Municipalities.
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
785/296-7698
jhutchins@holtonks.net
Current Responsibilities
Vice Chair, Federal & State Affairs Committee; Member, Environment, Agriculture, and Taxation Committees.
Experience
Second term in Kansas House of Representatives, 50th District.
Education
Washburn University – BA, 1985

Dan Johnson
Title
Representative, 110th District
Affiliation
Kansas House of Representatives
Address and Telephone
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Hays, KS 67601
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Current Responsibilities
Owner/Operator, Johnson Ranch; 3rd term, House of Representatives; 5th year Member, Environment Committee; 2nd year Chair, Agriculture Committee; Member, Board of Directors, Trego County Rural Water District No. 2.
Experience
Instructor, Fort Hays State University, 1961–1969; 15 years sales of automotive test equipment; 23 years, Kansas Army National Guard (Retired Lt. Colonel).
Education
Fort Hays State University –BS, 1958
Fort Hays State University – MS, 1968

Annie Kuether
Title
Representative, 55th District
Affiliation
Kansas House of Representatives
Address and Telephone
1346 SW Wayne Ave
Topeka, KS 66604
785/296-7669
Current Responsibilities
Member, Utilities and Higher Education Committees; Ranking Democrat Member, New Economy Committee; Member, Budget Committee on Government and Human Resources.
Experience
Administrative Assistant to Kathleen Sebelius, 4 years.
Education
Bowling Green State University

Wayne Lebsack
Title
Trustee / President
Affiliation
The Nature Conservancy/Lebsack Oil Production Inc.
Address and Telephone
603 S. Douglas
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Current Responsibilities
Trustee, TNC; Direct and manage oil and gas exploration and development.
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

901 S. Kansas Ave.
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al@kwo.state.ks.us

Current Responsibilities

Plan, market, develop, implement, and evaluate policies/programs for current and future water needs.

Experience

Senior Government Affairs Liaison, Gov. Graves; Administrative Assistant to Majority Leader, KS Senate, Lt. Gov. Frahm; Legislative Liaison and Agricultural Advisor, Gov. Hayden; Administrative Assistant to Majority 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

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Current Responsibilities

Assistant Minority Leader, Kansas Senate; Ranking Minority Member, Natural Resources Committee; Member Utilities Committee.

Experience

Involved in family ranching and farming operation; USD #238 Board of Education.

Education

Kansas State University – BS, 1970

Margaret Long

Title

Representative, 38th District

Affiliation

Kansas House of Representatives

Address and Telephone

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Current Responsibilities

Member, Utilities Committee.

Experience

Administrative Accountant.

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Title

Senior Manager, Biology & Conservation

Affiliation

Western Resources

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Current Responsibilities

Manager, Biology and Conservation Programs for Western Resources; Chair, Green Team; KACEE President; Chair of Topeka Chapter DU.

Experience

1985–1997, Manager, Environmental Management at Wolf Creek Generating Station; Green Team Steering Committee since 1991.

Education

Ohio State University – BS, 1981
University of Kansas – MS, 1985

Laura McClure

Title

Representative, 119th District

Affiliation

Kansas House of Representatives

Address and Telephone

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Current Responsibilities

Environment, Utilities Committees

Experience

School Bus Driver; Bookkeeper; Managed low-income and senior housing; Owner/operator flower and antiques shop; Grassroots Lobbyist.

Education

Mankato High School – 1968

Gene O'Brien

Title

Representative, 7th District

Affiliation

Kansas House of Representatives

Address and Telephone

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Current Responsibilities
Utilities Committee

David Pope

Title
Chief Engineer

Affiliation
Division of Water Resources, Kansas Department of Agriculture

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Current Responsibilities
Administration of laws related to conservation, management, use, and control of water and water-courses in Kansas.

Experience
Assistant Chief Engineer, DWR, 5 years; Manager, Southwest Kansas GMD 3, 3 years; Extension Irrigation Engineer, Cooperative Extension Service, 5 years.

Education
Oklahoma State University – BS, 1970
Oklahoma State University – MS, 1971

Scott Ross

Title
Water Commissioner

Affiliation
Division of Water Resources, Kansas Department of Agriculture

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Current Responsibilities
Water Commission for Division of Water Resources' Stockton Field Office regarding water rights for NW Kansas; Republican River Compact Engineering Committee.

Experience
Worked for U.S. Fish & Wildlife Service and Bureau of Reclamation before coming to DWR in 1981.

Education
Ft Hays State University – BS, 1977

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Title
Senator, 15th District

Affiliation
Kansas Senate

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Current Responsibilities
Chair, Agriculture Committee.

Experience
Special Counsel to the Governor; Assistant Attorney General.

Education
University of Kansas – BSJ, 1990
Leicester University (U.K.) – MA, 1992
Georgetown University – JD, 1996

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Affiliation
Kansas House of Representatives

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Current Responsibilities
Agriculture, Environment, Appropriations Committees.

Education
High School – 1958

Sharon Steele

Title
Member

Affiliation
Kansas Water Authority

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Current Responsibilities
Colby Tree Board; Chair, Colby Wellhead Protection/ Source Water Assessment Committee; Kansas Water Authority, LEP Funding Committee.

Experience
Chair, GMD 4 Board; Colby City Planning Commission; Colby United Methodist Church Building Committee; Community College Math Teacher.

Education
Kansas University – BA, 1957

Susan Stover

Title

Environmental Scientist IV

Affiliation

Kansas Water Office

Address and Telephone

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sstover@kwo.state.ks.us

Current Responsibilities

Planner for Upper and Lower Arkansas Basins, Cimarron Basin; Developing long-term management strategy for the Ogallala aquifer.

Experience

Bureau of Environmental Remediation, Kansas Department of Health & Environment; Cleveland Museum of Natural History.

Education

University of Nebraska – BA, 1979
University of Arizona, Louisiana State University
University of Kansas – MS, 1992

John Strickler

Title

Executive Committee Member

Affiliation

KACEE (Kansas Association for Conservation and Environmental Education)

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Current Responsibilities

Executive Committee Member, KACEE; Board of Trustees, The Nature Conservancy; Kansas Geological Survey GSAC.

Experience

Former Executive Director, KACEE; 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, KSU, 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

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Current Responsibilities

Legislative staff; drafting legislation; and legal advisor.

Experience

Revisor of Statutes Office, 27 years.

Education

University of Kansas – BA, 1971
University of Kansas – JD, 1974

Jim Triplett

Title

Chair

Affiliation

Biology Department, Pittsburg State University

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Pittsburg, KS 66762
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Current Responsibilities

Chair, Biology Department; Chair, Neosho Basin Advisory Committee; Chair, Statewide Council of Basin Advisory Committee.

Experience

Assistant Professor, PSU; Assistant Professor, Ohio State University, 5 years; Officer, U.S. Navy, 1968–1971.

Education

Kansas State College of Pittsburg – BA, 1966
Kansas State College of Pittsburg – MS, 1968
University of Kansas – PhD, 1976

Jack Walker

Title

Northwest Kansas Regional Representative

Affiliation

KESTA (Kansas Earth Science Teachers Association)

Address and Telephone

1785 Rd. 69
Goodland, KS 67735
785/899-3890

Current Responsibilities

Instructor at Goodland High School.

Experience

Farmer, School teacher.

Education

Hutchinson Community College – AA, 1961
Fort Hays State University – BS, 1966
Emporia State University – MS, 1975

Sid Warner
Title
Managing General Partner
Affiliation
Warner Ranches, L.P.
Address and Telephone
P.O. Box 309
13745 16 Road
Cimarron, KS 67835
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Current Responsibilities
Managing General Partner of Warner Ranches, L.P.
Experience
Farming; Ranching; Insurance; Commercial cattle feeding; Kansas Board of Regents.
Education
Kansas State University – BS, 1956

Sharon Weber
Title
Representative, 68th District
Affiliation
Kansas House of Representatives
Address and Telephone
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Herrington, KS 67449
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Current Responsibilities
Majority Leader, Kansas House of Representatives
Education
St. John's College & Academy
Moorehead State University

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Director and State Geologist
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Kansas Geological Survey
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Current Responsibilities
Director of administration and geologic research
Experience
Kansas Geological Survey, 2 years; Director and State Geologist, Utah Geological Survey, 10 years; Western Earth Science Technologies, Inc., 6 years; University of Utah Research Institute, 3 years; SOHIO, 3 years
Education
University of California, Riverside – BA, 1970
San Diego State University – MS, 1974
University of Massachusetts – PhD, 1986

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Associate Director
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Public Outreach, Kansas Geological Survey
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Current Responsibilities
Supervise publication and public outreach activities, media relations, and non-technical communications.
Experience
Kansas Geological Survey, 23 years; 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, 1982

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Current Responsibilities
Editor, Current Research bulletin; Editor and Writer, Geology Extension; Manager, GeoKansas website
Experience
Kansas Geological Survey, 6 years; Paleontological Institute, KU, 10 years
Education
University of Kansas – BA, 1980
University of Kansas – MA, 1985

Martin Dubois

Title

Research Geologist

Affiliation

Kansas Geological Survey

Address and Telephone

1930 Constant Ave.
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Lawrence, KS 66049
785/864-2178

Current Responsibilities

Geological research for the CO_2 enhanced oil recovery project, Central KS; Hugoton project, SW KS; and Gemini and MidCarb projects.

Experience

Kansas Geological Survey, 2 years; Exploration Manager, John O. Farmer, Inc., Russell, KS, 8 years; Consulting Geologist, Winfield, KS, 12 years; Cities Service Oil Co., 3 years.

Education

Kansas State University – BS, 1974
University of Kansas – MS, 1980

Bill Harrison

Title

Deputy Director and Chief Geologist

Affiliation

Kansas Geological Survey

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1930 Constant Ave.
Campus West
Lawrence, KS 66049
785/864-2070

Current Responsibilities

Plan and initiate major research programs; Assess scientific quality of current programs.

Experience

Kansas Geological Survey, 4 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

Jim McCauley

Title

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Affiliation

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Current Responsibilities

Geologic mapping, remote sensing, and public inquiries.

Experience

Kansas Geological Survey, 25 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

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Research Associate

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Current Responsibilities

Geology Extension, Kansas Field Conference, geologic mapping.

Experience

Kansas Geological Survey, 9 years; Petroleum Geology, 15 years; Engineering Geology, 6 years.

Education

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

Northwest Kansas

Water, Energy, and Natural History

2001 FIELD CONFERENCE

June 13-15, 2001

Welcome to the 2001 Field Conference, co-sponsored by the Kansas Geological Survey, the Kansas Department of Agriculture, the Kansas Water Office, and the Kansas Department of Health and Environment. Previous field conferences have focused on specific natural-resource issues, such as water or energy, or specific regions. This year the field conference moves to northwestern Kansas.

Northwestern Kansas faces a variety of natural resource issues. Many of those are related to the geology and climate of the area. During this year's field conference, we'll spend most of our time in two of the state's physiographic regions: the Smoky Hills and the High Plains. Much of the trip's first day will be spent in the Smoky Hills, where most of the bedrock was deposited in the Cretaceous Period of geologic history, about 80 to 100 million years ago. The Cretaceous rocks we'll see include shales, limestones, and especially chalks (a form of limestone) that were laid down by a shallow sea. Then we'll move onto the High Plains, where most of the rocks were deposited much more recently as they washed off the face of the Rocky Mountains and onto the plains of western Kansas. The uplift of the Rockies affected western Kansas, raising its elevation to more than 4,000 feet in some places.

The geology is not the only thing that is different about this corner of the state. This area receives, in an average year, less than 20 inches of precipitation. Because this part of Kansas is higher in elevation and is to the north, this area also experiences some of the state's coldest temperatures and has a relatively short growing season. With the lack of surface water and lack of precipitation, ground water is an all-important resource in this part of the state. We'll examine several of the issues related to ground water, particularly the role of the Northwestern Kansas Groundwater Management District and its programs.

Surface-water issues are prominent in parts of northwestern Kansas. Several of the state's major rivers get their start, or drain, this part of the state. The Smoky Hill River picks up considerable water as it moves through western Kansas, before eventually flowing into the Kansas River. The South Fork of the Republican River cuts across Cheyenne County in northwestern Kansas before moving into Nebraska. Other tributaries of the Republican cut across northwestern Kansas before dumping into the Republican in Nebraska. These rivers and streams raise issues that we'll discuss, including surface-water-quality regulation and the Republican River compact between Kansas and Nebraska.

This area is famous for its fossils. The chalk beds of the Niobrara Formation contain well-preserved specimens of both vertebrate and invertebrate animals. Fossil remains of sharks, turtles, fish, pterosaurs, mosasaurs, plesiosaurs, birds, and other animals are on display at museums throughout the world, but particularly good examples can be seen at the new Sternberg Museum of Natural History in Hays. Erosion has created unusual shapes and spires throughout the chalk beds, and we'll see some at Monument Rocks. Much of this rugged topography has been left uncultivated, in short-grass prairie, and we'll see an excellent example of that ground at the Smoky Valley Ranch.

Finally, this part of Kansas has long been crucial in oil and gas production. Ellis and Russell counties traditionally lead the state in oil production. Continuing that production, however, requires innovative techniques of petroleum exploration and production. We'll learn more about one particularly promising technique and the way it is being developed in Russell.

About the Kansas Field Conference

The 2001 Field Conference is the seventh in a series of the Survey's award-winning annual field conferences. The purpose of the Field Conference is to provide first-hand, on-site experience on natural-resource issues to the state's decision makers. Local and regional experts in resources 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 natural resources and related social, economic, and environmental issues in Kansas. 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 natural 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. The KGS employs about 70 full-time staff members and about 80 students and grant-funded staff. It is administratively divided into research and research-support sections. Survey programs can be divided by subject: water, energy, geology, and information dissemination.

Water. 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, water quality in the Arkansas River, the movement of contaminants into the Ogallala aquifer, the interaction between streams and aquifers, and a variety of other topics. The Survey recently completed a detailed analysis of the High Plains aquifer, which resulted in the publication of *An Atlas of the Kansas High Plains Aquifer*.

Energy. 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 is undertaking a multi-year study of the resources of the Hugoton Natural Gas Area and issues related to carbon sequestration.

Geology. Much of the Survey's work is aimed at producing basic information about the state's geology, information that 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.

Geologic Information. 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 2001 Field Conference:

- M. Lee Allison, Director and State Geologist
- William Harrison, Deputy Director and Chief Geologist
- Rex C. Buchanan, Associate Director, Public Outreach
- James R. McCauley, Assistant Scientist, Geologic Investigations Section
- Liz Brosius, Research Assistant, Geology Extension/Editing
- Robert S. Sawin, Research Associate, Geology Extension
- Marty Dubois, Research Assistant, Petroleum Research Section

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Kansas Department of Health and Environment

The Kansas Department of Health and Environment (KDHE) is composed of four divisions: a Center for Health and Environmental Statistics, a Division of Environment, a Division of Health, and a Division of Health and Environmental Laboratories. Of most interest during this Field Conference will be the work of the Division of Environment. Its 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 affect the environment. In addition, the Division administers other programs to remediate contamination, reduce nonpoint pollution, and evaluate environmental conditions across the state.

The Division of Environment works with operators to achieve compliance with state and federal environmental statutes and regulations. The regulatory programs rely upon compliance inspections and monitoring. The Division also conducts financial or technical assistance programs such as the Wastewater Revolving Loan Fund and the Pollution Prevention Program to assist the regulated community. Operators often correct compliance problems quickly and effectively; however, in some instances the Division issues administrative orders and fines. The agency's appeals section handles administrative appeals. Some cases are eventually resolved in state or federal district court.

The Division works to reduce pollution by increasing access to the Division's programs, strengthening the district offices, and providing information to the regulated community and the public at large. Notable examples are the annual state pollution prevention conference, responses to requests for information related to property transfers, and increased training for members of the regulated community.

The Division is organized into an Office of Planning and Prevention, Bureau of Air and Radiation, Bureau of Environmental Field Services, Bureau of Environmental Remediation, Bureau of Waste Management, and Bureau of Water. The Bureau of Water has programs in livestock waste management, nonpoint source pollution, public water supply unified watershed assessment, and underground injection control.

Clyde Graeber, Secretary
Kansas Department of Health and Environment

Ronald Hammerschmidt, PhD
Division of Environment

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Kansas Water Office

The mission of the Kansas Water Office (KWO) is to achieve proactive solutions for resource issues of the state and to ensure good quality water to meet the needs of the people and the environment of Kansas. The Office evaluates and develops public policies, coordinating the water-resource operations of agencies at all levels of government. 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 KWO develops the Kansas Water Plan, which is revised annually and addresses the management, conservation, and development of the water resources of the state. Numerous water-related public and private entities, as well as the general public, are involved in its preparation and planning. The Kansas Water Plan is approved by the Kansas Water Authority. This is a board composed of thirteen members who are appointed to their positions, along with ten non-voting *ex officio* members who represent various state water-related agencies. In addition to approving the Water Plan, the Kansas Water Authority approves water storage sales, federal contracts, administrative regulations, and legislation proposed by the Kansas Water Office. Much of the input for the Water Plan comes via twelve Basin Advisory Committees. These committees are composed of volunteer members from each of the twelve drainage basins in the state.

The Kansas Water Plan is directly linked with the State Water Plan Fund (SWPF). This fund, which takes in and expends approximately $18 million annually, provides funding for water- related issues that have been identified in the Kansas Water Plan. Every fall, the KWA makes recommendations to the Governor and the Legislature on distributing the funds to implement the State Water Plan.

In addition to these activities, the KWO has large responsibility for carrying out the Governor's Water Quality Initiative, the state's GIS policy board, and other activities.

Al LeDoux, Director
Kansas Water Office

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Kansas Department of Agriculture

The Kansas Department of Agriculture is responsible for aspects of food safety, consumer protection, and natural-resource protection in Kansas. The predecessor of the current Kansas Department of Agriculture, the State Board of Agriculture, was established in 1872. The Board of Agriculture was empowered to meet and elect officers and the Secretary of Agriculture and to make an annual report relative to the conditions of agriculture across the state.

In 1995, the Department of Agriculture was created and a nine-member Advisory Board of

Agriculture appointed by the Governor. The Secretary of the Department of Agriculture now is appointed by the Governor from a list of three nominees submitted by the advisory board, then confirmed by the Senate. The board advises the Governor and the Secretary and reviews and makes recommendations on rules and regulations and legislative initiatives.

The Department is, first and foremost, a regulatory agency. It is charged by law with ensuring the safety of the meat, milk, and egg supply; ensuring the responsible and judicious use of pesticides and nutrients; ensuring the integrity of weighing and measuring devices in commerce; and ensuring that the waters of the state are put to beneficial use. The Secretary of Agriculture also has a role in education and advocacy for agriculture.

The Department is organized into programs of Administration and Support, Food Safety and Consumer Protection, Dairy Inspection, Meat and Poultry Inspection, Agricultural Commodities Assurance, Grain Warehouse, Weights and Measures, Environmental Protection, Plant Protection, Fertilizer and Pesticide, and Laboratory.

Of particular importance to this Field Conference is the Department's Water Management Program. The water-resource programs are designed to provide both natural-resource protection and a public safety function through the management of the quantity of the state's scarce water resources and the inspection of water structures. The Department's water-appropriations program manages the state's water supplies through a system of permits, reviews, and inspections. It issues water rights, maintains data about water usage, and administers water rights during times of shortage. The water-structures program inspects and regulates the safety of dams. The program also monitors activities affecting the flow of rivers and streams to ensure these activities are properly planned, constructed, operated, and maintained. These activities include such structures as dams, levees, and other projects that change the flow of streams. The water-management-services program includes staff management and training for the water-resources programs; management of the Water Rights Information System (WRIS); and representing Kansas in four interstate river basin compacts. The subbasin-water-resource-management program works to address water quantity issues identified in the State Water Plan. This approach encompasses related water resources in a specific hydrologic basin to develop long-term water-management strategies, combining good technical information and expertise with the input of local citizens and state, federal, and local governmental agencies.

Jamie Clover Adams, Secretary
Kansas Department of Agriculture

David Pope, Chief Engineer
Water Management Program

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SCHEDULE & ITINERARY

Wednesday June 13, 2001

7:00 am	Breakfast at Holiday Inn, Hays
7:30 am	Conference Overview *Lee Allison*, Director, Kansas Geological Survey
8:00 am	**Bus Leaves Hampton Inn for Site 1**
8:10 am	**SITE 1**—Sternberg Museum of Natural History *Greg Liggett*, Fort Hays State University
10:00 am	Bus to Site 2
12:00 pm	**SITE 2**—Lake Scott State Park *Rick Stevens*, Kansas Dept. of Wildlife and Parks
12:10 pm	Lunch at El Cuartelejo Ruins Picnic Shelter
1:30 pm	Bus to Site 3
2:00 pm	**SITE 3**—Monument Rocks *Jim McCauley*, Kansas Geological Survey
2:30 pm	Bus to Site 4
3:15 pm	**SITE 4**—Smoky Valley Ranch Preserve *Alan Pollom*, The Nature Conservancy *Craig Freeman*, Kansas Biological Survey *Jim McCauley*, Kansas Geological Survey
6:30 pm	Chuckwagon Dinner at Smoky Valley Ranch
8:00 pm	Bus to motel
8:45 pm	Arrive Ramada Inn, Colby

Sternberg Museum of Natural History

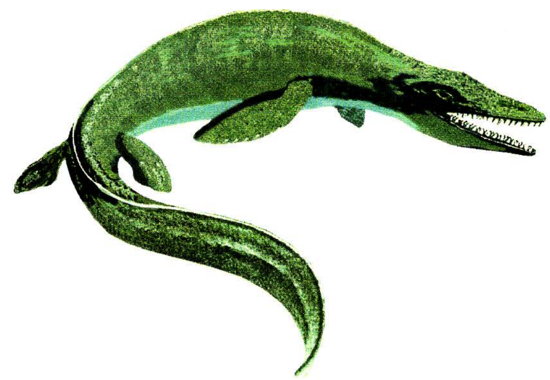
The Sternberg Museum of Natural History reopened on March 13, 1999, at its new site on the northeast edge of Hays. More than 120,000 people visited its exhibits during the first year of operation. The Sternberg Museum houses a variety of exhibits, but is best known for its fossils of Late Cretaceous dinosaurs and other animals that inhabited the Cretaceous seas of western Kansas about 80 million years ago.

The Sternberg Museum, part of Fort Hays State University, is named after a famous fossil-hunting family. Over 75 years, two generations of Sternbergs collected thousands of fossils, some of which are on display in the museum. Many of these fossils are from the Cretaceous chalk of northwestern Kansas, where Charles H. Sternberg, the head of the clan, began his fossil-collecting career with his 1876 discovery of a mosasaur, a kind of large swimming reptile.

Sternberg was passionate about fossil collecting: "The one great object of my life," he later wrote, was "to secure from the crumbling strate of this old ocean bed the fossil remains of the fauna of Cretaceous Times." His sons, George, Charles M., and Levi, were also prolific collectors and the four of them formed a fossil-hunting business in the early years of the 20th century. The Sternbergs had a huge impact on vertebrate paleontology in the late 19th and eartly 20th centuries, and specimens they collected are found in museums around the world.

The Sternberg Museum is home to a number of important fossils from the Kansas Cretaceous, including mosasaurs, plesiosaurs (another swimming reptile), and wonderfully preserved stemless crinoids called *Uintacrinus.* Perhaps most famous is the large bony fish *Xiphactinus* with a complete skeleton of its last meal, a 6-foot fish called *Gillicus,* preserved in its belly.

In addition to the exhibits, the museum also a hands-on educational area, a gift store, and restaurant. The museum's research collections are housed in the new collection and research area, which is equipped with environmental controls to prevent degradation of specimens.



Reconstruction of a Cretaceous mosasaur (drawing by Jennifer Sims, Kansas Geological Survey).

For more information, visit the Museum's web site at **www.fhsu.edu/sternberg/.**

References

Fort Hays State University, 2000, Sternberg Museum of Natural History: http://www.fhsu.edu/sternberg/ (May 7, 2001).

Liggett, Gregory A., 2001, Dinosaurs to Dung Beetles—Expeditions through Time (Guide to the Sternberg Museum of Natural History): Fort Hays State University, 127 p.

Sternberg, Charles, 1909, The Life of a Fossil Hunter: Henry Holt & Co., 286 p.

Resource Contact

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Smoky Hills

The region known as the Smoky Hills occupies the north-central part of the state. It is delineated by outcrops of Cretaceous age rocks and takes its name from the early morning haze that often gathers in the valleys.

During the Cretaceous Period (that interval of geologic time from about 140 to 65 million years ago), Kansas was once again under water. Unlike the relatively shallow seas of the Pennsylvanian and Permian, the seas that advanced and retreated during the Cretaceous were deeper and more widespread. Three principal rock outcrops characterize the Smoky Hills—the sandstones of the Dakota Formation, the limestones of the Greenhorn Limestone Formation, and the thick chalks of the Niobrara Chalk.

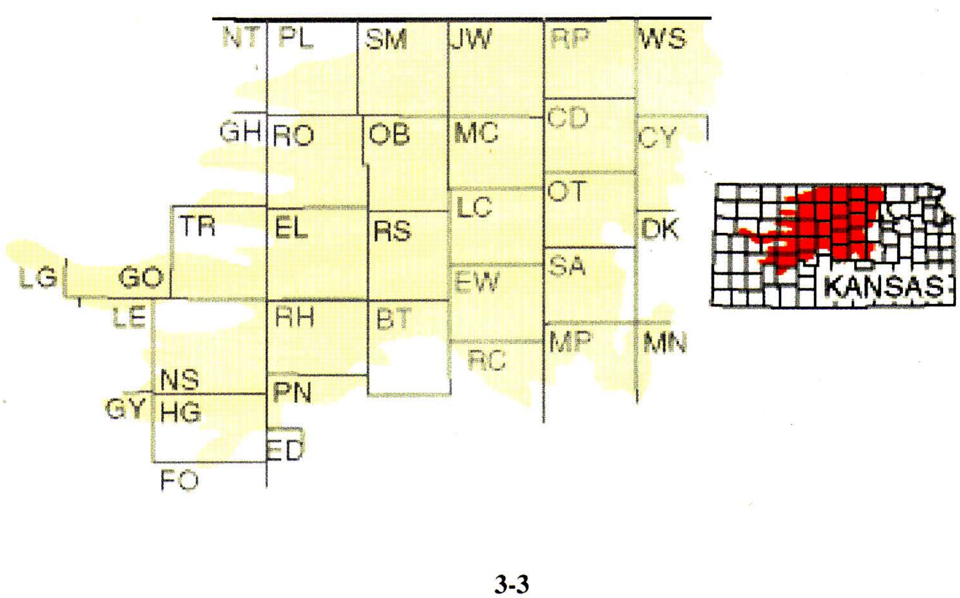
The Dakota Formation sandstones crop out in a wide belt from Rice and McPherson counties, in the south, to Washington County, in the north. They are the remains of beach sands and sediments dumped by rivers draining into the early Cretaceous seas. The hills and buttes in this part of the Smoky Hills, such as Coronado Heights in Saline County, are capped by this sandstone and rise sharply above the surrounding plains.

The next outcrop belt to the west is the Greenhorn Limestone, which is made up of thin (usually less than 6 inches) chalky limestones beds alternating with thicker beds of grayish shale. The Greenhorn Limestone was deposited in a relatively shallow part of the Cretaceous sea. Near the top of the Greenhorn is a limestone bed called Fencepost limestone. Because timber was scarce in this part of the state, limestone was used extensively by early settlers for buildings and fenceposts.

The third and westernmost range of hills in the Smoky Hills developed on the thick chalks of the Niobrara Chalk. These chalk beds, which were deposited in the deeper part of the Cretaceous ocean, are exposed in bluffs of the Solomon, Saline, and Smoky Hill rivers and in an irregular belt from Smith and Jewell counties to Finney and Logan counties. The Niobrara Chalk is known for the pinnacles, spires, and odd-shaped masses formed by chalk remnants, such as Castle Rock and Monument Rocks in Gove County. It is also known for fossils of swimming reptiles such as plesiosaurs and mosasaurs that lived in the ocean while dinosaurs roamed the land.

Reference

Kansas Geological Survey, 2001, The Smoky Hills Region (GeoKansas—The Place to Learn About Kansas Geology): http://www.kgs.ukans.edu/Extension/smoky/smoky.html (May 7, 2001).



High Plains

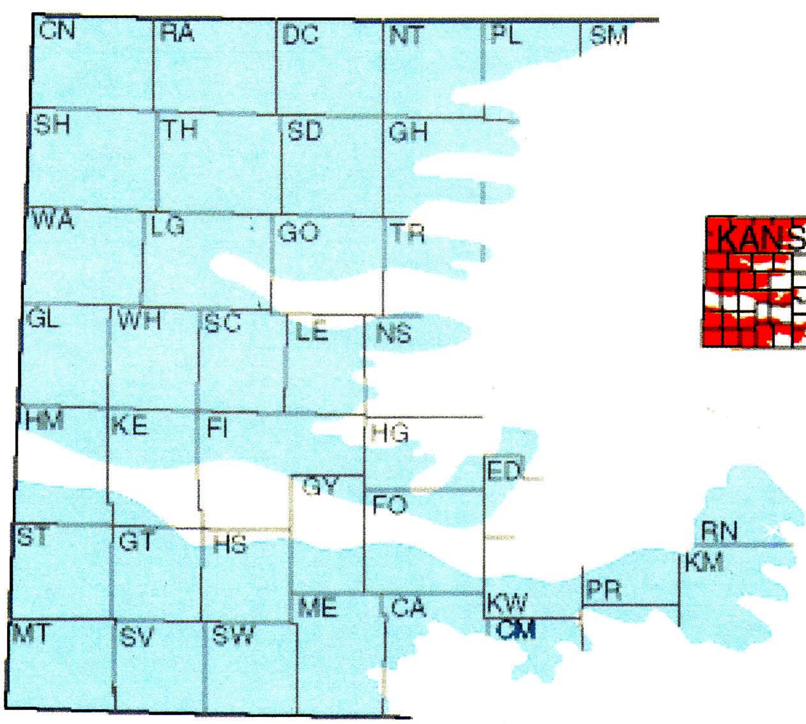
The High Plains region in Kansas essentially covers the western one-third of the state. In this area of vast flatlands and gently rolling hills, topographic relief is largely restricted to streams and river valleys, such as the Arikaree Breaks in Cheyenne County or along the Cimarron River in Seward County.

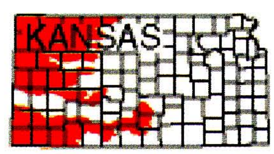
The High Plains developed on sediments that originated in the Rocky Mountains to the west. The Rocky Mountains were formed by deformations of the earth's crust at intervals during the last part of the Cretaceous Period and the Tertiary Period. By late Tertiary time, just a few million years ago, the Rockies were being eroded by wind and water. Streams flowing eastward out of the Rocky Mountains were full of sand, gravel, silt, and other rock debris. Over millions of years, this mass of eroded material filled the stream valleys and eventually covered the hills, creating a huge, gently sloping flood plain. The remnants of that region (which extends far beyond the Kansas border) is the region we call the High Plains.

The unconsolidated deposits (sands, gravels, clays, and other materials) that eroded off the face of the Rockies lie below the surface in the High Plains and make up the Ogallala Formation. Some of the deposits in the Ogallala Formation were cemented together and are known as mortarbeds. Most of the Ogallala is underground, but it crops out in many places, such as at Scott County State Lake. The Ogallala is one of the chief sources of ground water in western Kansas.

The High Plains get less precipitation than other parts of the state, averaging between 15 and 25 inches a year. The combination of low precipitation, windiness, and abundant sunshine makes for a dry, or semiarid, climate in much of the High Plains. Short, drought-tolerant grasses cover the uncultivated areas, trees are scarce, and desert-type plants, such as cactus and yucca, are common.

Loess covers much of the uplands in northern and western Kansas, concealing many of the rocks near the surface. Loess is a finely ground silt that





is deposited by the wind. In the High Plains of Kansas, loess was deposited by the wind during the Ice Ages of the past million years. This finely ground silt was formed as glaciers advanced over the continent, pulverizing rocks and sediments in their path. When the glaciers melted, this silt was deposited on the flood plains by streams coming from the melting ice sheet. Geologists think that temperature differences between the snow-covered regions to the north and the bare ground to the south may have created large differences in atmospheric pressure, which produced strong winds capable of moving large amounts of silt a considerable distance.

More then 90 percent of the soil in Thomas, Sherman, Cheyenne, Greeley, Wichita, Scott, Hamilton, and Lane counties has developed in loess deposits. In some places the loess has been eroded away by streams. The resulting draws and canyons have extremely steep sides. Loess can maintain a nearly vertical face without slumping or caving in. Along the Arikaree River in Cheyenne County, canyons carved into thick loess deposits form a rugged landscape called the Arikaree Breaks.

Reference

Kansas Geological Survey, 2001, The High Plains Region (GeoKansas—The Place to Learn About Kansas Geology): http://www.kgs.ukans.edu/Extension/highplains/highplains.html (May 7, 2001).

Lake Scott State Park

Lake Scott State Park is located west of Highway 83, between Oakley and Scott City on K-95. Listed by National Geographic's Traveler magazine as one of the country's 50 must-see state parks, the park's rugged canyons and craggy bluffs stand out from the typical shortgrass prairie of the High Plains region. The 1,200-acre park with its 100-acre lake is a popular place for boating, swimming, camping, hiking, and wildlife observation. The park officially opened on June 12, 1930, one of the first areas set aside in the Kansas parks system. It averages about 180,000 visitors a year.

In addition to the campsites, swimming beach, playground, and concession area, the park has nature trails that accommodate hikers, horseback riders, and naturalists. Wild turkey, deer, beaver, and bobcat have been found in the park. A privately owned herd of buffalo and elk can be viewed at the south end of the park. The park is also home to the Lake Scott riffle beetle, a very small insect that lives in the well-oxygenated riffles of the park's natural springs. This is the only location on earth in which this species is known to occur.

Ogallala Formation

The park is a good place to see outcrops of the Ogallala Formation, which is well known as an underground aquifer throughout the High Plains. Most of the water pumped for irrigation in the eight-state High Plains Region is pumped from the Ogallala Formation.

The Ogallala Formation underlies all or parts of eight western states: South Dakota, Nebraska, Wyoming, Colorado, Oklahoma, Texas, New Mexico, and Kansas. The formation was deposited during the Pliocene Epoch of geologic history, about 2–5 million years ago. The Ogallala is a thick blanket of a variety of rock types, fragments weathered from the Rocky Mountains, including igneous and metamorphic rocks that were rounded and smoothed during their trip across the plains. Some layers of the Ogallala are naturally cemented and are referred to as mortar beds.

At the park, these Ogallala mortar beds form the rim of a canyon above Lake Scott, which is called Devil's Backbone.

El Cuartelejo Indian Pueblo

Near the west edge of the lake is the site of a pueblo built in 1664 by a group of Pueblo Indians from Taos, New Mexico, who migrated north to escape Spanish rule and settled with a band of Plains Apache. They constructed pueblos and cultivated crops using a system of irrigation ditches from a nearby spring. Their village became known as El Cuartelejo, meaning "old barracks or building." It is the northernmost pueblo in North America. They lived here for 20 years before returning to their homes in the south. The site was occupied again in 1701 by a band of Picurie Indians, who settled there for about two years. In 1717, Juan Uribarri, who led La Salle to his fatal ambush, opened a trading post at El Cuartelejo. The site was abandoned in 1727.

The El Cuartelejo Ruins, as they are now called, have been designated as a National Historic Landmark. The lower portions of the pueblo's stone walls were excavated in 1889, along with stone and bone tools, ornaments, and pottery sherds. Since that time, erosion has destroyed all but two sections of the outer wall, portions of the stone hearths, and several post holes. In 1971 the Kansas State Historical Society reconstructed the foundation walls, which visitors can see at the site.

References

El Cuartelejo informational brochure (publisher and date unknown).

Gutentag, Edwin D., 1988, Ogallala Formation (Miocene), western Kansas: Geological Society of America Centennial Field Guide—South-Central Section, Decade of North American Geology, p. 63-66.

Kansas State Parks, 2001, Lake Scott State Park : http://www.kdwp.state.ks.us/parks/pages/scott.html (May 11, 2001).

McCauley, Jim, 1998, Ogallala Formation; *in*, Field Guide, 1998 Field Conference--Southwest Kansas--Water, Petroleum, and Recreation, Bob Sawin and Rex Buchanan, eds.: Kansas Geological Survey, Open-file Report 98-19.

The Scott County State Park: http://www.scottcity.net/lakescott/history.html (May 11, 2001).

Resource Contact

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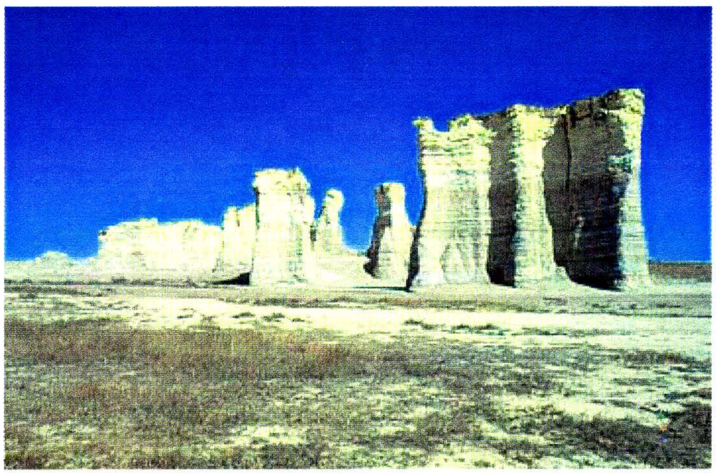
Monument Rocks

Monument Rocks is a series of chalk monoliths in western Gove county. Like Castle Rock in the eastern part of the county, Monument Rocks served as a landmark for early travelers and pioneers. It remains a popular tourist site in the Smoky Hill River Valley.

Monument Rocks was carved by wind and water in the thick chalk of the Smoky Hill Chalk Member of the Niobrara Chalk. Chalk is a soft, porous, very fine-grained kind of limestone that crumbles easily. In its pure form, it is white, but it may be colored by iron oxide or other impurities. Harder layers within the chalk protect the underlying rock from erosion, creating the distinctive buttes or monuments. But erosion continues to wear away pieces of these monuments, as was dramatically demonstrated several years ago by the toppling of Cobra Rock, near Castle Rock in eastern Gove County.



Monument Rocks, Gove County.

Chalk is a kind of limestone that forms from the seafloor accumulation of tiny marine organisms that lived near the surface. As the tiny shells piled up, a soft limy ooze formed, perfect for engulfing and preserving the remains of other animals—such as fish, sharks, turtles, clams, pterodactyls, mosasaurs, and plesiosaurs—that fell to the bottom of the sea. The chalk here at Monument Rocks was deposited at the bottom of a great inland sea that covered most of North America during the later part of the Cretaceous Period, about 80 million years ago.

The Niobrara Chalk in western Kansas is world famous for its fossils. Beginning in 1867, with the discovery of a large swimming reptile called a plesiosaur, the Cretaceous chalks and shales have produced a variety of large vertebrate fossils, which attracted paleontologists from around the world. In addition to mosasaurs and plesiosaurs, another type of swimming reptile, paleontologists found fossil remains of sharks, turtles, pterodactyls, bony fish. The invertebrate fossils discovered there were also interesting and included some of the world's largest clams—inoceramid clams with 6-foot diameters—and a rare fossil crinoid called *Uinatcrinus.*

Monument Rocks has been designated a National Natural Landmark. Although Monument Rocks is open to the public, visitors should bear in mind that it is located on private property.

References

Kansas Geological Survey, 2001, Smoky Hills, Places to Visit (GeoKansas—The Place to Learn About Kansas Geology): http://www.kgs.ukans.edu/Extension/smoky/places.html (May 16, 2001).

McCauley, Jim, Charlton, John, and Buchanan, Rex, 1992, Portraits of Change—Rephotographing the Chalk Monuments of Western Kansas: Kansas History, Vol. 15, No. 4, p. 220–239.

Smoky Valley Ranch Preserve

With the acquisition of the Smoky Valley Ranch in Logan County in January, 1999, The Nature Conservancy Kansas Chapter established a 16,800-acre (more than 25 square miles) preserve that can support much of the rich diversity of animals and plants that inhabited the shortgrass prairie region. The Conservancy considers the Smoky Valley Ranch Preserve to be a truly remarkable opportunity because of its many benefits to the collective preservation of outstanding natural, historical, and cultural resources contained within this exceptional and irreplaceable property.

Purchase of the Smoky Valley Ranch by The Nature Conservancy is the largest private-land acquisition for conservation in Kansas history and represents the most ambitious undertaking to date by the ten-year-old Kansas Chapter. Characterized by chalk bluffs overlooking the Smoky Hill River and large expanses of grassland and rocky ravines, the breaks along the upper reaches of the Smoky Hill River represent the transition zone between the mixed grass and shortgrass prairie regions. Even though 80 percent of the shortgrass prairie that formerly blanketed the High Plains has been lost in Kansas, very few examples of any size have come under conservation management.

The seemingly endless miles of shortgrass prairie that once covered western Kansas have given way to cultivation and dryland farming over the past century. Some of the most significant representations of these native prairies occur along the Smoky Hill River and its tributaries in Wallace, Logan, and Gove counties. Many of these prairies have been well managed as grazing pastures for decades but periodic dislocations in the cattle market and improved dryland crop varieties have induced increasing numbers of landowners to convert their native pastures to cropland.

The ranch was previously used for grazing, and cattle will still be an important component of the ranch. The Nature Conservancy intends to continue cattle ranching with an eye toward searching out management techniques that are both ecologically and economically viable.

Geology and Paleontology

Smoky Valley Ranch Preserve in Logan County is much more than a remnant of the vanishing shortgrass prairie landscape. In addition to its biological importance, it also contains significant geological and paleontological resources.

The chalk badlands along the Smoky Hill River and its tributaries are scenic bluffs, pinnacles, and steep-walled canyons, sculpted by water from the soft chalk. Harder layers of chalk were quarried for building stone at several locations on the ranch. When first uncovered, the stone is soft enough to cut with a saw; after it is exposed to the air, it becomes harder. Ranch headquarters and other structures in the area were built with stone from the ranch quarries.

The chalk contains a rich fossil record of the vertebrate and invertebrate animals that lived in a vast inland sea that covered Kansas during the Cretaceous Period, some 80 million years ago. The Cretaceous Period was part of the Age of Reptiles, an era famous for its dinosaurs. Although dinosaurs were restricted to landmasses far from western Kansas, their marine representatives, mosasaurs and plesiosaurs, roamed the seas. Besides these large marine reptiles, huge turtles, sharks, flying reptiles, and toothed-birds inhabited the area.

Giant clams, up to four feet across, were common invertebrates of the sea floor. They were colonized by encrusting oysters and small fish. Smoky Valley Ranch is one of a few locations where a rare crinoid—an ancient relative of the starfish—can be found.

Because fossil remains are so well preserved and scientifically significant, the chalk badlands are among the world's most famous locations for vertebrate and invertebrate fossils. Specimens from Kansas are exhibited in museums around the world.

Resource Contact

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Topeka, KS 66603
785/233-4400

SCHEDULE & ITINERARY

Thursday June 14, 2001

7:00 am	Breakfast at Ramada Inn, Colby
7:45 am	**Bus Leaves Ramada Inn for Site 5**
8:00 am	**SITE 5**—Groundwater Management District No. 4/Center Pivot
	Wayne Bossert, Groundwater Management District No. 4
	Dwayne Kersenbrock, NRCS/GMD No. 4
8:45 am	Bus to Site 6
8:50 am	**SITE 6**—Two Pool Concept/Subsurface Drip Irrigation
	Al LeDoux, Kansas Water Office
	Susan Stover, Kansas Water Office
	Scott Ross, Kansas Dept. of Agriculture/DWR
	Bob Luck, Farmer and Businessman
9:35 am	Bus to Site 7
10:00 am	**SITE 7**—McCarty Dairy
	Tom McCarty, McCarty Dairy
	John Harsch, Kansas Dept. of Health and Environment
11:30 am	Bus to Lunch
11:50 am	Lunch in Colby, Kansas
12:40 pm	Bus to Site 8
1:15 pm	**SITE 8**—Upper Republican River: Compact and Litigation
	Scott Ross, Kansas Dept. of Agriculture/DWR
	John Cassidy, Attorney General's Office
2:00 pm	Bus to Site 9
	Public Water Supplies - Selenium, Arsenic, and Nitrates
	Dave Waldo, Kansas Dept. of Health and Environment
4:15 pm	**SITE 9**—Solomon River Basin Sustainability
	Bob Hooper, Chair, Solomon Basin Advisory Committee
4:45 pm	Bus to Site 10
5:00 pm	**SITE 10**—Proposed Water Quality Standards for Kansas
	Mike Tate, Kansas Dept. of Health and Environment
	Ann Jacobs, U.S. Environmental Protection Agency
5:45 pm	Bus to Hays
6:30 pm	Arrive Hampton Inn, Hays
7:00 pm	Bus to Dinner
7:05 pm	Refreshments and Dinner at the Golden Ox Pavilion
8:30 pm	Bus to Hampton Inn

The High Plains Aquifer

The High Plains aquifer, which includes the well-known Ogallala aquifer, is the most important source of water for much of western and central Kansas. Water from the High Plains aquifer supports the region's cities, industry, and much of its agriculture. However, large-volume pumping from this aquifer has led to lower water levels in some areas, and the region faces several critical water-related issues.

The High Plains Aquifer Defined

Aquifers are layers of permeable rock, or sands and gravels, that are saturated with water that can be pumped out and used. The High Plains aquifer lies beneath parts of eight states in the Great Plains, including about 33,500 square miles of western and central Kansas. The High Plains aquifer is composed of sand, gravel, silt, clay, and other rock debris that washed off the face of the Rocky Mountains (and other local sources) and onto the High Plains of western Kansas within the past several million years.

Geology determines many of the important characteristics of the High Plains aquifer. First, the aquifer varies greatly from place to place—thick in some places and thin in others; very permeable (or able to transmit water easily) in some areas, and not so permeable in others. Second, where water in this aquifer is held in permeable rock, the water is relatively easily removed; thus, the aquifer can support large volumes of pumping. Finally, sand and gravel in the aquifer has acted as something of a natural filter and the water is generally of extremely high quality.

The largest and most widespread component of the High Plains aquifer is the Ogallala aquifer. In some locations, the Ogallala crops out at the surface (such as Lake Scott State Park in Scott County), forming a naturally cemented rock layer called "mortarbeds." In the subsurface, the Ogallala consists of silt and clay beds that are interlayered with sand and gravel that is unconsolidated, or not naturally cemented together.

Several other aquifers are hydraulically connected to the Ogallala, meaning that water can move from one aquifer to the other. Together these connected aquifers make up the High Plains aquifer. The most important of these connected aquifers in Kansas occur in the south-central part of the state, to the east of the Ogallala. The best-known of these connected aquifers are the Great Bend Prairie aquifer and the Equus Beds aquifer, both of which are composed of rock materials that are similar to those in the Ogallala. The unconsolidated clay, silt, sand, and gravel of these aquifers were deposited more recently than the Ogallala.

Lying beneath the High Plains aquifer is much older, consolidated bedrock, usually sandstone, limestone, or shale. In some localities, this bedrock may hold ground water and these bedrock aquifers may be connected to the High Plains aquifer. Sandstone aquifers in the Dakota Formation, for example, may be connected to the overlying High Plains (similarly, much younger, unconsolidated alluvial aquifers along streams lie above the High Plains aquifer and may be connected to it). In many areas, however, the underlying bedrock does not hold water. In southwestern Kansas, particularly along Bear Creek in Kearny County and Crooked Creek in Meade County, movement of the earth along ancient faults has pushed this bedrock much closer to the surface. Where these faults are close to the surface, there is less unconsolidated rock material above the bedrock to act as an aquifer. In parts of south-central and far southwestern Kansas, the underlying bedrock aquifer contains brine. Where that aquifer comes into contact with the High Plains aquifer, it may pose a threat to water quality.

Water Resources in the High Plains Aquifer

Most of the water in the High Plains aquifer is in the pore spaces between the particles of sand and gravel. This water (called ground water) accumulated slowly, over thousands of years, mostly as a result of precipitation that moved naturally down into the aquifer. In the subsurface, water in the aquifer moves generally from west to east, but this movement is very slow, in the order of tens of feet per year.

Ground water can be quantified in various ways. Water regulators often discuss water in acre-feet—that is, the amount of water it takes to cover an acre of ground (or a parcel about the size of a football field) with a foot of water. An acre foot equals about 325,851 gallons of water. In 1990, an estimated 15.7 million acre-feet of ground water was removed from the High Plains aquifer across the eight-state region. Ground water is also discussed in terms of general availability or the amount of water that can be removed by a well over a small period of time. Because substantial amounts of water are present and because the High Plains aquifer is relatively permeable, large volumes of water can be removed from the High Plains, more than 500 gallons per minute in many locations. In much of the rest of the state, wells generally produce much smaller amounts, less than 100 gallons per minute. A good household well is capable of producing 5 to 10 gallons of water per minute, though many household wells produce less.

One of the most common and useful measures of water is saturated thickness—that is, the thickness of the sands, gravels, and other materials that are saturated with water. In Kansas, the saturated thickness in the High Plains aquifer is generally greatest in the southwestern part of the state, particularly in Stevens, Seward, Grant, Haskell, and southern Finney counties, where more than 300 feet of the aquifer was saturated with water before the onset of large-scale irrigation (a time that is often referred to as "pre-development"). In much of the rest of the aquifer, saturated thickness was 100 to 200 feet, with smaller amounts in west-central Kansas and around the edge of the aquifer.

The natural movement of water into an aquifer, usually from precipitation, is called recharge. For the most part, recharge to the High Plains aquifer is low because much precipitation occurs in the spring and summer when water may be picked up by plants and does not reach the water table. In western Kansas, where precipitation is scant and the aquifer is relatively deep (several hundred feet) in many places, recharge occurs infrequently and the long-term average is less than an inch per year. However, in central Kansas, in Harvey, Reno, and McPherson counties, where the aquifer is closer to the earth's surface, where soils are sandier, and precipitation amounts are greater, recharge can be significant, as much as four to six inches or more per year.

Water Level Declines in the Aquifer

Large-scale irrigation began in western Kansas in the late 1800's, with the use of ditches to divert water from the Arkansas River. Ground water quickly became the major irrigation source because surface water (lakes, rivers, and streams) is relatively scarce in western Kansas. With the advent of large-capacity pumps that were capable of drawing several hundred gallons of water per minute, people began to exploit that ground water. Using a technique called flood irrigation, water was pumped through long pipes or ditches along the edges of a field, then out onto rows of crops.

In the 1950's and 1960's, technological developments led to a dramatic increase in large-scale pumping. In particular, center-pivot irrigation systems—large sprinklers that roll across the landscape on wheels—allowed people to irrigate uneven terrain, thus opening up large new areas for irrigation. These irrigation methods led to the cultivation of crops, such as corn, that could not previously be grown reliably in the area. That grain production led, in turn, to large feedlots and packing plants and a boom in the economy of much of western Kansas, all largely dependent on ground water. One study estimated that the economic impact of irrigation in southwestern Kansas alone amounts to more than $188 million annually.

For many years, people believed that the High Plains aquifer contained an inexhaustible amount of water. However, large-volume pumping (mostly for irrigation) eventually led to substantial declines in the water table, and people realized that the amount of water in the aquifer was finite and could be exhausted. According to estimates, about 30 percent of the High Plains region in Kansas has seen water level declines of more than 150 feet.

Yet in much of the aquifer, considerable amounts of water remain. For example, declines of 100 feet or more may have occurred in parts of southwestern Kansas, yet that represents less than half of the original saturated thickness, and 100 to 200 feet (or more) of saturated thickness may remain. However, in parts of west-central Kansas—such as Greeley, Wichita, and Scott counties and northern Finney County—the original saturated thickness was much less, often less than 100 feet. In these places, where 50 to 75 feet of the aquifer have been depleted, less than 50 feet of water remains.

When Will the Aquifer Run Dry?

Perhaps the most common, and important, question about the High Plains Aquifer is: How much longer can it support large-scale pumping? It's a simple question with a complicated answer. First, the aquifer will probably be able to support small, domestic wells far into the future. With proper planning, most cities and towns should be able to provide for their water needs. Second, the future of agricultural use of the aquifer depends on a variety of factors, including the price of irrigated crops, the price and availability of energy (the deeper the water table, the more energy is required to pump water), climate, and how the water is managed. Third, it is important to remember that the aquifer is not a single, homogenous unit. Rather, it varies considerably from place to place. In places, the aquifer consists of less than 50 feet of saturated thickness and receives little recharge. In other places, the aquifer is far thicker or receives considerably more recharge.

With those qualifications in mind, researchers at the Kansas Geological Survey have made projections about the aquifer, based on the rates that water has been used in the past. Obviously, the actual future use of water will be affected by commodity prices, energy prices, climate, and management policies. In addition, relatively little data is available for some parts of the aquifer, and projections are not practical in those areas. However, based on past declines, and using a saturated thickness of 30 feet as the minimum amount necessary to support large-scale pumping, parts of the aquifer are already exhausted in Greeley, Wichita, and Scott counties. Other parts of the aquifer, in areas such as southwestern Thomas County, would have a lifespan of less than 25 years. However, the biggest share of the aquifer would not be depleted for 100 to 200 years. It is important to remember that these projections are based on past use and future changes could alter the situation dramatically.

For detailed maps related to this issue, see *An Atlas of the Kansas High Plains Aquifer* (Kansas Geological Survey Educational Series 14), which will be distributed as part of the 2001 Field Conference.

Managing Water in the Aquifer

By Kansas law, water belongs to the people of the state. However, individuals, companies, municipalities, and other entities can put that water to a beneficial use if they have a water right. Water rights are not required for small amounts of water, such as a domestic well, but only for those uses that require larger amounts. Kansas water law is based on the doctrine of prior appropriation. That is, when there is insufficient water to meet all water rights, the date of the water right determines who has the right to use the water. This doctrine is commonly expressed as "First in time, first in right."

Responsibility for managing water use in Kansas is spread over several agencies. The Division of Water Resources of the Kansas Department of Agriculture is responsible for administering water rights, and thus is primarily responsible for regulation related to the quantity of water used. Water issues are also subject to local control. Five groundwater management districts have been created in Kansas to provide local management of the resource within the framework of law as administered by the Kansas Department of Agriculture. Together they cover nearly all of the state underlain by the High Plains aquifer. Groundwater management districts, guided by their staff and an elected board of volunteers, develop and implement policies to help manage water, undertake educational activities, and work with the Department of Agriculture in regulating water use.

A variety of other agencies deal with other aspects of water in the state. The Kansas Geological Survey, for example, is a research and service division of the University of Kansas and undertakes a variety of water-related activities, but has no regulatory responsibility. The Kansas Department of Health and Environment monitors water-quality issues. The Kansas Water Office, working with the Kansas Water Authority, is responsible for water planning. That planning is according to drainage basins, or areas that are drained by a common stream, such as the Solomon River or Neosho River. Each of those basins is represented by a volunteer basin advisory committee. The Kansas Department of Wildlife and Parks, Kansas State University's Extension program, the Kansas Biological Survey, the U.S. Geological Survey, and other state and federal agencies have various responsibilities for water.

For more information, see "Agency Authority and Responsibilities for Water in Kansas" (Kansas State University Agricultural Experiment Station and Cooperative Extension Service, MF-2503), included in the Field Guide.

References

Kansas Geological Survey, 2000, An Atlas of the Kansas High Plains Aquifer: http://www.kgs.ukans.edu/HighPlains/atlas/ (May 25, 2001).

Schloss, J. A., Buddemeier, R. W., and Wilson, B. B., eds., 2000, An Atlas of the Kansas High Plains Aquifer: Kansas Geological Survey, Educational Series 14, 92 p.

K-STATE Kansas State University

Agency Authority and Responsibilities for Water in Kansas

Water is a natural resource vital to life. It is essential to aquatic life support, human and livestock consumption, agriculture, and industry. Water is also important for recreation, energy production, and waste removal. Throughout history, the quality and quantity of water resources available for use have been a determining factor in where communities are located and the type of commerce and land utilization that can occur in a specific region. It is no wonder such an important resource is so intensely monitored and managed.

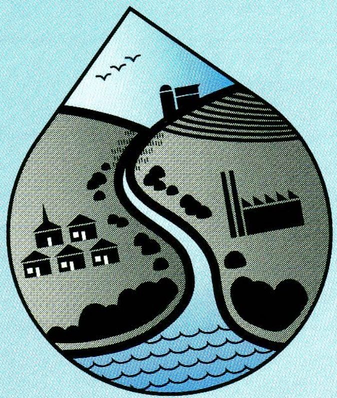
Over 20 separate national, state, and local governmental agencies address water or water-related issues in Kansas. The involvement of so many agencies is, in part, a reflection of the many ways in which we utilize this resource. A single water resource often has multiple designated uses. A reservoir, for example, may simultaneously provide flood control, energy production, wildlife habitat, a recreation resource, drinking water, and an irrigation water supply. Each use has quality and quantity issues relating to it. These use issues often impact each other, and may also be impacted by yet other uses both up and down stream, such as navigation or waste removal.

When this tangled water-use web is combined with the jurisdictions of local, state, and federal agencies, the clarity of water responsibilities becomes even more muddled. This publication was developed to represent and simplify the complexity of the many agencies roles and responsibilities relating to water.

This chart is not a comprehensive listing. The agencies and organizations listed here are represented because of their continuous responsibilities for water resources. Organizations with intermittent or situation-specific responsibilities were omitted for the sake of chart simplification. Examples include: Federal Emergency Management Agency (flood response), and Kansas Corporation Commission (water use in the production of gas and oil).

The data shown here was developed from the information contained in *State and Federal Water Programs— 1999,* Red Book, compiled by the Kansas Water Office. A draft of the chart was provided to each listed state and federal agency for review and correction prior to final editing.

Revisions to this chart are anticipated. Please send written changes to Extension Biological and Agricultural Engineering, 237 Seaton Hall, Manhattan, Kansas 66506 or by email to: *mpowell@bae.ksu.edu*. Please include your name and contact information.



Agency Authority and Responsibilities for Water in Kansas

Federal Agencies

Agency	Water well drilling or plugging	Nonpoint source Surface water quality	Groundwater	Water rights and use	Floodplains	Levees and dams	Drinking water systems	Water supply —storage	Drainage systems	Urban storm runoff	Wastewater	Recreation	Wetland and riparian area	Aquatic life support	Industry/power generation	Confined animal facilities	Agriculture/ irrigation
US Army Corps of Engineers 816-983-3157		Perm Reg			Info Mgmt Plan Reg	Own PlnA		Mgmt Own PlnA Plan	Info Plan			Mgmt Own Plan	Plan Reg	Mgmt Mon Plan	Mgmt		
US Bureau of Reclamation 308-389-4622		Mon Res		Own Mon Rept		Own		Mgmt Plan	Fund Mgmt Mon Own Plan			Mgmt Own Plan	Fund Mgmt Plan	Mgmt Plan			Fund Info Mgmt Own Plan Res
USDA Natural Resource Conservation Service 785-823-4500		Fund Info Plan		Plan	Plan	Fund Info Plan PlnA Mon		Fund Info Plan PlnA Mon	Fund Info Plan	Info Plan	Info Plan	Fund Info Plan PlnA	Fund Info Mon Plan PlnA Reg	Plan		Fund Info Mon Plan PlnA	Info Fund Mon Plan PlnA
US Environmental Protection Agency 913-551-7080	Perm Plan	Info Fund Mgmt Perm PlnA Reg Std	Fund			Reg	Info Fund Plan Reg Std	Std		Info PlnA Reg Std	Info Mon Mgmt Rept Reg Std	Reg Std	Fund Info Mon Plan Reg Res Std	Info Reg Std		Perm Reg Std	Info Plan
US Fish and Wildlife 785-539-3474		Mon Plan Res Std		Mgmt	Plan	Plan	Plan	Mgmt Plan	Plan		Std Plan	Mon Plan Std	Info Mgmt Own Std	Info Mon Plan Std		Plan	Plan
US Geological Survey 785-842-9909		Mon Res	Mon Res	Mon Res	Mon			Mon Res		Mon Res				Mon	Mon		Mon Res
KS Biological Survey 785-864-7725		Mon Res								Info			Mon Res	Info Mon Res			
Dept. Of Agriculture, Division of Water Resources—State Water Engineer 785-296-3717	Perm			Perm Mgmt Mon PlnA Plan Reg Std	Mgmt PlnA Plan	Mgmt Mon PlnA Plan		Perm Mgmt PlnA Reg Std	Perm PlnA Reg			PlnA		Perm	Perm PlnA Rept	Perm Rept	Perm PlnA Rept
KS Dept. of Health and Environment, Division of Water 785-296-1535	Info Mgmt Mon Perm Reg Rept	Fund Info Mon Plan PlnA Reg Rept Res Std	Info Mon Reg Res Std				Fund Info Mon Perm Plan PlnA Reg Res		Mon	Mon	Fund Info Mon Perm Reg Rept Std	Mon Reg Res Std		Mon Reg Rept Res Std	Mon Perm Reg Res	Mon Perm Reg Res Std	
												Fund	Fund	Fund			

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State Ag	KS Dept. of Wildlife and Parks 7[illegible]96-2281		Fund Res		Own Plan	Fund Plan	Plan		Mgmt Plan		Plan		Info Mgmt Plan Rept	Info Mgmt Mon Plan	Mgmt Mon Plan Rept			
	KS Forest Service 785-532-3300		Fund Info Mgmt Plan			Fund Info Mgmt Plan								Fund Info Mgmt Plan				
	KS Geological Survey 785-864-3965	Info Res	Info Mon Res	Info Mon Rept Res	Res				Info Res					Res				Res
	K-State Research and Extension 785-532-5820	Info Res	Info Res	Info Res	Info Res			Info		Info		Info Res		Info Res			Info Res	Info Res
	KS Water Office/ KS Water Authority 785-296-3185	Info	Fund Info	Info	Info Mgmt Plan Rept	Info	Info Fund	Info	Fund Info Mgmt Plan	Info	Info	Info	Fund Info Mgmt Plan	Info	Info Mgmt Plan	Info Mgmt Plan	Info	Info
	State Conservation Commission 785-296-3600	Fund	Fund				Fund		Fund				Fund	Fund			Fund	Fund
Local Agencies	Drainage, Irrigation or Levee District*				Mgmt Own Plan Reg Rept		Mgmt Own Plan			Mgmt Own Plan				Mgmt				Mgmt Mon Own Plan Rept
	Groundwater Management District*	Mgmt Plan Res		Info Mgmt Res	Info Mgmt Res Std											Mgmt Mon Pln		Mgmt Mon Plan Res
	Health Dept., Local Sanitary Code*	Info Reg										Perm Info Mgmt PA Reg Rept	Mgmt				Info Reg	
	Local Water District or Wastewater Utility*	Mon Plan Rept	Mgmt Mon		Mgmt Own Plan			Mgmt Mon Own Plan Rept	Mgmt Own Plan		Mgmt Mon Own Plan Rept	Mgmt Mon Own Plan Rept						
	Conservation or Watershed District*	Fund Info	Fund Info			Info Plan	Info Mgmt Own Plan	Fund	Mgmt Plan		Info		Mgmt Own	Fund Mgmt Own Plan			Fund Info	Fund Info

* See local telephone directory

Key to Designated Responsibilities:

Info = Information /Education — Develops or distributes information or educational materials.
Fund = Provides funding or financial assistance.
Mon = Monitoring — Monitors progress, status or quality.
Mgmt = Management — In charge of on-going status of resource.
Own = Ownership — Owns resource-infrastructure.
Perm = Permitting/ Certification — Issues official authority for activity.
PlnA = Plan Approval — Official acceptance of plans or action.
Plan = Planning — Provides services for planning and implementation.
Reg = Regulation/Enforcement — Upholds established standards or laws.
Rept = Reporting — Data gathering and Reporting for government requirements.
Res = Research/Data Collection — Collects or interprets information through research.
Std = Standards — Establishes enforceable parameters or guidelines.

Kansas Environmental Leadership Program Reference: *State and Federal Water Programs,* 1999 Redbook, Kansas Water Office

General Agency Authority Involving Water

Federal Agencies

US Army, Corp of Engineers—public works projects for navigation and flood control.
US Bureau of Reclamation—public works projects for irrigation, drainage and flood control.
USDA Natural Resources Conservation Service (NRCS)*—resource assessment and technical assistance for private lands and watersheds
US Environmental Protection Agency—water quality protection and enforcement
US Fish and Wildlife Service—monitor and protect aquatic species and habitats
US Geological Survey—research, monitor and report quantity and quality of water

State Agencies

KS Biological Survey—research and monitor of aquatic habitat and species
KS Dept. of Agriculture, Division of Water Resource—water quantity and water use laws
KS Dept. of Health and Environment—water quality protection, monitor and enforcement
KS Dept. of Wildlife and Parks—aquatic habitat and species, state lakes, and wetlands
KS Forest Service—riparian and wetland zone habitat
KS Geological Survey—research, monitor and report quantity and quality of water
K-State Research & Extension—research and education programs
KS Water Office/Water Authority—state water plan, program coordination and marketing water
State Conservation Commission—fund for conservation, wetland, and watershed practices

Local Agencies

Conservation District*—encourages and administers soil and water conservation on private land
Drainage, Irrigation or Levee District—own, operate, and maintain infrastructures
Drinking Water, Stormwater, Wastewater District or Utility—own, operate, and maintain infrastructure
Groundwater Management Districts—plan and manage groundwater within district
Health or Environmental Office; (Sanitary Code)—administer local laws and regulations for health and environment protection. (Onsite wastewater systems)
Watershed District*—own, operate, and maintain watershed infrastructure

**NRCS partners with local Conservation Districts and Watershed Districts*

The purpose of the Kansas Environmental Leadership Program is to teach environmental leadership to Kansans and to encourage and support the practice of environmental leadership in communities. For more information please contact K-State Research and Extension, Biological and Agricultural Engineering, 785-532-5813, e-mail: *kelp@ksu.edu* or World Wide Web at ***http://www.bae.ksu.edu/kelp/***

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Publications from Kansas State University are available on the World Wide Web at: http://www.oznet.ksu.edu

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-2503 March 2001

Northwest Kansas Groundwater Management District

Groundwater Management Districts (GMDs) are locally managed political subdivisions in Kansas that have been formed to manage ground-water resources. GMDs cooperate with other water-related agencies and are bound by the state's ground-water laws and regulations. The Legislature authorized formation of GMDs by the Groundwater Management District Act of 1972. There are five GMDs in Kansas (fig. 4-1): Northwest Kansas Groundwater Management District No. 4, Southwest Kansas Groundwater Management District No. 3, Big Bend Groundwater Management District No. 5, Western Kansas Groundwater Management District No. 1, and Equus Beds Groundwater Management District No. 2.

Northwest Kansas Groundwater Management District No. 4 has been organized to locally manage the ground-water reserves within its boundaries. This management program is designed to establish the rights of local landowners and water users to determine their destiny regarding the use of ground water within the district boundaries and within the basic laws and policies of the State of Kansas. The purpose of the district is:

*To locally organize, develop, and administer proper management and conservation practices of the ground-water resource for the benefit of the entire district.

*To establish a framework by which local landowners and water users can help determine their own policies and programs with respect to the vital management and use of the ground-water resource within the district.

*To support and participate in research and education relevant to the proper use and management of the limited ground-water resource.

*To derive optimum social and economic benefits accruing from the wise development, use, and management of the ground-water reserves.

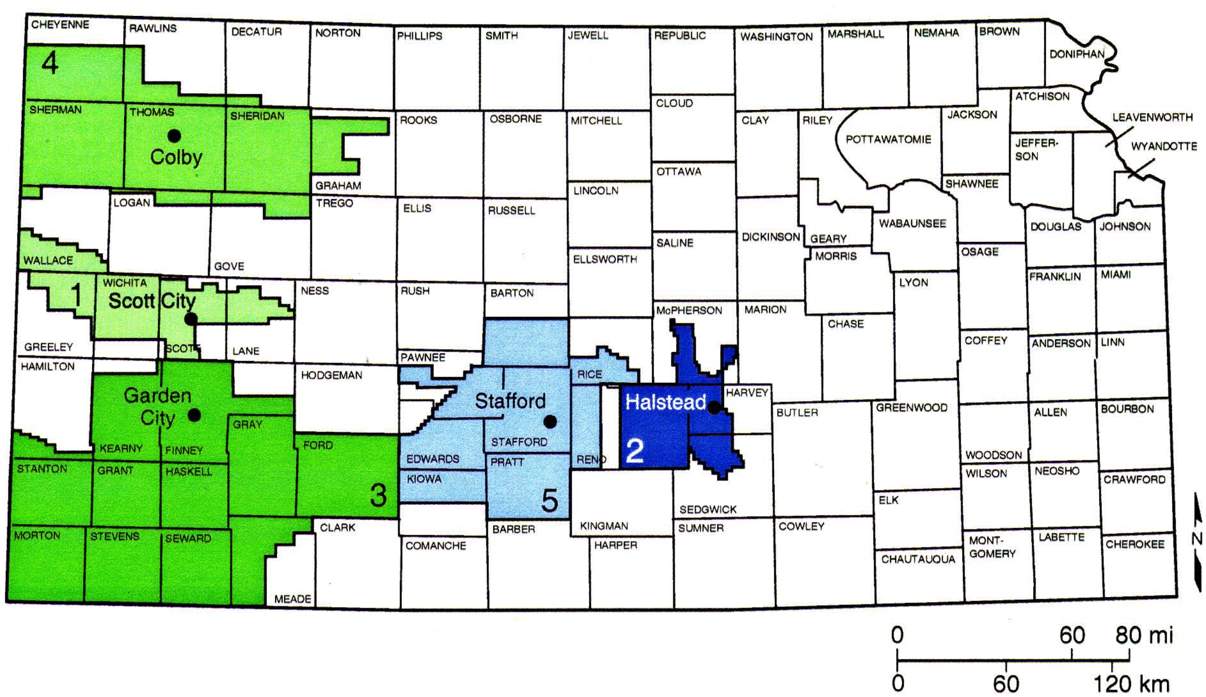

Fig. 4-1. Groundwater Management Districts in Kansas.

*To cooperate with all levels of government and all district members in order to accomplish the objectives of the district and the Groundwater Management District Act and amendments thereto.

Northwest Kansas Groundwater Management District No. 4 includes all of Sherman, Thomas, and Sheridan Counties and portions of Cheyenne, Rawlins, Decatur, Graham, Gove, Logan, and Wallace counties in northwest Kansas. GMD 4 was established in 1976 and covers approximately 3,110,000 acres.

Average annual precipitation ranges from 17 inches in the western tier of counties (Cheyenne, Sherman, and Wallace) to 21 inches in Graham County on the eastern edge of the district. Rain showers account for the majority of the annual precipitation falling during the growing season from April to September. Daily and annual temperatures vary significantly with summer days being warm and summer nights generally cool. This is true when the relative humidity is low, even during the hottest periods of the summer. Low relative humidity and frequent cloudless or near cloudless days are typical for the area, as are moderate to strong surface winds most of the year. Hail and damaging winds associated with severe thunderstorms and/or tornadic activity generally occur in the spring or summer months when low-pressure storm centers tend to be most intense. Overall, the climate is well suited for grassland and certain agricultural crops. This is particularly true if irrigation is developed to supply needed moisture during dry periods.

Soils in the district are primarily those resulting from windblown loess deposited during the Pleistocene Age. Most of the river valleys contain a more granular soil type resulting from stream-laid deposits.

Surface water within the district is limited to surface runoff during and shortly after periods of moderate to heavy rainfall, and base flows in the South Fork Republican and South Fork Solomon rivers. Streams, rivers, and creeks within the district are largely intermittent in nature and supply a vary small percentage of the district's total water requirements. Many of the early surface-water rights along these creeks and rivers are used only occasionally because of unreliable base flows. The majority of surface-water rights being filed recently are from retention structures collecting rainfall runoff and irrigation tailwater.

Ground-water resources in the district supply a large percentage of municipal, industrial, domestic, and agricultural needs. All of the district overlies the Ogallala aquifer, a formation consisting of silt, sand, and gravel deposited a couple million years ago. It ranges in thickness from 300 feet in the west to 50 feet or less in the eastern portions of the district. The thickness of the Ogallala can vary significantly within a relatively short distance. The saturated thickness of the Ogallala ranges from 225 feet in the west to 30 feet or less in the east and along the district's northern and southern borders. The U.S. Geological Survey estimates the district has approximately 40,000,000 acre-feet of water in storage with a median saturated thickness of 86 feet. Within the district, about 3,570 wells are registered with the Division of Water Resources (3,520 irrigation wells, 35 municipal wells, and 12 industrial wells), accounting for approximately 898,000 acre-feet of appropriated water (880,800 acre-feet for irrigation, 25,000 acre-feet for municipal, and 1,500 acre-feet for industrial). Current development has resulted in declining ground-water levels in certain areas of the district.

Alluvial deposits along the major rivers, streams, and creeks are generally 30 to 80 feet thick. These deposits usually do not exceed 50 feet in saturated thickness, but their medium to course texture often yields enough water for limited irrigation.

Northwest Kansas, for the present and future, is largely dependent on the availability of good-quality ground water. A large percentage of the local economy is based on agriculture and agri-related business, which in turn depend heavily on this resource. Contributing to the economy are cultivated cropland, both irrigated and dryland; associated farm businesses such as implement dealers, irrigation supply dealers, feed and seed dealers, well drillers, elevators, and marketing personnel; the cattle industry; and many others. Major crops grown from cultivated ground are corn, wheat, sorghum, sunflowers, sugar beets, alfalfa, and soybeans. All of these crops, except wheat, are generally irrigated. Current economic trends indicate that the marketing potential for these crops remains a stimulus for the higher production achieved by irrigation. The cattle industry in the area depends on the production of feed grains and forage crops from irrigated land and is one area of the present economy which has the best potential for expansion

Irrigation Planning

Irrigation development plans are required by GMD 4 on all new water right applications, changes in place-of-use applications, and appropriate violations of the district's irrigation tailwater regulation. With almost 800 plans in place, and approximately 75 new plans being done annually, the water use efficiency of district irrigators has steadily improved.

Resource Development Plans (RDPs) require that irrigation application rates be matched to soil infiltration rates so that water movement within the field is minimized, and runoff from the field is eliminated. The plan's final design considers land slope, crops, residue, system application rate (gallons per minute), system length, soils, and wetted diameter. RDPs are technical designs, based on crop and operational methods proposed by the water right applicant, for applying irrigation water efficiently. They do not address individual management issues which are covered by other district policies.

The RDP process has recently been streamlined. Originally, an applicant had to visit both the GMD and Natural Resources Conservation Service (NRCS) offices to satisfy the full process. Now, an NRCS employee is located full time in the GMD office. What had been a two-stop process taking six months or longer now requires one stop and half the time. This arrangement does not exist anywhere else in the state, and has allowed GMD 4 to produce more effective resource-development plans.

References

NW Kansas Groundwater Management District No. 4, 2001, Current GMD 4 Management Program: http://colby.ixks.com/-wbossert/mp.thml (May 25, 2001).

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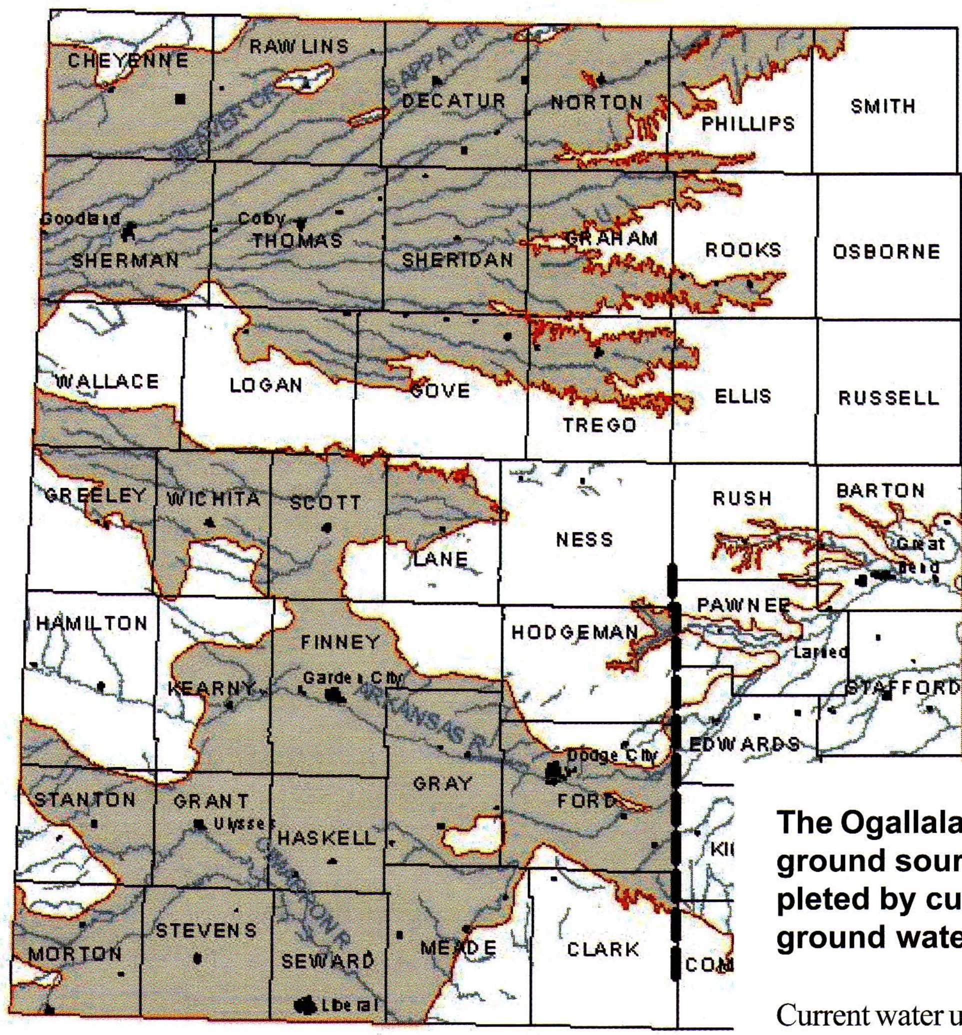
A New Idea for Managing the Ogallala Aquifer for the Future

A new idea for managing the Ogallala aquifer is proposed that will address the rate of depletion of ground water supplies in western Kansas and protect some of it for future generations.

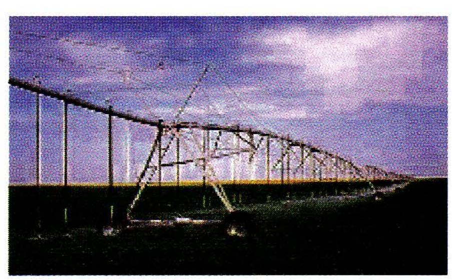


The Ogallala Aquifer, a large underground source of water, is being depleted by current water usage and ground water development

Current water usage, primarily widespread large-volume pumping for irrigation, is depleting the primary supply for western Kansas. Water is being pumped faster than it can be replenished each year by precipitation that seeps through the soil and down to the aquifer. If current pumping rates continue, the usable supply of ground water eventually will be exhausted.

The decline of the Ogallala Aquifer poses a tremendous challenge to the economy of western Kansas.

As ground water supplies become inadequate to support widespread, large volume irrigation, not only will farmers be affected, but so will the businesses and communities that are part of the irrigated agriculture economy. Water planning and management can help individuals, businesses, and communities prepare for the future.



The idea of managing "two pools" of water in the Ogallala: a plan for the future?

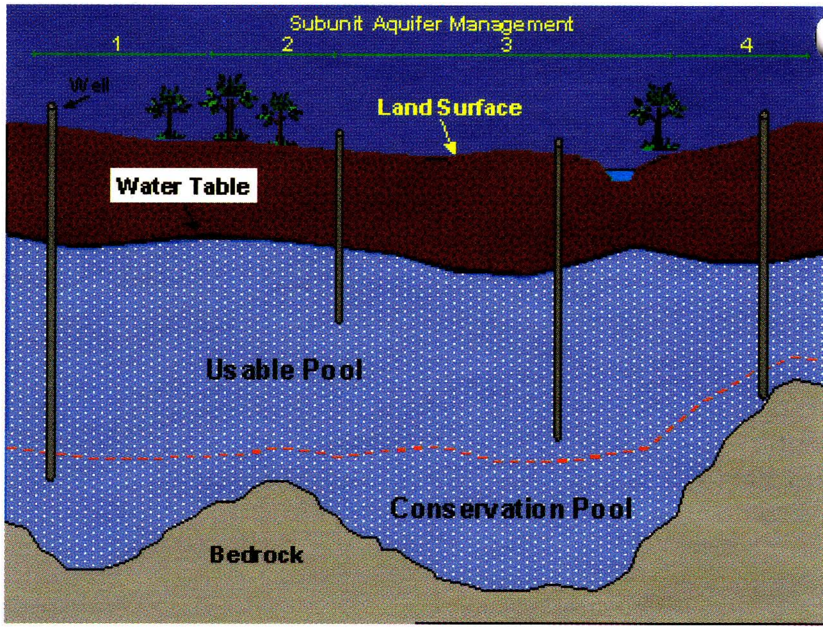
The two-pool idea could make the inevitable transition to reduced water consumption a successful one.

The two-pool idea is based on the premise that the remaining water supply in the Ogallala can be divided into two separate volumes of water. One volume, the conservation pool, would be based on the recharge rate, plus any additional volume necessary for the water to sustain communitites and the environment. The annual recharge is that portion of the annual precipitation that seeps down through the soil into the ground water. This small pool of water renewed each year by recharge is a supply that could sustain healthy communities for all time if annual pumpage remained less than the annual recharge minus the stream outflows. The other much larger pool of water, the usable pool, is the remaining quantity that will be depleted over time. It is stored in the aquifer and will eventually be used up within some period of time depending on the level of use.

In most areas of the Ogallala, existing pumping uses ground water in excess of the amount replenished by recharge minus stream outflows. If the two pools concept is adopted, water use must decrease as the level of aquifer depletion approaches the volume in the conservation pool.

Is this a good idea for western Kansas?

The distinction between the conservation pool and the usable pool could facilitate the management, transition, and planning for reduced, sustainable regional water use. Ultimately, to sustain healthy communities, water usage must be limited to an amount that will not deplete the conservation pool. Also, the length of time it takes to deplete the usable pool provides an opportunity to prepare for this decrease in water use.



Kansas Water Office, 2000

Communities must decide how to manage water use.

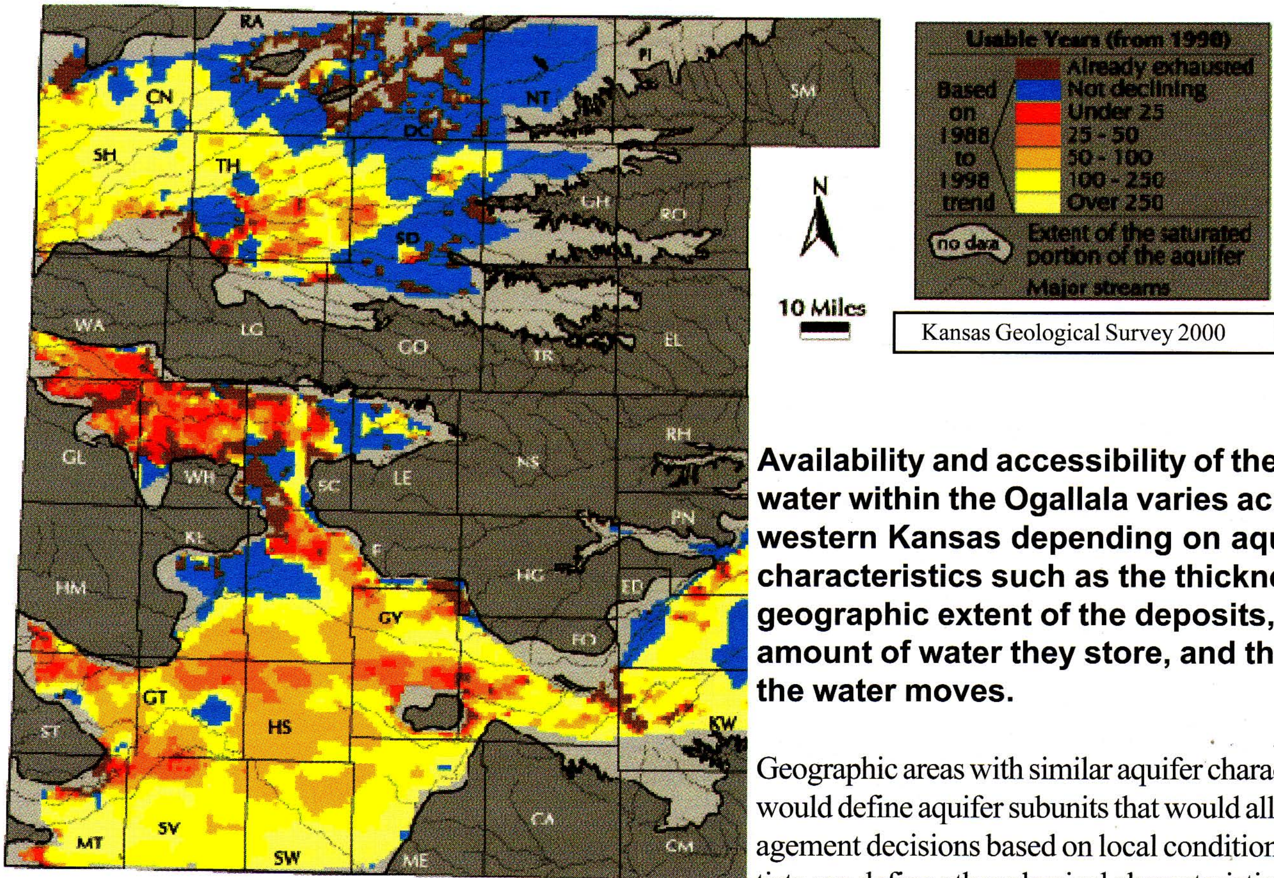
Communities share common interest in the ground water resource and in the management approach. Therefore they should provide some input to assumptions made by scientists that involve water management risks when technical data is uncertain. This is particularly important in helping determine how to control the rate of depletion, protect the conservation pool, and define the line that separates the volume in the conservation pool and the usable pool. They must also help decide the water management options for a healthy community and the time frame in which the usable pool will be depleted. Various local organizations, such as groundwater management districts, watershed and conservation districts, and basin advisory committees, that typically represent communities are essential participants in these matters.

Communities include those who use water in western Kansas:

- o Irrigators, other producers
- o Cities/towns
- o Businesses
- o Industries
- o Individuals who rely on water in western Kansas

The Ogallala Aquifer is not uniform across western Kansas

The aquifer consists of stored ground water that is moving slowly through deposits of sand, gravel, silt and clay.



Availability and accessibility of the ground water within the Ogallala varies across western Kansas depending on aquifer characteristics such as the thickness and geographic extent of the deposits, the amount of water they store, and the rate the water moves.

Geographic areas with similar aquifer characteristics would define aquifer subunits that would allow management decisions based on local conditions. Scientists can define other physical characteristics of the subunits that would affect the amount and availability of water such as:

- o Water table level
- o Recharge rate
- o Ground water outflows to streams
- o Aquifer decline rate trends

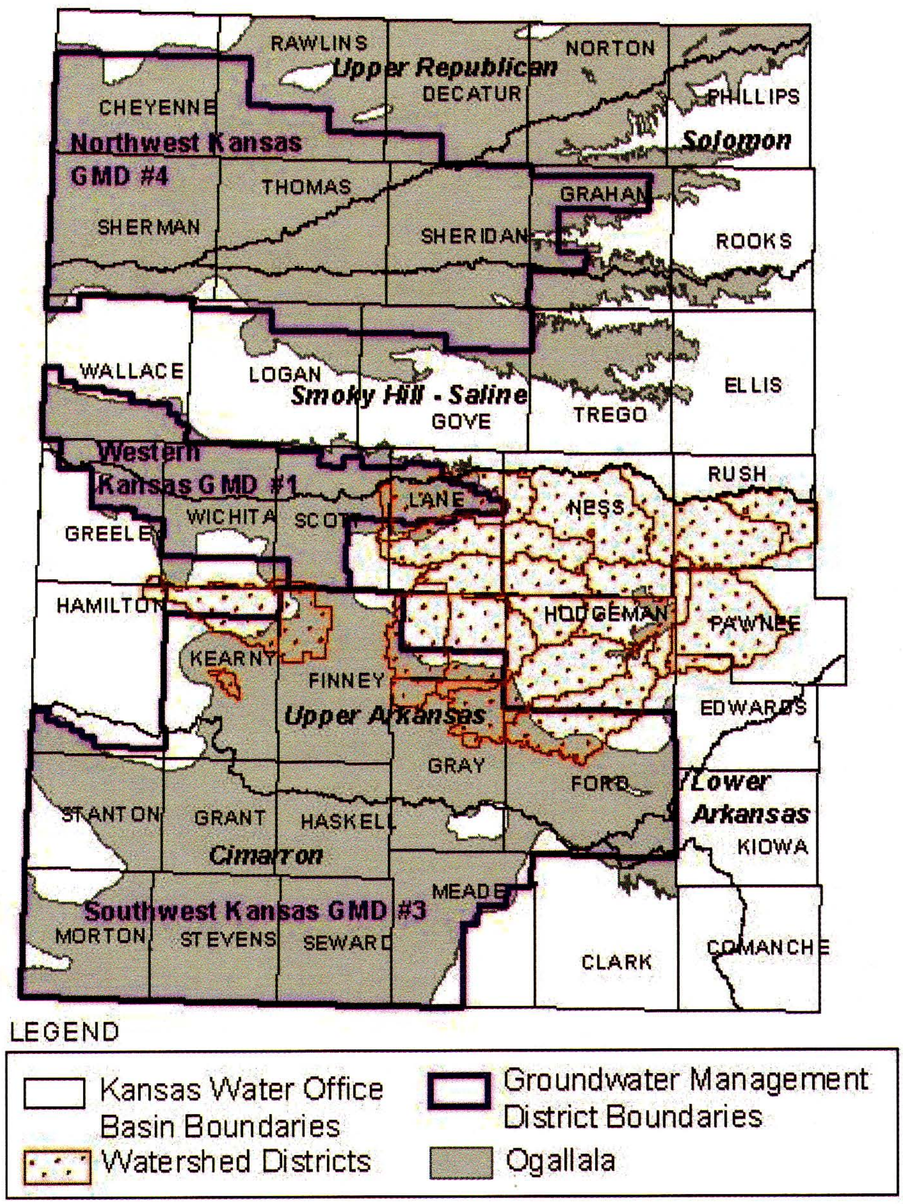
Many technical issues must be worked out to make this concept work. The volume of water contained in the conservation pool is determined by the annual recharge and the water level that must be maintained in the aquifer to make it available for use. The rate water is pumped will determine the time remaining to deplete the usable pool. Scientific analysis within each subunit will determine its geographic extent, estimated volumes in the two pools, and a refined time to deplete the usable pool based on given water use throughout the Ogallala.

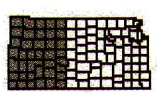
The market for land and water rights within the context of the Water Appropriation Act and the related rules and regulations will serve to protect water users and to support transitions to decreased water use.

Water in the conservation pool would be administered according to prior appropriation, not on type of use; that is, first in time is first in right. A water right is a real property right that can be bought, sold, or leased. Communities can project when the usable pool might be exhausted, and plan for buying, if needed, senior water rights that would allow them to withdraw from the conservation pool. Availability of water in sufficient quantities for priority uses will determine the value of water rights as time passes. The existing Water Appropriation Act would continue to protect existing water rights as the usable pool is depleted.

This idea, if implemented, would be consistent with the Kansas Water Plan 2010

Objective: By 2010, reduce water level declines within the Ogallala Aquifer and implement enhanced water management in targeted areas.





Ogallala boundary taken from KGS and USGS investigations.

The water planning process will work through local community organizations

Public education and consensus on a plan will be addressed through a series of public information meetings. Water users in the communities within the Ogallala Aquifer area will have an opportunity to learn about the idea of two pools. They also will be given an opportunity to be involved in management decisions concerning the future of their water supply.

References

An Atlas of the Kansas High Plains Aquifer, Kansas Geological Survey, 2000. Available on the website: www.kgs.ukans.edu/HighPlains/atlas

Rules and Regulations, Kansas Water Appropriation Act, Kansas Department of Agriculture, Division of Water Resources, Sept. 22, 2000.

Kansas Water Appropriation Act, K.S.A. 82a-701 et. seq.

Kansas Water Plan, Fiscal Year 2002, Kansas Water Authority, July, 2001. Available on the website: www.kwo.org

Two-Pool Concept Update

For the next few months, two select committees appointed by Al LeDoux, Director of the Kansas Water Office, will work together to develop a plan to enhance the management of the water resources of the Ogallala aquifer. LeDoux was directed by the Kansas Water Authority to appoint committee members to recommend ways to meet the Kansas Water Plan's 2010 objective: ". . . reduce water level decline rates within the Ogallala aquifer and implement enhanced water management in targeted areas." The Kansas Water Authority (KWA) is the statutorily appointed group that advises the Governor and the Kansas Legislature.

The two committees, a management committee and a technical committee, met jointly May 23, 2001, at the Quartelejo Museum in Scott City. The meeting was open to the public.

Results of the committees' work will be submitted to the KWA in November. KWA members then will determine whether the suggested plan should be considered by the public through the state's water-planning process. Public meetings on the proposed plan would then be held in the spring of 2002.

The management committee is made up exclusively of western Kansans whose livelihoods are directly affected by what happens to the Ogallala. Chairman of the committee is Tom Bogner, a farmer/stockman who formerly served as a board member on Groundwater Management District No. 3 and the KWA.

The technical committee membership includes western Kansans and state agency representatives with expertise in the geology, hydrology, and hydraulics of the Ogallala aquifer and Kansas water law. Local Kansans will provide hands-on regional knowledge of water usage and agricultural practices. The technical committee is charged with providing data support to the management committee and developing ideas based on the best available information. If more information is needed, the technical committee will recommend steps to obtain it.

The proposed "Two-Pool Concept" was one idea that served as a starting point for discussion. It was an outgrowth of the 1999 Kansas Legislature's passage of Senate Bill 287, which directed the KWA to assess Ogallala aquifer ground-water resources and competing needs for water. One outcome of the assessment was a detailed resource guide, "An Atlas of the High Plains Aquifer," prepared by staff members of the Kansas Geological Survey and the Kansas Water Office and approved by the KWA.

Scientists completing the report projected that parts of the Ogallala, given past water-decline trends, could lack sufficient water to support irrigation and other large-volume pumping within 25 years. The Two-Pool Concept addresses the rate of ground-water depletion, provides time for transition to reduced use, protects some ground-water for future generations, and matches management decisions to local aquifer conditions. The Two-Pool Concept is just one of many ideas the management and technical committees will explore.

The recently appointed ad hoc committees are authorized as part of the state's overall State Water Planning process that addresses all water-related issues. That process starts with the views of citizens expressed through the state's twelve Basin Advisory Committees and technical expertise from the state's water-related agencies. Development of the annually updated State Water Plan is a multi-step process with ample opportunity for public input from January through June of each year.

For more information on the workings of the Management Committee or the Technical Committee, contact the Kansas Water Office at (785) 296-3185 or (888) KAN-WATER, e-mail Al LeDoux at al@kwo.state.ks.us, or write to Kansas Water Office, 901 S. Kansas Ave., Topeka, KS 66612.

Management Committee Members

Tom Bogner, Committee Chairman, farmer/stockman, Dodge City

Carolyn Armstrong, Colby City Manager, Colby
David Brenn, irrigator, KWA member, Garden City
Brenda Davis, City Clerk, Scott City
Jay Garetson, general manager of Providence Grain LLC and irrigator, Copeland
Greg Graff, farmer and chairman of the Kansas Grain Sorghum Producers Assn., Marienthal
Representative Carl Dean Holmes, land manager, Liberal
Cliff Mayo, irrigator, KWA member, Garden City
Larry McCants, president of First National Bank, Goodland
Senator Steve Morris, farmer, Hugoton
Don Paxson, Penokee, farmer and KWA member
Steve Rome, irrigator and member of the Cimarron Basin Advisory Committee, Hugoton
Dick Sterrett, farmer and member of the Smoky Hill-Saline Basin Advisory Committee, Quinter
Carol Weibert, controller, Decatur County Feedyard LLC, Oberlin
Wayne West, Deerfield City Administrator, Deerfield

Technical Advisory Committee

Al LeDoux, Committee Chairman, Kansas Water Office
Fred Askren, irrigator, Garden City
Walt Aucott, U.S. Geological Survey, Lawrence
Wayne Bossert, manager of Groundwater Management District No. 4, Colby
Hank Hansen, Groundwater Management District No. 3, Garden City
Bill Harrison, Kansas Geological Survey, Lawrence
Kirk Heger, Southwest Kansas Irrigators Assn., Hugoton
Louis Hines, irrigator, Colby
Marc Johnson, dean of the College of Agriculture, Kansas State University, Manhattan
Keith Karnes, crop manager, Oakley
Larry Kepley, farmer, Ulysses
Keith Lebbin, manager of Groundwater Management District No. 1
Representative Melvin Neufeld, Ingalls
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McCarty Dairy

The McCarty family established a new dairy near Rexford, Kansas, in the spring of 2000. The McCartys came to Kansas from Pennsylvania, where they operated a dairy farm for several years. To bring their sons into the business, the McCartys needed to expand the dairy. Because of development pressures in Pennsylvania, the family decided to relocate their business to the midwest. After considering several states, and three sites in Kansas, the McCartys decided the Rexford site best fit their needs.

Located approximately five miles west of Rexford, the dairy site was selected because of its isolation from surrounding residential areas and adequate agricultural land to utilize the animal manure nutrients using an intensive management approach. Except for two habitable structures (for which waivers are on file at the Thomas County Register of Deeds), the dairy owns all structures in the vicinity.

The dairy is currently milking 850 cows three times a day and producing about 65,000 pounds of milk each day (average of 74 pounds of milk per cow). Altogether, there are about 1,100 head at the facility. All of the milk is shipped to a cheese factory in Ravenna, Nebraska.

Design

McCarty Dairy is designed for approximately 3,000 milking cows (average live weight of 1,350 pounds per cow), to be expanded in three phases. Currently operating in Phase One (fig. 4-2), the facility consists of a freestall confinement barn, a 24-stall milking parlor (expandable to 50 stalls), and a maternity/treatment barn, for sick, maternity, and dry cows. All calves and replacement cows are kept off-site. The manure-management system includes a sand separator basin, two manure settling basins, a wastewater-storage lagoon, and a recycled wastewater flush system.

The Phase Two expansion, expected within three years, would involve construction of another freestall confinement barn and expansion of the milking parlor to 50 stalls. The manure settling basins and the wastewater storage lagoon were designed and built to accommodate the Phase Two expansion.

Phase Three will involve the addition of two more freestall confinement barns, an additional 50-stall milking parlor, an extension to the maternity/treatment barn, a second recycled wastewater flush system, two more manure settling basins, and another wastewater storage lagoon. Phase Three is expected to be built within the next three to five years.

A pollution-control permit has been approved for the full capacity of 3,560 total cows (3,000 cows in milk and 560 dry cows). Design details for phases one and two have been approved by Kansas Department of Health and Environment (KDHE). Updated design details for Phase Three will be presented to KDHE for review and approval prior to construction.

Waste Management

Wastewater and manure flow by gravity to two manure settling basins where settleable solids are removed. Overflow wastewater is conveyed to the wastewater storage lagoon. Water from the storage lagoon is recycled to flush the freestall confinement barn and directed to a center pivot for managed irrigation and nutrient application.

The manure-management system for the first two phases utilizes two, parallel manure settling basins and a wastewater storage lagoon designed to exceed minimum KDHE design standards. The freestall confinement building is routinely flushed with recycled wastewater from the storage lagoon that sends the manure to the manure settling basin where the settleable solids are removed and the overflow wastewater drains into a single cell storage lagoon. The milking parlor is washed with fresh water, which is also recycled for flushing the freestall barn. The maternity/treatment barn has small open lots with adjacent sediment basins. Drainage from the open lots is directed to the storage lagoon. All other storm-water runoff is diverted around the manure settling basins and the storage lagoon. The lagoon is managed in accordance with the best available technology to assure optimum utilization of nutrients and minimum odor.

All animal manure generated by this complex is recycled and utilized on the surrounding crop land. Approximately 1,800 acres of crop land are adjacent to the complex. Liquid manure is applied to the land areas utilizing center pivot sprinkler irrigation systems. Solid manure is applied to the land using portable spreading equipment. All soil plant filter areas will receive controlled applications consistent with infiltration capabilities of the natural soils and the nutrient needs of crops. Application buffers are maintained between manure utilization areas, streams, and property boundaries.

Resource Contacts

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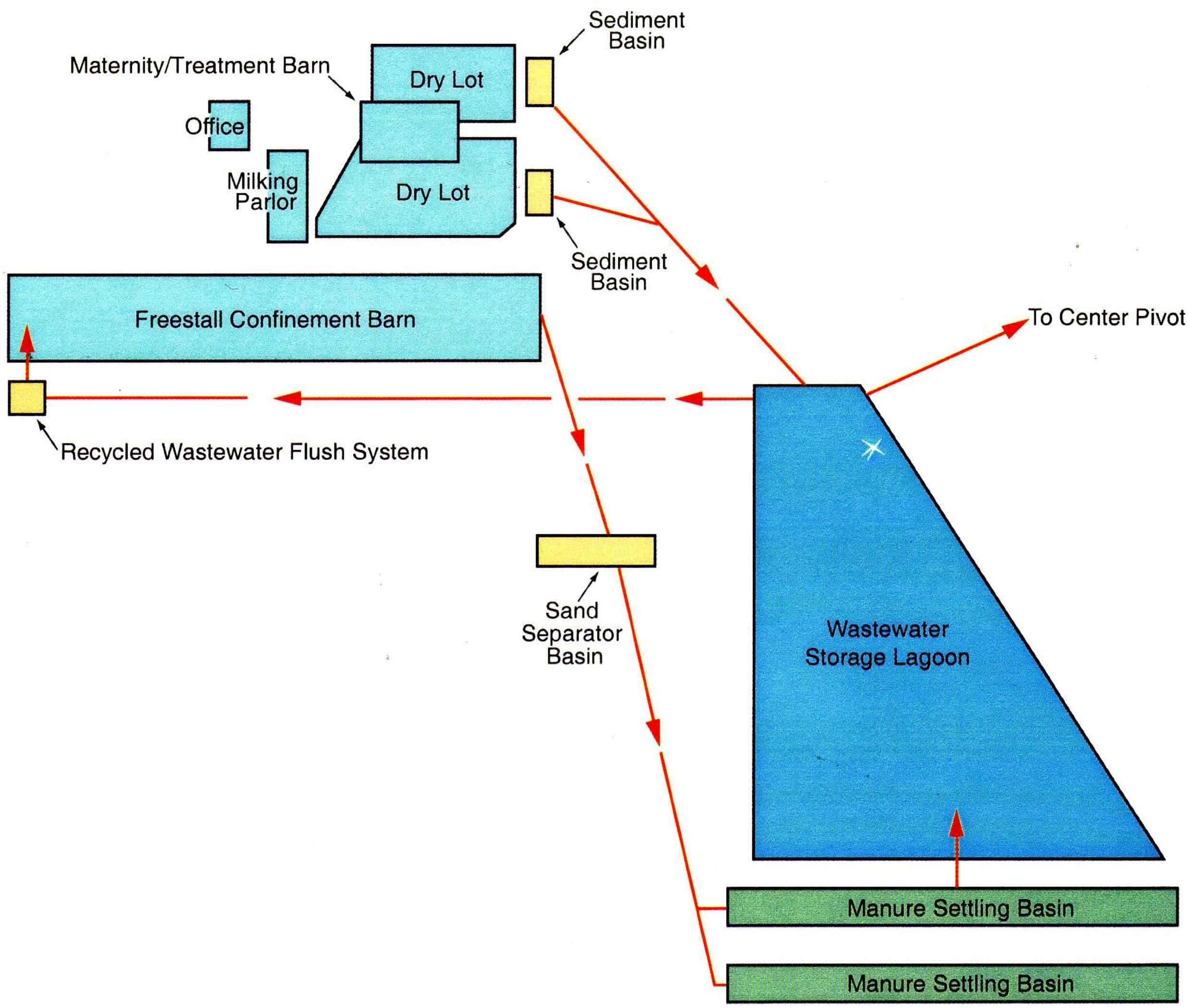

Fig. 5-2. Diagram of the McCarty Dairy.

Republican River Compact and Litigation

The Republican River begins in the plains of eastern Colorado, flows through northwest Kansas and southwest Nebraska, and, after traversing a good part of southern Nebraska, returns to Kansas in Republic County before emptying into Milford Lake. After leaving Milford, the Republican River joins the Smoky Hill to form the Kansas River (fig. 4-3).

Following Congressional consent and Presidential approval of the Republican River Compact in May 1943, the Bureau of Reclamation and Corps of Engineers began the planning and development of projects in the basin. The federal projects in place today include a system of seven Bureau of Reclamation reservoirs, two Corps of Engineer's projects (Harlan County Reservoir in Nebraska and Milford Lake), and six irrigation districts.

In addition to the federal projects, significant ground-water development has occurred in the Republican River basin. This ground-water development is at the heart of the current controversy between Kansas and Nebraska. Kansas alleges that in many years, Nebraska's ground-water use, when combined with its surface-water use, places it over its allocation under the Compact.

Significance to Kansas

The Republican River and its tributaries are important resources to the State of Kansas. Kansas interests in the basin include: (1) ground- and surface-water rights in the upper Republican River tributaries of northwest Kansas, including the South Fork Republican River, Sappa Creek, Beaver Creek, and Prairie Dog Creek including the Almena Irrigation District; (2) the Kansas Bostwick Irrigation District; (3) both surface water and ground-water users of the mainstem Republican River in Kansas; and (4) users of Milford Lake including downstream users on the Kansas River.

The Republican River Compact

The Republican River Compact was negotiated during the early 1940's with participation by the states of Colorado, Kansas, and Nebraska and a representative of the President of the United States. The Compact was formally signed on December 31, 1942.

Its purposes, as stated in Article I, are to (1) provide for equitable division of such waters, (2) remove all causes of controversy, (3) promote interstate comity, (4) promote joint action by the States and the United States in the efficient use of water and the control of destructive floods, and (5) provide for the most efficient use of waters in the Republican River basin.

To accomplish these purposes, the negotiators of the Compact determined the basin's virgin water supply, defined as "the water supply within the basin undepleted by the activities of man." Based on the virgin water supply determination, the Compact made specific allocations to each of the three states in fourteen different sub-basins. The Compact includes provisions for adjustment to the virgin water supply and allocations based on future records and/or changing conditions.

The Compact has a number of provisions related to the federal government's actions in developing projects within the basin to the benefit of the various states. Major federal developments anticipated by the Compact were flood control projects (clearly shown as being needed following the 1935 flood) and irrigation development.

The Compact makes it the duty of the three states to administer the Compact through the official in each state who is charged with administering water law. The Compact grants to those officials, in their capacity as Compact Commissioners, the power to adopt by unanimous vote, rules and regulations consistent with the provisions of the Compact. In the late 1950's, following the construction of several of the federal projects, the Compact Commissioners met to establish the administration of the Compact. The meetings resulted in the adoption of rules and regulations by which the Compact is administered on July 15, 1959. During the annual meetings in the early 1960's, methods were adopted to annually estimate, by sub-basin, the virgin water

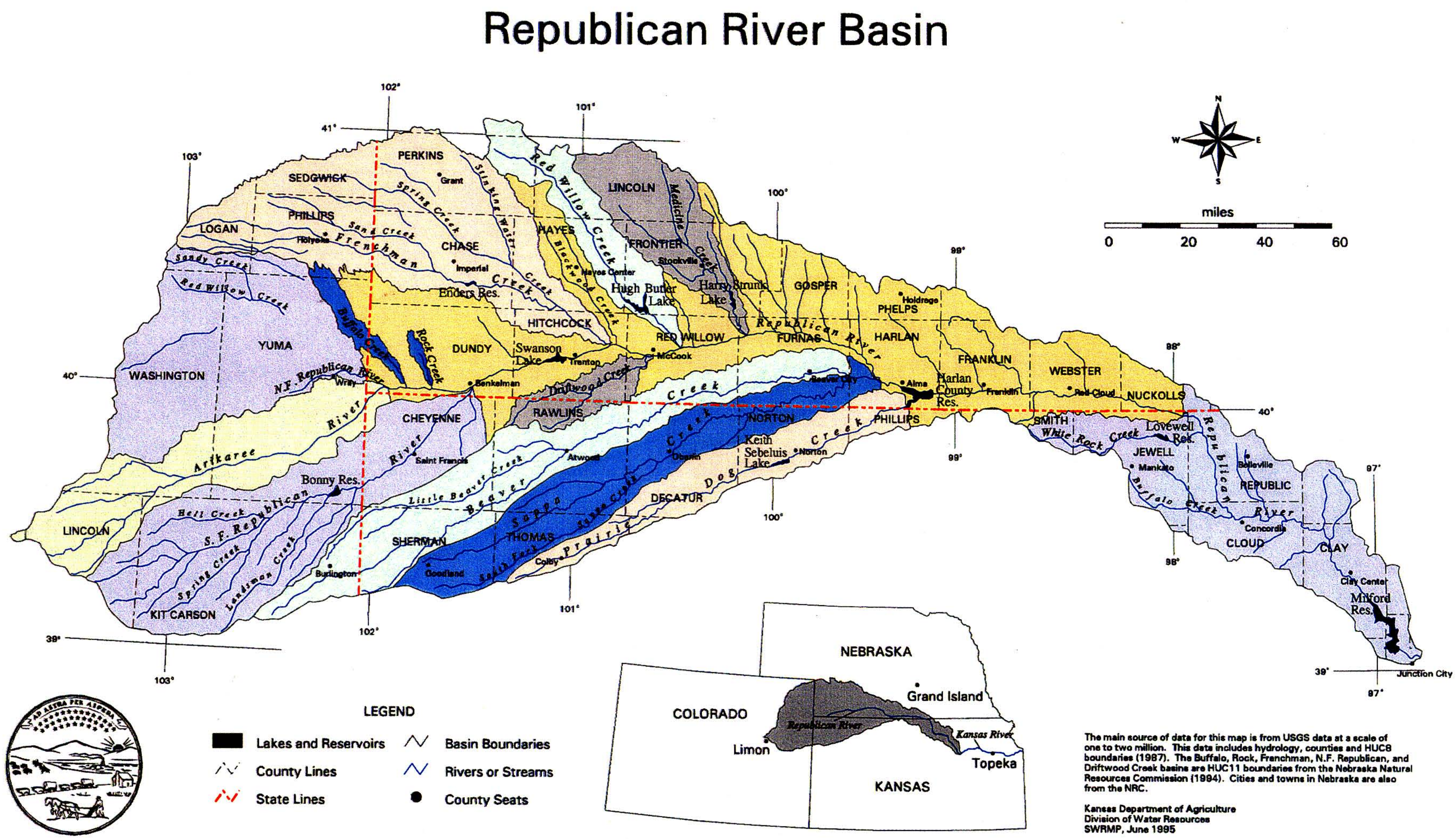

Fig. 4-3. Republican River Basin (Kansas Department of Agriculture, Division of Water Resources).

supply and consumptive use of surface water and ground water by each of the states. The Compact Administration meets annually to report on events pertaining to the Compact and to take any necessary action regarding the administration of the Compact. The states can make rules and regulations for administration of the Compact only by unanimous vote. During the 1960's, the Compact Administration developed methods to estimate the basin's water supply and uses of the supply, and each year these estimates are prepared by the Compact Administration. Annual estimates were discontinued in 1995 because the states disagreed on the methods used to make these estimates.

Litigation

After years of seeking to resolve concerns about Nebraska's overuse of its Republican River Compact allocations through the Compact Administration, in May 1998, Attorney General Stovall, on behalf of Kansas, filed a lawsuit before the U.S. Supreme Court to seek relief. Kansas' complaint stated that Nebraska had breached the terms of the Republican River Compact by allowing the proliferation and use of ground-water wells that are hydraulically connected to the Republican River and its tributaries, and by failing to protect the surface flows from other unauthorized appropriations. On January 19, 1999, the U.S. Supreme Court issued its order agreeing to hear Kansas' case.

In April 1999, the Court invited Nebraska to file a motion to dismiss Kansas' case based on its contention that ground water is not regulated by the Compact. During the summer of 1999, Nebraska, Kansas, Colorado, and the federal government each filed briefs on the motion to dismiss. The Supreme Court appointed a special master to hear the motion to dismiss. On January 4, 2000, oral arguments on Nebraska's motion to dismiss were heard before Special Master Vincent McKusick. The state of Colorado and the U.S. Department of Justice presented oral arguments at the hearing, arguing, along with Kansas, that ground water is regulated by the Compact and that Nebraska's motion to dismiss should be denied.

On January 28, 2000, the special master submitted his report and recommendations to the Court on Nebraska's motion to dismiss. The master recommended that the Court reject Nebraska's motion, firmly rejecting Nebraska's claim that ground-water consumption could not be restricted by the Compact. The master also rebuffed Colorado's argument that the Compact could not restrict non-alluvial (Ogallala) pumping. On June 29, 2000, without oral argument, the Court denied Nebraska's motion to dismiss and recommitted the matter to the special master for further proceedings.

On October 16, 2000, at a case status conference, the special master ruled from the bench denying, without prejudice, the motions for leave to participate as friends of the court for 16 Nebraska political subdivisions (power districts, irrigation districts, and natural resource districts).

On October 19, 2000, the special master issued case management order No. 6, identifying a number of legal issues for resolution and setting forth an aggressive, detailed trial preparation schedule that has trial commencing on March 1, 2003.

On February 12, 2001, after briefing by all the parties and the U.S., the special master ruled on three of the issues identified at the case status conference of October 16, 2000. The special master's rulings supported Kansas' positions that a state is not entitled to consume any water allocated to another state if not put to beneficial use and that a state need not show injury to obtain prospective relief. However, on the third issue the special master ruled against Kansas' position that the published numbers by the Republican River Compact Administration for 1959–1994 of virgin water supply, allocations, and consumptive use were not conclusive. Thus, he will not allow these figures to be recomputed for the impact of Ogallala pumping. However, the special master left open which years prior to 1995 showed excessive water use. In addition, the special master will allow hydrologic investigation for purposes of determining compliance with the Compact since 1994.

The parties are now involved in the discovery phase of trial preparations. Initial Disclosures by the parties and the United States were completed by April 16, 2001, as required by order of the special master. The parties are now actively involved in inspections of federal agencies sites for documents that are relevant to the case. Site visits to the other parties will occur mid-to late summer.

References

Barfield, D., 2000, Republican River Compact, Background and Update: unpublished text for website (May 5, 2000). Edited 5/11/2001 by George Austin and David Barfield.

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Selenium and Arsenic in Public Water Supplies

Selenium

In 1974, Congress passed the Safe Drinking Water Act, requiring the U.S. Environmental Protection Agency (EPA) to determine safe levels of chemicals in drinking water that do or may cause health problems. These non-enforceable levels, based solely on possible health risks and exposure, are called Maximum Contaminant Level Goals (MCLG). The EPA has set the maximum contaminant level for selenium at 0.05 ppm because it believes, given present technology and resources, this is the lowest level to which water systems can reasonably be required to remove this contaminant should it occur in drinking water.

Selenium is a naturally occurring metal. Selenium can be either beneficial or toxic to plants, animals, and humans depending on its concentration. Found throughout the environment, selenium is derived mainly from rock weathering. In Kansas, the parent material for selenium-rich soils comes from the Pierre Shale and the Niobrara Chalk, both deposited during the Cretaceous Period (142 to 65 million years ago). Selenium is distributed by volcanic activity, combustion of fossil fuels, soil leaching, ground-water transport, metabolic uptake and release by plants and animals, sorption and desorption, chemical or bacterial reduction and oxidation, and mineral formation. Selenate, a compound of selenium, is highly mobile, easily leached from soils, and readily taken up by plants. Although natural water tends to have low concentrations of selenium, relatively high concentrations can occur if the water is alkaline or if it leaches and drains seleniferous rocks and soils.

The greatest use of selenium compounds is in electronic and photocopier components, but they are also widely used in glass, pigments, rubber, metal alloys, textiles, petroleum, medical therapeutic agents, and photographic emulsions.

Selenium is an essential nutrient at low levels. However, EPA has found selenium can potentially cause hair and fingernail changes, damage to the peripheral nervous system, and fatigue and irritability when people are exposed to it at levels above the maximum contaminant level (0.05 ppm) for relatively short periods of time. Long-term exposure to selenium can cause hair and fingernail loss, damage to kidney and liver tissue, and damage to the nervous and circulatory systems.

The toxicity of selenium depends on whether it is in the biologically active oxidized form, which occurs in alkaline soils. These conditions can cause plant uptake of the metal to be increased. It is known that selenium accumulates in living tissues.

Arsenic

The EPA is finalizing a regulation to reduce the public health risks from arsenic in drinking water, which would decrease the current drinking water standard for arsenic from 50 parts per billion (ppb) to 10 ppb by 2006. Studies have linked long-term exposure to arsenic in drinking water to cancer and other health problems, including cardiovascular disease and diabetes, as well as neurological effects. EPA is currently reviewing the new arsenic in drinking water standard.

Arsenic occurs naturally in rocks, soil, water, air, and plants and animals. It can be further released into the environment through natural activities such as volcanic action, erosion of rocks, and forest fires, or through human actions. Approximately 90 percent of industrial arsenic in the U.S. is currently used as a wood preservative, but arsenic is also used in paints, dyes, metals, drugs, soaps, and semi-conductors. Agricultural applications, mining, and smelting also contribute to arsenic releases in the environment.

The current standard of 50 ppb was set by EPA in 1975, based on a Public Health Service standard originally established in 1942. A March 1999 report by the National Academy of Sciences concluded that the current standard does not achieve EPA's goal of protecting public health and should be lowered as soon as possible.

EPA is setting the new arsenic standard for drinking water at 10 ppb to protect consumers against the effects of long-term, chronic exposure to arsenic in drinking water. EPA is using its discretionary authority under the 1996 Amendments to the Safe Drinking Water Act to set the standard at a level that "maximizes health risk reduction benefits at a cost that is justified by the benefits."

The new standard will apply to 54,000 community water systems nationwide. A community water system is a system that serves 15 locations or 25 residents year-round, including most cities and towns, apartments, and mobile home parks with their own water supplies. EPA estimates that roughly five percent, or 3,000, of community water systems, serving 11 million people, will have to take corrective action to lower the current levels of arsenic in their drinking water.

The new standard will also apply to 20,000 water systems that serve at least 25 of the same people more than six months of the year, such as schools, churches, nursing homes, and factories. EPA estimates that five percent, or 1,100, of these water systems, serving approximately 2 million people, will need to take measures to meet the new arsenic standard. Of all of the affected systems, 97 percent are small systems that serve fewer than 10,000 people each.

The average increase in household cost for water that meets the new arsenic standards depends on the size of the water system and how many people are served by that system. EPA estimates that for small community water systems (those serving fewer than 10,000 people), the increase in cost is expected to range between $38 and $327 annually. For community water systems that serve greater than 10,000 people, annual household costs for water are expected to increase from $0.86 to $32.

In April, 2001, EPA outlined the process by which it will work with the National Academy of Sciences and the National Drinking Water Advisory Council to review the science and cost estimates behind the standard. On May 22, 2001, EPA announced that it will delay the effective date for the standard until February 22, 2002, allowing time to complete the reassessment process and to afford the public a full opportunity to provide further input.

References

Juracek, K. E., and Ziegler, A. C., 1998, Selenium in Reservoir Sediment from the Republican River Basin: U.S. Geological Survey, Fact Sheet 080-98, July 1998, 3 p.

U.S. Environmental Protection Agency, 2001, Arsenic: http://www.epa.gov/safewater/arsenic.html (May 25, 2001).

U.S. Environmental Protection Agency, 2001, Drinking Water Standard for Arsenic: EPA Fact Sheet 815-F-00-015, January 2001, 2 p.

U.S. Environmental Protection Agency, 2001, Selenium: http://www.epa.gov/safewater/dwh/c-ioc/selenium.html (May 25, 2001).

Welch, A. H., Watkins, S. A., Helsel, D. R., and Focazio, M. J., 2000, Arsenic in Ground-Water Resources of the United States: U.S. Geological Survey, Fact Sheet FS-063-00, May 2000, 4 p.

Whitmer, J. M., 2001, Fate and Transport of Selenium and Uranium in the Upper Arkansas River Valley of Southwestern Kansas: Kansas Geological Survey, Open-file Report 2001-8, 218 p.

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High Plains Aquifer Sustainability—Statement to the Kansas Water Authority, July 11–13, 2000, by Bob Hooper, Chair, Solomon Basin Advisory Committee (reprinted with permission)

We of the Solomon Basin Advisory Committee know who we are, and we recognize the limitations of our official role. We are charged with giving you of the Kansas Water Authority and the Kansas Water Office the best advice we can, in the best long-term interests of the inhabitants of our basin—for today and for those who we hope will live here the remainder of this new millennium and those centuries to follow. We wish the public to understand clearly what our committee has advocated. While we have not yet had time to meet and consider together the "final Draft" of the Solomon Subsection of the 2002 Kansas Water Plan, I believe the Committee will continue to have serious objections about key elements.

Briefly, I believe:

We will hold to our recommendation that a specific timetable of 2015 be established to achieve sustainable use of water in our basin, concentrating first on those areas of significant depletion within the High Plains Aquifer.

We will question the KWO's estimate of reductions in reported usage needed in our basin to reach sustainable use (p. 124).

We will point to the indication by the KWO that recent years may show that rates of decline are returning to past conditions (p. 124).

We will argue that an expressed 2010 goal of stabilizing decline rates to sustain the usable life of the aquifer to 50 to 75 years is no real improvement over earlier projections, and demonstrates further temporizing and delay (p. 125).

We will note a seeming contradiction—in that under WATER RIGHT MANAGEMENT sub-basin, the goal is to "*reduce* water decline rates within the Ogallala Aquifer." [This is acceptable only if the goal is expressed as a *significant and quantifiable* reduction.] (p. 127)

We will suggest that the KWO-stated goal of achieving sustainable yield by 2010, but *outside* the High Plains Aquifer region, avoids the real problem, which precisely *inside* the High Plains Aquifer region (p. 125).

We will question the wisdom and source of the words "typically considered reasonable" when "reasonable" is used to justify the continued mining of an irreplaceable and vital resource (p. 127).

You are charged with accepting or rejecting our considered advice. History will hold both you and us accountable.

When we look at the Kansas Geological Survey's maps in *An Atlas of the High Plains Aquifer* in the western third of Kansas, our eyes are drawn to the prominent blotches of townships colored bright red to indicate that a 90 percent reduction in appropriated water is necessary to bring those areas into line with safe yield. Southwest Kansas and central-west Kansas seem awash, not in water, but in a sea of blood. Northwest Kansas, the neighborhood of our Solomon Basin Advisory Committee, is significantly better, the statistical tint less crimson—which is not to say that it is good.

We cannot but remark the sad irony that some in Kansas government and commerce proclaim an economic miracle in the very areas where the most tragic environmental mistake continues day by day, year by year. By what stretch can they or anyone celebrate Southwest Kansas as a wise or responsible model for economic development? And while the scenario there is most dramatic, the philosophy of planned depletion elsewhere in the western third of Kansas is the same. Where is the wisdom in all that?

An irreplaceable resource millions of years old is being mined in a relatively short time (even in human terms) because of arbitrary value judgments and the force of political and economic inertia. Yes, we allow that in some areas and to some degree, progress has been made. But not enough, and not fast enough.

Some small steps toward regulation have begun. Reported use (even though the figures in our area come largely from unmetered wells) is substantially less than appropriated acre feet. More stringent requirements have been placed on drilling new wells, and blatant over-pumping, where it can be can be documented, has finally been targeted by the Division of Water Resources, if not yet addressed. To date, however, the biggest positive factors like low-pressure drops to deliver water under the crop canopy and irrigation timing to avoid evaporative loss have been driven primarily by economic payback. Millions of dollars have been spent over several decades on hydrologic data-gathering and economic studies. More expenditures are proposed—yet the essential fact remains: the aquifer remains greatly over-appropriated and is still being depleted by policies and practices still in force.

Some "experts" have been adept in adding up and publicizing the short-term costs and dislocations of adopting an environmental policy of sustainability within a timespan sufficient to preserve real options for future generations. We only wish those same experts had been as thorough and assiduous in calculating or publicizing how much more costly the loss of the resource will be for future generations, who will have no options to use our once overflowing gift in a kinder way.

I have made no mention thus far of the continuing, probably permanent, loss of surface manifestations of groundwater—the little springs, seeps, creeks (and those less dramatic places where wildlife gather and flowers bloom), or loss of stream baseflow. Kansas Geological Survey research in Public Information Circular 9 says that "because of declines in ground-water levels, streamflows in western and central Kansas have been decreasing, especially since the 1970's," and an accompanying chart shows clearly the loss of stretches of once-perennial streams. Unfortunately, the minimum desirable streamflow law passed in 1982 says nothing about protecting such now intermittent streams or more subtle outflows of groundwater to the surface, effectively ignoring or discounting the damage that has been done. There is a sad tendency, for some, to dismiss the importance of these wetland areas because of their subtlety and modest scale, and yet both esthetically and ecologically they are critical in semi-arid Western Kansas.

Surely, we do not inhabit this planet only for today, nor do we all believe that making money is the most honorable achievement of our species. Yet, today, many in government and in the public have adopted an attitude that such problems cannot be solved except by economic incentives; that is, people must be paid to do the right thing or the right thing cannot be accomplished. That seems to me an unfortunate and erroneous, even perilous, attitude.

Without question, economic incentives work—sometimes very well. But often there remain those things money cannot buy, and problems that dollars cannot solve. Some solutions require sacrifice. Some take courage, which seems to be a rarer commodity. And there are always the questions of culpability—and proportionality of culpability.

We believe the issue before us—the addiction to groundwater mining—will take a combination of approaches: economic incentives, political courage, and material sacrifice. Over-appropriating the resource has been an error in judgment, to say nothing of greed and power, and those things frequently demand a price. It is rare that a serious and chronic problem is solved painlessly. In the righting of large wrongs, those directly responsible often suffer, but also those around them. Sometimes those who will suffer most have not yet been born. If reaching the goal of sustainability requires us to face "ugly" choices in the present—as a GMD manager recently characterized it—what word then describes the choices which we leave the future?

"Hideous," perhaps.

Make no mistake. The State of Kansas, represented by those in regulatory agencies and boards, bears great responsibility for the over-appropriation of water in this state. In 1994, the Division of Water Resources adopted Kansas Administrative Regulation 5-3-9, which, in its pertinent part, says that "unless otherwise provided by regulation, it shall be considered to be in the public interest that only the safe yield of any source of water supply, including hydraulically connected sources of water supply, shall be appropriated." The authorization for this new administrative regulation, which has the force of law, is K.S.A. 82a-706a—

which first became law in 1957! In other words, since 1957, the Chief Engineer has had the authority to enforce safe-yield in the public interest, but did not fully accept that responsibility until nearly forty years later, thus apparently "locking the barn door after nearly all the horses had departed."

Those who have encouraged and supported those unwise decisions of agencies and boards are equally culpable, whether it be those in the legislature or those advocating for special interests. Likewise guilty are those like myself in the general public who then and now have been so materially comfortable as to ignore our duties as citizens in failing to demand genuine stewardship of our natural resources, and letting ourselves be satisfied with rhetoric and procrastination.

The federal government, like the state, also bears a measure of guilt in failing to understand and honor the environmental dimension in crop subsidies and investment credits, for example—championing economic development and awarding subsidy dollars for water-intensive cropping where water is being mined, or for granting tax breaks for groundwater depletion.

Now, to step away from our addiction means that:

(1) The State of Kansas elected representatives and bureaucracy must admit primary responsibility for creating the problem and allowing it to persist, and courageously begin to exercise regulatory powers to remove incentives and to reduce pumpage over a specific timetable.

(2) The government of the United States must likewise accept blame and instigate changes in federal farm and tax policies which have previously allowed or encouraged groundwater mining.

(3) Taxpayers at both federal and state levels must pay for some portion of an accelerated transition away from a policy and practice of depletion to a policy of sustainability.

(4) Those who have used and benefited substantially from pumping over-appropriated wells, some for over a generation, must expect at best only a partial financial bailout, and accept some level of sacrifice.

Can all that be done? We think it can and must.

In the early 1990's, John Opie, from the New Jersey Institute of Technology, crisscrossed the land of the Ogallala gathering opinion and data, and stopped in Colby. There in 1990, Opie reports, a progressive Goundwater Management District board and staff had set a zero-depletion goal to be reached in as little as ten years—that of course would be this very year. Opie quoted a district official as saying, "the declining levels meant zero-depletion anyway, so why not opt to reach the same goal earlier while maintaining an acceptable quantity of water for future management options." To do just that, the official had said, was a "logical extension of its stated mission." The goal was soon abandoned, more than likely not because it was technologically unfeasible, but because the short term costs were judged by influential vested interests as economically, and thus politically, unpalatable.

It is important to note that the goal the Solomon Basin Advisory Committee has just recommended provides for what now would be a quarter of a century to actually accomplish in fact what GMD 4 accepted as their mission. In 1993 Opie, whose book, *Ogallala: Water for a Dry Land,* is considered a classic, wrote "irrigation on the plains is still in a self-destruct mode, and the Ogallala is still a non-renewable resource." We believe we are in solid company with John Opie and others like him in our own assessment of the situation, and we believe we are advising you properly—no matter how unpleasant and painful some will find it.

In March of 2000, J. A. Schloss, B. B. Wilson, and R. W. Buddemeier of the KGS compiled data to suggest that reductions of a third to a half at the township level would bring extraction to the approximate magnitude of recharge. In June those estimates were re-examined, and some areas were found to be in worse shape than originally thought. However, our own Solomon Basin, where depletion has been less severe, is still an excellent candidate for reaching a balance of withdrawing no more than is recharged naturally within the time frame we recommend. We have lost comparatively less, and consequently have more to protect.

We think it is not unreasonable to believe that average annual reductions of perhaps three to four percent (of the original reported use over the 15 years we've recommended) would achieve a state of safe yield—if not "sustainable yield," as strictly defined. However, it should be understood that continued depletion even at a lessening rate would result in the continued loss of additional hydrologically connected wetlands. That is a cost we who live in the Solomon Basin reluctantly may have to bear. Congress, too, may be ready to ask federal taxpayers as well to accept a share of the cost.

In June of 2000, Senator Bingaman and Representative Udall of New Mexico introduced companion bills in the Senate and House, which, so far as I know, are the first congressional recognition that federal funds are needed to help solve the problem. Senator Bingaman's bill, the first introduced and now in the Senate Agriculture Committee (where our own Senator Pat Roberts is an important member), proposes a $70 million expenditure for each of twenty years to address groundwater depletion in the High Plains Aquifer. In my own opinion, there are some fundamental changes to be made, with the hope that the funding will be made available on a proportional matching formula based on areas of decline, and acre-feet reductions in water appropriations needed—and can be targeted specifically toward reducing pumping. It is only reasonable to believe such funds should be made available to states who have established a timetable to achieve safe yield or sustainable use, and will make a proportional commitment of funds from a larger share of state water plan moneys.

These proposed state and federal funds are not, of course, manna from Heaven. They represent a share of the considerable fiscal pain ordinary taxpayers must accept for complicity in the problem—but it is neither fair nor just that they bear the pain alone.

Those who will see their pumpage reduced over a transition period are entitled to some economic support but cannot in fairness expect a "fair-market" buyout of the quantity of water which Kansas Statute says they do not own, but have indeed been allowed to use in excess over the years—in what was once mistakenly judged to be in the interest of the people of Kansas—and now has proved not to be so. In addition, Kansas and other states with areas of groundwater depletion must press for changes in federal farm and tax policies, as I have noted.

There is one more element to speak of here, which requires absolutely no money to solve. That is the issue of equitable representation in the governance of water.

In 1986, Stephen Hurst, then Director of the Kansas Water office, summarized the representational issues for Kansas Water Authority in a paper entitled "Concerns Associated with the Groundwater Management District Act." At that time, the League of Municipalities, the City of Hays, and the Solomon Basin Advisory Committee were among those who had raised the question. In August 1999, Mr. Hurst reviewed the events of 1986 for Mr. Le Doux, present KWO Director. In retrospect, Mr. Hurst said he felt that the representational issues concerning the GMD structure "were too politically volatile to deal with and chose not to do so." The issue was passed to legislative committees who made no recommendations for change. In 1999, again no substantive changes were recommended. Perhaps they truly felt none were needed, but perhaps again, the issue was just "too volatile" to deal with.

If my memory and notes serve me correctly, much earlier than 1986, a graduate student of KU Law Professor John Peck was among the first to question the fairness of "the fox guarding the henhouse," alluding to what he saw as a bias toward irrigation interests in setting important water policy.

In 1992, a Regents' Task Force, convened by the Governor *(Kansas: creating tomorrow through quality of life)*, said that (a) natural resources belong to all Kansans and future generations of Kansas, (b) there must be a long-term goal of sustainability, (c) the state must move from a reactive stance to a proactive stance in the stewardship of the environment, and (d) [the state must eliminate] "sending the fox to guard the henhouse" by biased boards and regulating agencies. All of these are recommendations that merit careful public attention.

So, finally, we ask what is it that the Solomon Basin Advisory Committee has advocated that is not in harmony with the goals of protecting the

Kansas Geological Survey
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Safe Yield and Sustainable Development of Water Resources in Kansas

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Introduction

The importance of water to every Kansan cannot be overstated. Drinking supplies for urban and rural households, irrigation for crops, and water for livestock, wildlife, recreational, and industrial purposes are uses that touch us all. Water is considered a renewable resource, but on a local or regional level, and in terms of a human lifetime, this is not always apparent. Most of us know of a stream, creek, or river that is now dry or carries less water than it did 25 years ago. The Arkansas River, particularly in western and central Kansas, is a classic example. With the boom in irrigation in the 1960's and 1970's, ground-water levels dropped substantially, again most dramatically in western Kansas (the Ogallala aquifer is an example). In some parts of Kansas, water resources are not being renewed, at least in the short term. Instead, exploitation continues, and aquifers are being depleted and streams are drying up.

State and local agencies have recognized the significance of these problems for some time and have implemented policies that address development of surface and ground water in the state. Termed *safe yield*, these policies attempt to address sustainable development of water resources—the idea of limiting the use of water now so that future generations will have the same opportunities. This circular will explain why the entire water system (hydrologic cycle) needs to be considered in managing water resources, and how ground water and surface water interact. It will show why safe yield is *not* sustainable yield, describe the concept of sustainable development of water resources, and illustrate how that concept can be applied to water-resource management in Kansas.

Terms printed in **boldface type** are defined in the glossary at the end of the circular.

The Hydrologic Cycle

To understand sustainable development of water resources, it is necessary to understand the relationships between surface water, ground water, climate, landscape, and the biosphere (**hydrology**). Water on earth circulates endlessly in what is known as the **hydrologic cycle** (fig. 1). This cycle has no beginning nor end, but from a global perspective, the oceans are the major source of water. Evaporation from the oceans and, to a lesser extent, the land surfaces supplies the atmosphere with water that condenses to form clouds and falls as precipitation. Most precipitation returns to the atmosphere as evaporation and as transpiration from plants. Transpiration in plants is similar to respiration (breathing) in animals and releases water vapor to the atmosphere. The processes of evaporation and transpiration are usually lumped together and called **evapotranspiration.** Precipitation that falls on the land either infiltrates the ground to replenish soil moisture or become ground water, or runs off as surface water to form lakes, streams, and rivers. Streams and rivers eventually flow into the oceans, where the cycle starts all over again. This cycle repeats itself over and over again with no loss or gain of water from the global system. On a local or regional level, however, fluctuations of the hydrologic cycle can be dramatic, sometimes producing floods and droughts. (For how Kansas fits into the hydrologic cycle, see p. 2.)

In some parts of Kansas, water resources are not being renewed, at least in the short term

Stream-aquifer Interaction

Precipitation and surface water that percolate through the soil and reach the aquifer are called **recharge.** Ground water slowly flows through the aquifer from areas of recharge (usually uplands) to areas of **discharge** (usually lowlands), such as springs, streams, or wetlands. Under natural conditions (prior to development by wells), aquifers are in a state of approximate dynamic equilibrium, which

Ground water and surface water are both part of a very complex hydrologic system, in which the alteration of one part affects all of the system

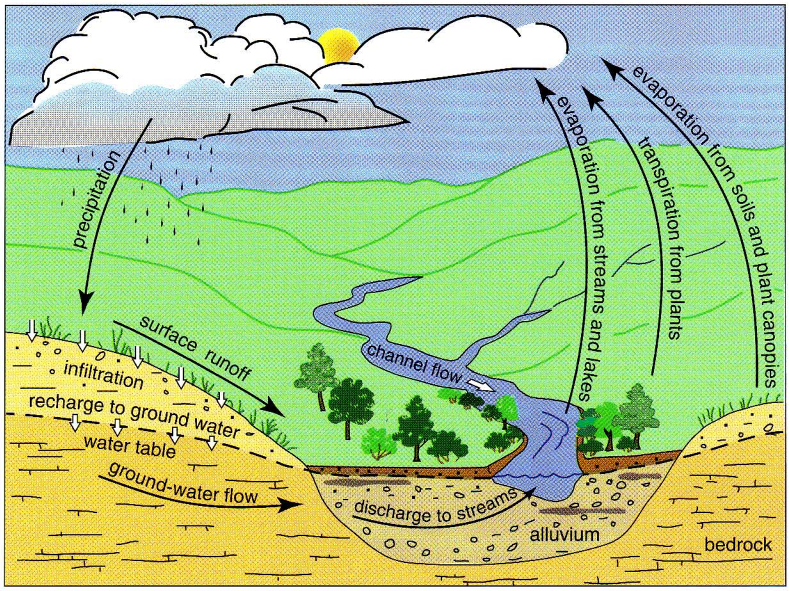


Figure 1—*The hydrologic cycle. Precipitation falls to the earth's surface, runs off or infiltrates the ground, then moves back into the atmosphere through transpiration or evaporation.*

means there is a balanced inflow and outflow of water in the system (fig. 2A). Over hundreds of years, wet times (in which recharge exceeds discharge) offset dry times (when discharge exceeds recharge). Pumping water from wells upsets this balance, oftentimes causing water-table levels to drop (fig. 2B), thereby producing water loss from aquifer storage.

The decline of ground-water levels around pumping wells located near streams captures some of the ground-water flow that would have, without pumping, been discharged to the streams. In fact, if enough water is pumped out of the aquifer, these declining ground-water levels can induce flow out of a body of surface water into the aquifer, a process known as induced recharge. The sum of these two effects leads to streamflow depletion.

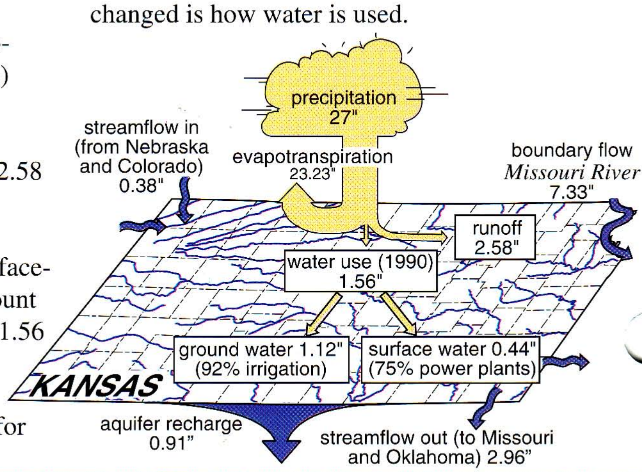
As pumping continues, a new state of dynamic equilibrium can be reached only when the amount c

Water Budget of Kansas

Like a household budget, the state's water budget is based on credits and expenditures. Most water enters the state as precipitation and leaves the state in streams and through evaporation and transpiration. Studying the state's water budget allows us to see where water expenditures are going and determine whether additional water is available for use or whether its use should be restricted.

It is easier to visualize the state's water budget if we think in terms of inches of water, averaging the amounts to cover the entire state. More than 98% of the water available for use enters Kansas as precipitation. The statewide average annual precipitation is about 27 inches (69 cm). Evapotranspiration returns about 23.23 inches (60 cm) back to the atmosphere. Aquifer recharge uses approximately 0.91 inches (2.3 cm). Runoff to rivers that originate within the state represents 2.58 inches (6.6 cm), and when combined with streamflow into the state from Nebraska and Colorado (equivalent to 0.38 inches, 1 cm), surface-water outflows to Missouri and Oklahoma account for about 2.96 inches (7.5 cm). Approximately 1.56 inches (4 cm) of water are used by Kansans annually. Ground-water use represents 1.12 inches (2.8 cm) of that total (92% is used for irrigation) and surface-water use equals 0.44 inches (1.1 cm) (75% is used by power plants). The equivalent of 7.33 inches (18.6 cm) flows by the northeast corner of the state in the Missouri River, but little of this water is used in Kansas (data from Sophocleous 1997b).

Although the precipitation, evapotranspiration, and other factors in the water budget vary widely from year to year, the averages over several decades remain nearly constant. The main water supply for Kansas—precipitation that falls on the state—has changed little in the last 150 years. What has changed is how water is used.



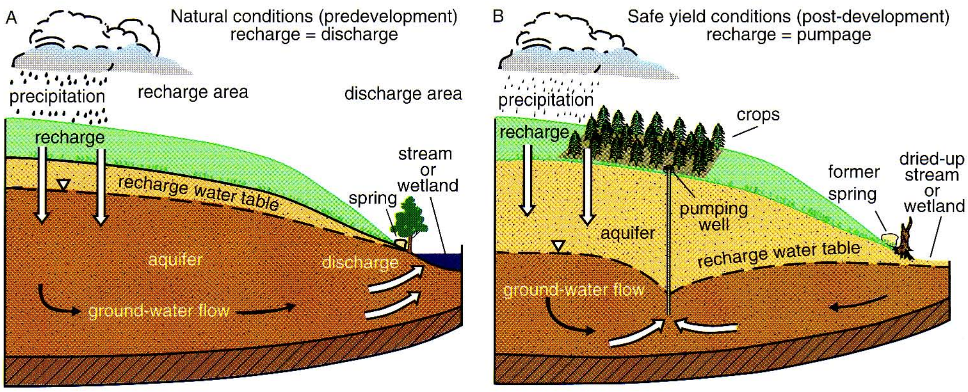


Figure 2—*Stream-aquifer interaction. A) Under natural conditions (prior to development by wells), aquifers are in a state of balance; inflow (recharge) equals outflow (discharge). B) Pumping may lower the water table, causing springs, streams, and wetlands to dry up; in this instance, recharge equals pumping.*

water removed from the aquifer is balanced by an increase in recharge (i.e., induced recharge), a decrease in natural discharge, a loss of storage in the aquifer, or a combination of these factors (Theis, 1940). Thus, pumping uses water from two sources, induced recharge and ground-water storage.

Since permanent streamflow is usually a result of ground-water discharge, lowering the water table below that of the streambed will reduce, or perhaps stop, streamflow. The same thing happens to wetlands and springs. Because streamflow is sometimes a source of recharge to some aquifers, a reduction in streamflow can also affect ground-water levels. Problems in the Smoky Hill River watershed (see p. 6) illustrate these interconnections between streams and aquifers.

In short, ground water and surface water are both part of a very complex hydrologic system, in which the alteration of one part affects all of the system. Surface and ground water are not separate components, and development of either water resource must be based on an understanding of the whole system.

Sustainable Development of Water Resources

Sustainable development is broadly defined as development of ource that meets the needs of the present without compromising the ability of future generations to meet their own needs. In this circular, sustainable development of water resources refers to a holistic approach to development, conservation, and management of water resources, an approach that considers all components of the hydrologic system. This concept requires that, in the long term, a balance must exist between the amount of water entering and the amount leaving the system. In other words, discharge to streams, springs, and wetlands (and pumping) must equal recharge, and ground water and surface water must be considered together.

To protect ground-water supplies from overdevelopment, some state and local agencies have enacted regulations and laws based on the concept of safe yield. Safe yield is defined as the attainment and maintenance of a long-term balance between the amount of ground water withdrawn (pumped) annually and the annual amount of recharge (Sophocleous, 1997a). Safe yield is a management concept that allows water users to pump only the amount of ground water that is replenished naturally through precipitation and surface-water seepage (recharge). As defined, safe yield ignores natural discharge from the system.

As stated earlier, under natural conditions, recharge to an aquifer is balanced by discharge. Consequently, if pumping is allowed to equal recharge, the streams, marshes, and springs will eventually dry up, because pumping removes the water that would otherwise be discharged naturally. Clearly, limiting water use to the amount of natural recharge is not enough. Nonetheless, this so-called safe yield concept is still mistakenly viewed as sustainable management.

Water-resource Management in Kansas

Ground-water pumping in the last 50 years has depleted parts of the **High Plains aquifer**, especially in southwestern Kansas, where water levels have dropped as much as 200 feet (61 m) in some places. These declines in the **saturated thickness** of the aquifer (fig. 3), especially in western Kansas, prompted the Kansas Legislature to pass the Kansas Groundwater Act in 1972, authorizing the formation of local ground-water management districts (GMD's) to help direct the development and use of ground-water resources. Since passage of the act, five districts have been formed 4).

The three western districts (GMD's 1, 3, and 4) overlie all or parts of the Ogallala aquifer and have the greatest number of large-capacity wells and the highest rate of water-level declines, while having the least precipitation and ground-water recharge. Each of these districts has adopted a plan that will allow a portion of the unappropriated aquifer to be depleted (no more than 40%) over a period of 20 to 25 years (planned depletion policy), implying that the Ogallala is not a renewable resource, at least within a human generation. This plan applies only to appropriations that were established since the policy was adopted in the late 1970's. By 1990, GMD 4 had switched to a zero depletion policy, for new wells only. Under zero depletion, an established average water level is maintained, regardless of the recharge rate.

In the late 1970's and early 1980's, GMD's 2 and 5 in central Kansas, which receive more precipitation (and thus more ground-water recharge), initially adopted the traditional safe-yield approach to ground-water management. According to this policy, the total amount of water that could be appropriated was limited to the

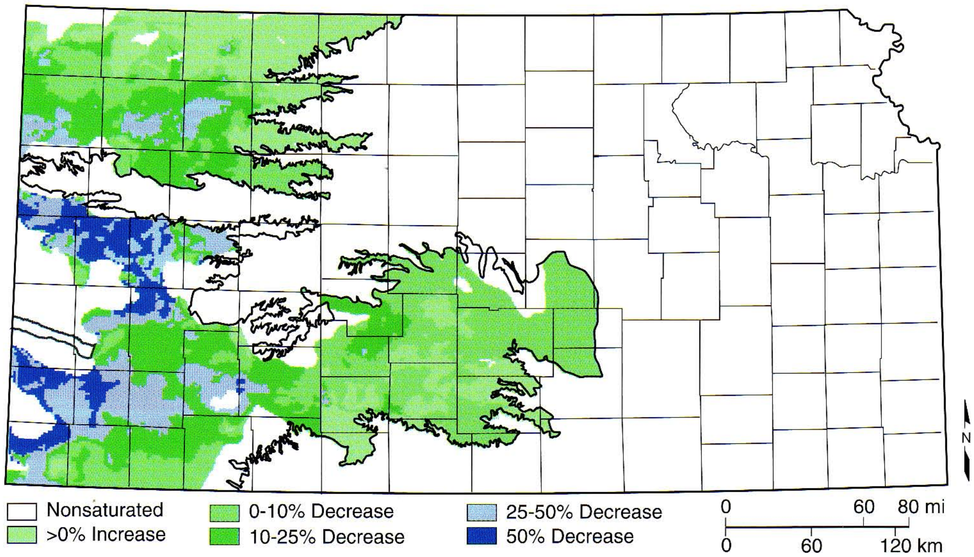


Figure 3—*Percent change in saturated thickness (predevelopment through 1996) of the High Plains aquifer in western and central Kansas (adapted from Sophocleous, 1997b).*

long-term annual recharge, implying a renewable ground-water resource. This was the first endeavor in the state to manage ground water as a renewable resource.

Because of declines in ground-water levels, streamflows in western and central Kansas have been decreasing, especially since the mid-1970's. In response to these streamflow declines, the Kansas Legislature passed the minimum instream flow law in 1982, which requires that minimum desirable streamflows be maintained in different streams in Kansas. Although the establishment of minimum desirable streamflows was a major step toward conservation of riverine habitat within the state, streamflows have continued to decline (Ferrington, 1993). Maps comparing the perennial streams in Kansas in the 1960's to those of the 1990's show a marked decrease in miles of streamflow in the western third of the state (fig. 5) .

As a result of continued declines in ground-water levels and streamflow in parts of GMD's 2 and 5 during the 1980's, both GMD's re-evaluated their safe-yield policies and regulations in the early 1990's. Beginning in 1994, these GMD's changed to **conjunctive management** of stream-aquifer systems by enhancing their existing safe-yield policies to include the natural ground-water discharge to streams (baseflow) when evaluating a ground-water permit application. The new regulations moved towards a sustainable-yield approach, but for regulatory and name-recognition purposes, GMD 2 continues to refer to them as safe yield, whereas GMD 5 changed theirs to sustainable yield. Both districts are monitoring the effect of the enhancements.

Policymakers, water regulators, and water users have come to realize that ground water and surface water are closely interrelated systems. Ground water feeds springs and streams, and surface water recharges aquifers. The interactions of ground and surface water affect quality as well as quantity. Ground water can be contaminated by polluted surface water, and surface water can be degraded by discharge of saline or other low-quality ground water. Streams and their alluvial aquifers are so closely linked in terms of water supply

***M**aps comparing the perennial streams in Kansas in the 1960's to those of the 1990's show a marked decrease in miles of streamflow in the western third of the state*

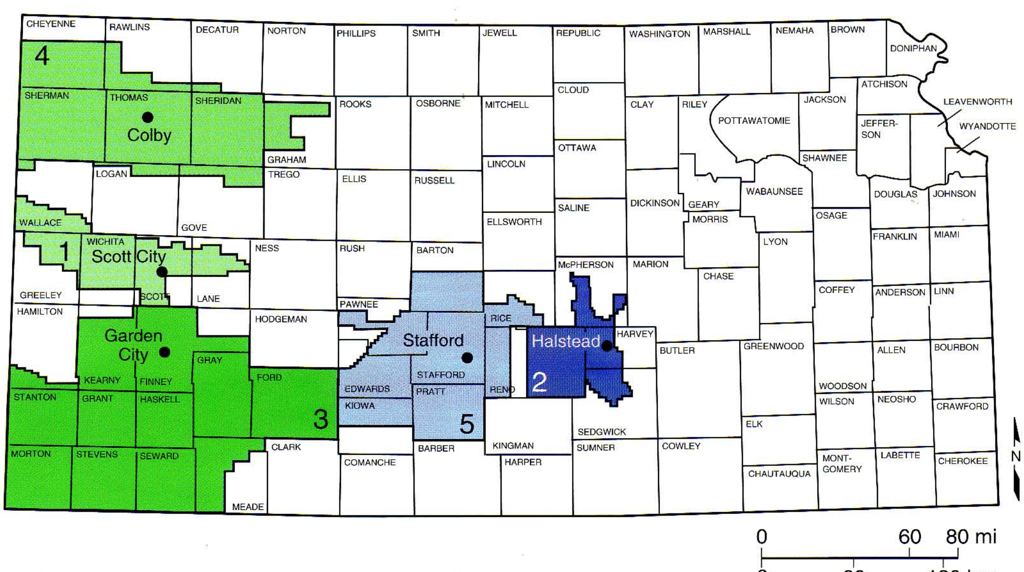


Figure 4—*Ground-water management districts in Kansas.*

The evolution of Kansas water-management policy away from the traditional notion of safe yield is an important first step toward the sustainable development of water resources in Kansas

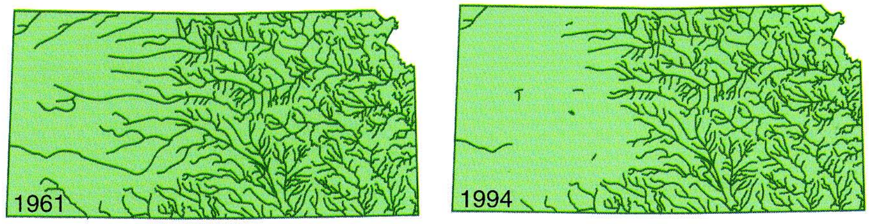


Figure 5—*Major perennial streams in Kansas in 1961 and 1994 (Angelo, 1994).*

and water quality that neither can be properly understood or managed by itself, and therefore the combined stream-aquifer system must be considered.

The Division of Water Resources, Kansas Department of Agriculture, is attempting to develop a comprehensive management program in areas of Kansas with significant water problems. Working within the framework of existing state laws, this program intends to develop proactive, long-term solutions, which take into account surface-water depletions, ground-water declines, and deterioration of the water quality. This holistic approach (referred to as the watershed-ecosystem approach) recognizes that streams are the products of their drainage basins or **watersheds** and their associated aquifers, not simply water flowing through a channel, and that to understand such stream-aquifer interactions, it is necessary to understand the surface- and ground-water watersheds associated with the stream. Close consultation and cooperation with the local GMD's, irrigators' associations, and other interested parties are integral parts of this program.

Management of the ground water and surface water of a watershed or drainage basin using the ecosystem approach is beginning to take hold in Kansas. The evolution of Kansas water-management policy away from the traditional notion of safe yield is an important first step toward the sustainable development of water resources in Kansas.

Further Reading

More information about the issues surrounding safe yield and sustainable development of water resources is available in a publication by the Kansas Geological Survey titled "Perspectives on Sustainable Development of Water Resources in Kansas" (Sophocleous, 1997b). Written primarily for water users, policymakers, and water regulators, this semitechnical volume provides background information about hydrologic systems and water-resource management in Kansas and discusses the concepts of safe yield, stream-aquifer systems, and sustainability. Other chapters address safe yield and confined aquifers, water chemistry, surface waters, and impacts of agriculture, climate change, and the complexity of hydrologic systems. The purpose of this publication is to educate Kansans about water-resources sustainability issues, to promote a better understanding of water resources in Kansas, and to encourage proactive and holistic management of these resources.

References and Additional Information

Angelo, R.T., 1994, Impacts of declining streamflow on surface water quality: 11th Annual Water and the Future of Kansas Conference Proceedings, Manhattan, KS, p. 1–2.

Baker, C. H., Jr., Kenny, J. F., and Pope, D. L., 1987, Kansas—Water supply and use: U.S. Geological Survey, Water-supply Paper 2350, p. 259–266.

Bennett, G., 1978, Ground water—An undervalued resource: U.S. Geological Survey Yearbook, Fiscal Year 1978, p.7–12.

Buchanan, R., and Buddemeier, R. W. (compilers), 1993, Kansas ground water: Kansas Geological Survey, Educational Series 10, 44 p.

Ferrington, L. C., Jr., 1993, Endangered rivers—A case history of the Arkansas River in the Central Plains: Aquatic Conservation—Marine and Freshwater Ecosystems, v. 3, p. 305–316.

Ratzlaff, J. R., 1987, Variations in runoff in the High Plains section of the Smoky Hill drainage, 1951–1980: Transactions of the Kansas Academy of Science, v. 90 no. 1-2, p. 25–34.

Sophocleous, M., 1997a, Managing water resources systems—Why "safe yield" is not sustainable: Groundwater, v. 35, no. 4, p. 561.

Sophocleous, M., ed., 1997b, Perspectives on sustainable development of water resources in Kansas: Kansas Geological Survey, Bulletin 239 (in press).

Theis, C. V., 1940, The source of water derived from wells: Civil Engineering, v. 10, no. 1, p. 277–280.

Glossary

Conjunctive management: An approach to the management of ground and surface waters that maximizes the net benefits from both resources over time.

Discharge: The movement of ground water to the land surface, surface water, or atmosphere.

Evapotranspiration: A collective term for water that moves into the atmosphere from evaporation from land or water and from transpiration from plants.

High Plains aquifer: In Kansas, three, hydraulically connected but distinct aquifers: the Ogallala, Great Bend Prairie, and Equus Beds aquifers. In general, the Ogallala Formation is made up of unconsolidated sand, gravel, silt, and clay deposited by streams that flowed east from the Rocky Mountains during the Miocene Epoch. The Great Bend Prairie and Equus Beds aquifers are also composed of silt, clay, sand, and gravel deposits left by streams flowing through central Kansas, but these deposits are generally younger (Pleistocene and Holocene) than the Ogallala. In some areas, these aquifers are in contact with each other and thus form one continuous aquifer.

Hydrologic cycle: The constant circulation of water from the earth's surface, through the atmosphere, to the earth's surface, and back to the atmosphere through transpiration and evaporation.

Hydrology: The study of the characteristics and occurrence of water, and the hydrologic cycle. Hydrology concerns the science of surface and ground waters, whereas hydrogeology principally focuses on ground water.

Recharge: The replenishment of water to an aquifer.

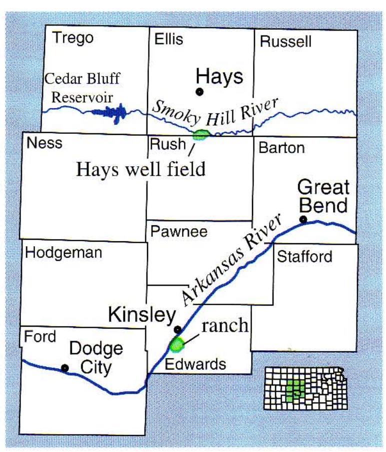
Saturated thickness: The vertical thickness of an aquifer that is full of water. The upper surface is the water table.

Watershed: The area of land drained by a single stream or river.

A Failure to Recognize Stream-aquifer Interconnections: Unexpected Things Can Happen!

Sometimes a decision about one aspect of a water system in Kansas has an impact on a variety of systems, impacts not necessarily intended or even recognized when the original decision was made.

In 1951, the Bureau of Reclamation constructed Cedar Bluff Dam on the upper reaches of the Smoky Hill River in Trego County in west-central Kansas. Cedar Bluff captures drainage from the Smoky Hill and two of its major tributaries. The dam was intended to provide flood control, water for irrigation and municipal use, and water for a fish hatchery. Shortly after the dam was completed, heavy spring and summer rains in 1951 and 1957 filled the reservoir. In the mid-1960's, however, inflow into the reservoir slowed substantially. Decreased inflow to Cedar Bluff was attributed to a lessening of streamflow related to lower water tables and the increased use of conservation practices in agriculture, such as terracing and building of farm ponds, that dramatically decreased runoff. Because of this lack of inflow, the contents of Cedar Bluff Reservoir averaged only about 13% of the designed level from 1980 to 1987 (Ratzlaff, 1987). Releases of water from Cedar Bluff to entities with water rights were curtailed in 1979.



Hays, Kansas, a city of about 18,000 people, is about 22 miles (35 km) downstream from Cedar Bluff Reservoir and about 10 miles (16 km) north of the Smoky Hill River. One of the city's primary water sources is a well field in the alluvial aquifer of the Smoky Hill River, which produced about 2,500 acre-feet of water annually. Lessened streamflows in the Smoky Hill—caused by the lower water tables, decreased runoff, and the lack of discharge from the reservoir—meant that considerably less water was available in the Smoky Hill to recharge the alluvial aquifer. Yields in the Hays well field dropped to about 1,000 acre-feet annually. Because of dwindling water supplies, Hays began a number of conservation efforts, resulting in a substantial reduction in per capita water use. The city also began aggressively seeking additional water sources, and eventually purchased land and water rights to a ranch in Edwards County, Kansas, about 85 miles (136 km) away, with plans of transferring water for municipal use in Hays, in spite of considerable opposition to the plan in Edwards County.

In short, then, lessened streamflow in the Smoky Hill River had the domino effect of lessening supplies in Hays, leading to the possible transfer of water away from the Arkansas River drainage basin, more than 100 miles (160 km) away from Cedar Bluff. The reservoir's construction, along with other factors, had a variety of consequences—related to agricultural, municipal, and irrigation water supply, as well as streamflow—that reverberated far beyond the simple building of a dam in Trego County.

The mission of the Kansas Geological Survey, operated by The University of Kansas in connection with its research and service program, is to conduct geological studies and research and to collect, correlate, preserve, and disseminate information leading to a better understanding of the geology of Kansas, with special emphasis on natural resources of economic value, water quality and quantity, and geologic hazards.

The Geology Extension program furthers the mission of the KGS by developing 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.

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October 1997

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resource—not just for the benefit of a segment of the economy for the next 50 or 100 years—but for this generation of Kansans and those who will follow in the centuries to come? Are we not asking for sustainability? Are we not being proactive in advocating stewardship?

While it will be difficult and painful to achieve, we believe sustainable use in our basin *is* achievable. We believe our basin can be a positive example for others to follow. We think a combination of approaches is advisable. We think, together and determined, we can do something significant. And we think it's past time to set an actual date and get serious.

[An etymological footnote: The word "steward" derives from the Anglo-Saxon words "stig warder," which meant, literally, the warder or herder of the "stig" or pigsty. The responsibility of the steward, then, from antiquity has required, if not altogether courage, then a certain willingness to face an often unwilling and determined opposition, and in less than pleasant circumstances.]

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Proposed Rules for Kansas Water Quality Standards

Under the Clean Water Act (CWA), states and tribes have the primary responsibility for developing and implementing water quality standards. The Clean Water Act requires that states review their standards at least once every three years and submit the results to the Environmental Protection Agency (EPA) for its review. EPA is required to either approve or disapprove such standards, depending on whether they meet the requirement of the CWA. Where EPA disapproves a standard, and the State does not revise the standard to meet EPA's objection, the CWA requires EPA to promptly propose substitute federal standards and to promulgate final federal standards 90 days thereafter.

In October 1994, the Kansas Department of Health and Environment (KDHE) submitted water quality standards to EPA for review and approval. In February 1998, EPA approved most of the State's new or revised standards, and disapproved certain provisions which were inconsistent with the CWA and EPA's implementing regulations.

In June 1999, Kansas completed a triennial review of its water quality standards, and submitted these revised standards for EPA review and approval in August 1999. In its submission, Kansas changed several provisions previously disapproved by EPA in February 1998. On January 19, 2000, EPA approved most of these new or revised portions of the states' water quality standards; however, six items remain unresolved. EPA's approval of these new or revised standards eliminated the need for a Federal promulgation to correct many of the previously disapproved provisions. A consent decree between the Kansas Natural Resources Council, Sierra Club, and EPA was signed on May 15, 2000, in which EPA agrees to propose the replacement standards for Kansas. The proposed Water quality standards for Kansas were published in the Federal Register on July 3, 2000.

EPA is proposing to promulgate the following six items:

Effluent created flows. KDHE revised the language in the 1999 standards to reflect that a Use Attainability Analysis (UAA) would be conducted prior to designating a stream as effluent created. Once the UAA was completed, the designation would be applied for the purpose of issuing a National Pollutant Discharge Elimination System (NPDES) discharge permit. EPA objected to this language and contends the effluent created designation must be adopted into the standards and approved by EPA before it can be implemented into a permit.

Default low flows. KDHE applies a default low flow of one cubic foot per second to NPDES permits when actual stream flow data is unavailable. EPA contends this allows for dilution where it does not exist and will propose language that allows only actual flows be used in permit derivations.

Private surface waters. Kansas statute excludes application of water quality standards to surface waters that are surrounded by privately held property (e.g., farm ponds, watershed lakes, and other small impoundments or wetlands). EPA contends these are waters of the United States and water quality standards must apply. EPA will propose language to include those waters as classified surface waters.

Surface water register—primary contact recreation. Primary contact use designation, or "swimmable and fishable," is the highest use designation for waters under the Clean Water Act. Waters are presumed swimable and fishable unless proven otherwise with a UAA. Over 1,400 waters (1,292 stream segments and 164 lakes) contained in the register have been disapproved for the secondary contact recreation designated use. Surface waters without a formal UAA conducted upon them, by default receive the secondary contact recreation use designation. In Kansas, the 1,456 disapproved segments fall into this category. EPA contends the default designation must be for primary, not secondary, contact recreation and only through a UAA can the use be changed to secondary contact.

Domestic water supply criteria for alpha- and beta-endosulfan. These two compounds are broad spectrum insecticides used in the fruit, vegetable, and tobacco industries. The 1994 standards did not include criteria for these two pollutants. The 1999 standards made reference to the criteria promulgated at the federal level under the National Toxics Rule (NTR). Since these two parameters were not promulgated for Kansas under the NTR, the reference is incorrect and was disapproved again. EPA must now promulgate the criteria to satisfy the requirements for the NTR. KDHE proposed approvable criteria for these two parameters on June 15, 2000, in an update of the standards.

Anti-degradation policy. EPA has disapproved a portion of KDHE anti-degradation policy, contained within the surface water implementation procedures, because it does not address how nonpoint sources of pollution will be accounted for in an anti-degradation review for point sources. EPA will promulgate replacement anti-degradation language to address nonpoint sources.

Costs and Benefits

EPA has estimated the potential costs to NPDES dischargers in Kansas to implement the new standards will be approximately $2,000,000. Most of the costs are attributable to the need for dischargers to install disinfection to meet the State's bacteria criteria for the primary contact recreation use for 1,456 waters. The proposed standards will help ensure that discharge to streams and lakes in Kansas will meet the criteria for primary contact recreation use. The proposed standards will also help to ensure that aquatic life are adequately protected and safe to consume.

Update

In April, 2001, Governor Bill Graves signed legislation that sets up a process for KDHE to follow when classifying streams. The law takes effect September 1, 2001. On May 16, 2001, KDHE submitted new proposed water quality standards to EPA that would analyze all streams and lakes to determine whether they are suitable for recreation. KDHE estimates this process will cost about $100,000 a year and be completed in 2005. A public hearing on the proposed standards is set for July 24, 2001 in Topeka.

References

Ernst, H., 2000, EPA's Proposed Rules for Kansas Water Quality Standards: HydroGRAM, Fall 2000, p. 9–12.

U.S. Environmental Protection Agency, 2000, Proposed Rule for Kansas Water Quality Standards—Rescheduling of Public Hearings and Extension of the Public Comment Period: EPA Fact Sheet 823-F-00-012, 3 p.

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SCHEDULE & ITINERARY

Friday June 15, 2001

7:00 am	Breakfast at Holiday Inn, Hays
8:00 am	**Bus Leaves Hampton Inn for Site 11**
8:40 am	**SITE 11**—Old Russell Power Plant *Don Augustine*, City of Russell
9:15 am	Bus to Site 12
9:30 am	**SITE 12**—The Russell Energy Center/ICM Ethanol Plant *Dave Vander Griend*, ICM, Inc. *Don Augustine*, City of Russell
11:00 am	Bus to Site 13
11:15 am	**SITE 13**—Carbon Dioxide Enhanced Oil Recovery *Martin Dubois*, Kansas Geological Survey
12:00 pm	Bus to Hays
12:30 pm	**Arrive Hampton Inn, Hays**

The Russell Energy Center / ICM Ethanol Plant

On August 23, 2000, a natural gas leak caused an explosion at the Russell power plant. The explosion injured two workers and temporarily left much of the city without power. After exploring different options for the new power plant, the City of Russell decided to use gas turbines to generate the city's electricity. The new Russell Energy Center is being constructed with funds from an insurance settlement.

What makes this power plant unique is that it will share energy with an ethanol plant, being built adjacent to the new power plant. This innovative arrangement, known as cogeneration, will reduce production costs for both the power plant and the ethanol plant. The ethanol plant will be built and operated by ICM, a design engineering firm based in Colwich, Kansas.

Here's how the cogeneration process will work. The power plant will generate electricity for the City of Russell using gas turbine engines (similar to ones used to propel airplanes). The heat exhaust from the turbines (a byproduct of gas-turbine generation) will be captured and transferred to a Heat Recovery Steam Generator (HRSG), in which the heat passes through boilers to make steam. The steam will be used in the ethanol production process. Not all the exhaust heat will be used up generating steam; the remaining heat will be sent through a 9-foot diameter pipe to the ethanol plant, where it will be used to dry the distillers grains, a by-product of the ethanol process (fig. 5-1).

In addition, the ethanol process produces carbon dioxide (CO_2), which can be captured and marketed to the oil industry to use to recover more oil from depleted fields, in a process called CO_2 Enhanced Oil Recovery. The CO_2 generated at the Russell plant will be used in a pilot project at the Hall-Gurney field, located six miles southeast of Russell (see following section on CO_2 Enhanced Oil Recovery).

Ethanol is an alcohol, the same found in beer and wine. It is made by fermenting any high-carbohydrate biomass (such as starches and sugars) in a process similar to brewing beer (fig. 5-2). It is mostly used as a fuel additive to reduce a vehicle's carbon monoxide and other smog-causing emissions.

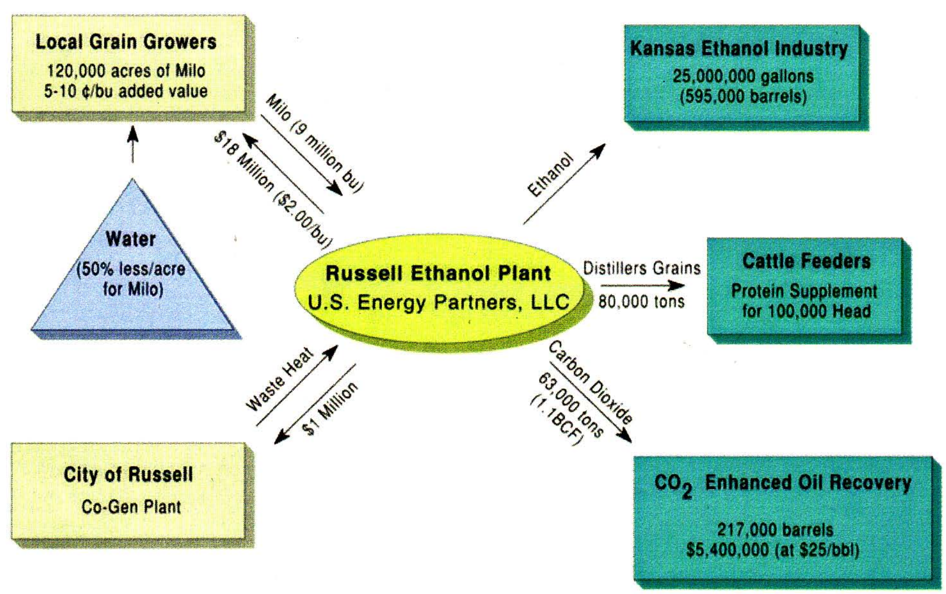

Fig. 5-1. Annual impact of the Russell Ethanol Plant.

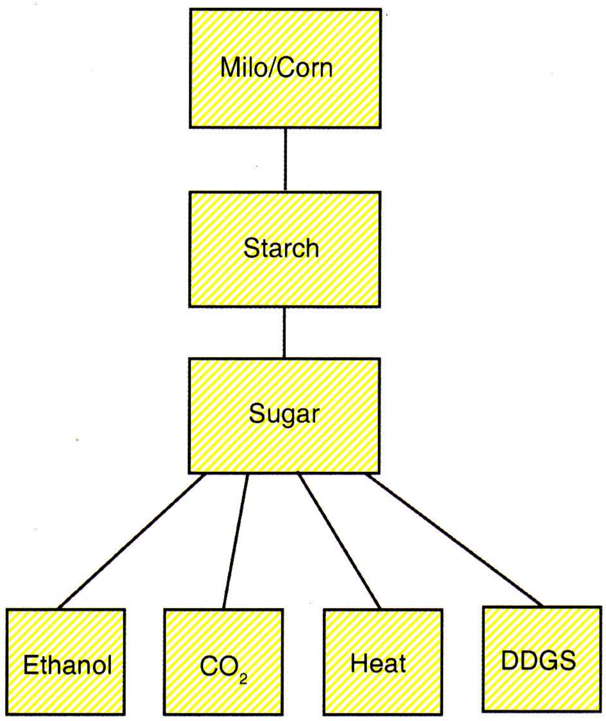

Fig. 5-2. Diagram of basic fermentation process from milo or corn to ethanol and its co-products.

Interest in ethanol production has increased due to U.S. Department of Agriculture incentives and stricter environmental regulations that phase out the use of methyl tertiary butyl ether (MTBE), a gasoline additive. Ethanol is an alternative to MTBE.

The new ethanol plant, which will operate under the name of U.S. Energy Partners LCC, expects to process 9 million bushels of locally grown milo and corn into 25 million gallons of ethanol each year. This will make it the largest ethanol plant in Kansas. As byproducts of ethanol production, 80,000 tons of distiller's grains (used for cattle feed) and 63,000 tons of CO_2 will be produced by the plant each year.

References

NREL, 2001, Introduction to biofuels, National Renewable Energy Laboratories—Clean Energy Basics: http://www.nrel.gov/clean_energy/biofuels.html (May 24, 2001).

The Salina Journal, Feb. 2, 2001, Russell to build ethanol plant (by Amy Sullivan).

Topeka Capital-Journal, Feb. 2, 2001, Ethanol plant proposed to be largest in state (A.P. story).

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CO_2-Enhanced Oil Recovery in Kansas

A pilot project to determine the technical and economic feasibility of a technique known as CO_2 miscible flooding is underway at a site outside Russell, Kansas. In CO_2 miscible flooding, liquid CO_2 is pumped under high pressure into a depleted oil reservoir through injection wells, creating a CO_2 flood bank (fig. 5-3). The front of this CO_2 bank mixes with the trapped oil, causing it to become more mobile. As more oil is encountered, an oil bank forms and is pushed ahead of the CO_2 flood bank toward producing wells. The producing wells pump the oil to the surface where the CO_2 is separated from the oil and reinjected back underground.

For the six-year pilot project, researchers at the Kansas Geological Survey (KGS) and the Tertiary Oil Recovery Project (TORP), both based at the University of Kansas, are partnering with the Department of Energy and MV Energy LLC. Also involved in the project are Kinder-Morgan CO_2 Co. LP; ICM, Inc.; and the Kansas Department of Commerce.

Table 1. Impact of CO_2 Enhanced Oil Recovery. Abbreviations: mcf = million cubic feet, BO = barrels of oil.

	One Ethanol Plant	8-inch CO_2 Pipeline
CO2 Output (mcf)		
daily	3,100	27,397
annual	1,131,500	10,000,000
20 years	22,630,000	200,000,000
Oil Recovered (BO)		
daily	775	6,849
annual	282,875	2,500,000
20 years	5,657,500	50,000,000
Gross revenue		
annual	$7,071,875	$62,500,000
20 years	$141,437,500	$1,250,000,000
Royalties to Landowners		
annual	$883,984	$7,812,500
20 years	$17,679,688	$156,250,000

The site for the pilot project is approximately six miles southeast of Russell, at the Hall-Gurney field (fig. 5-4). The project will target the Lansing-Kansas City reservoir and involve one or two CO_2 injector wells and five or six production wells.

The economic potential of CO_2-enhanced oil recovery is significant (see table 1). Researchers estimate that it could more than double the current daily oil production, ultimately producing hundreds of millions of barrels of additional oil and generating thousands of additional jobs. Oil prices and the cost of CO_2 will determine the economic feasibility of this technique.

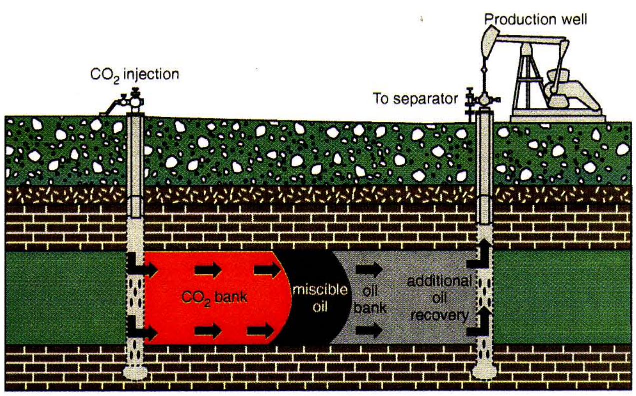

Fig. 5-3. CO_2-enhanced oil recovery.

Currently, Kansas has no CO_2 wells, and no pipeline carries CO_2 into the state. But the new ethanol plant being built in Russell will provide the pilot project with a source of CO_2. ICM, the owner of the ethanol plant, is one of the partners in the pilot project.

In addition to the enhanced oil production, CO_2 sequestration may be one way to address growing concern about the relationship between increasing atmostpheric CO_2 concentrations and global climate change. Sequestering CO_2 in geological reservoirs may be one way to safely manage CO_2 over long periods of time. KGS researchers, in conjunction with four other state geological surveys, are studying the geological feasibility and costs associated with CO_2 sequestration. They are also looking at the

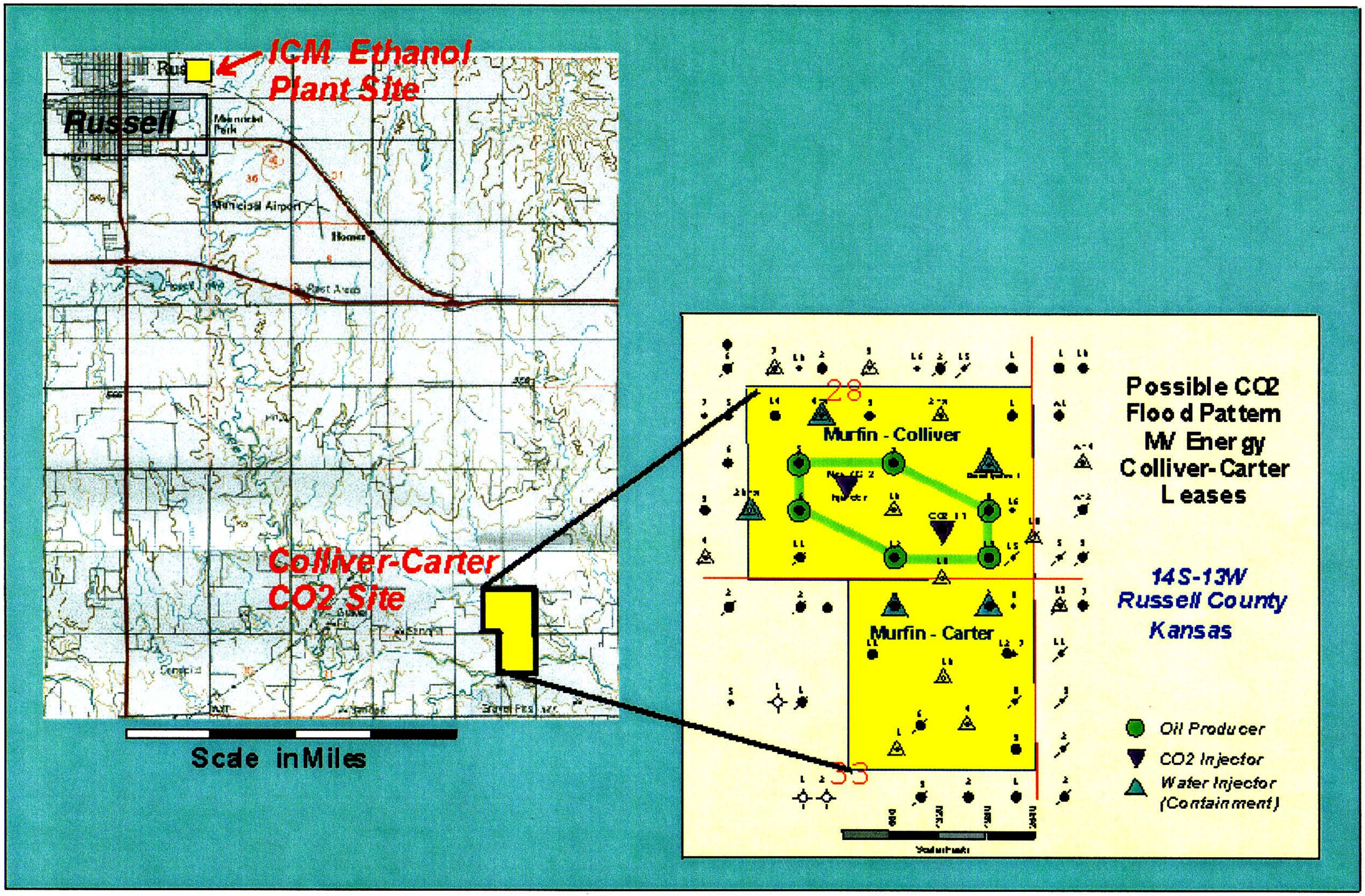

Fig. 5-4 Locations of CO2 enhanced oil recovery demonstration site and ICM ethanol plant.

feasibility of collecting CO_2 from the flue gases discharged at electrical generating facilities. If this CO_2 can be captured, it will not only lower costs of the oil recovery but it will serve to reduce the amount of greenhouse gas released into the atmosphere.

In the future, CO_2 emissions may be restricted. Electric utilities and other large CO_2 producers may be required to recover CO_2 from their flue gas and remove it from the atmosphere.

References

Kansas Geological Survey, 1999, CO_2 May Bring New Life to Old Oil Fields: Kansas Geological Survey, The Geologic Record, v. 5.2, 4 p.

Petroleum Technology Transfer Council, 1999, CO_2 sequestration in Kansas: University of Kansas, Petroleum Technology News (Third Quarter 1999), 6 p.

Petroleum Technology Transfer Council, 2000, Contract with DOE Finalized for CO_2 Pilot Test in Central Kansas: University of Kansas, Petroleum Tecnhology News, First Quarter 2000, 6 p.

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