Kansas Field Conference

Smoky Hill and Republican River Valleys

Water, Wind, and Economic Development

2008
Field Conference

June 4–6, 2008

Kansas Geological Survey
Kansas Water Office • Kansas Dept. of Transportation
Kansas Dept. of Wildlife and Parks

KANSAS FIELD CONFERENCE

FIELD GUIDE

2008 FIELD CONFERENCE

SMOKY HILL AND REPUBLICAN RIVER VALLEYS

WATER, WIND, AND ECONOMIC DEVELOPMENT

JUNE 4–6, 2008

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THIS PROJECT IS OPERATED BY THE KANSAS GEOLOGICAL SURVEY AND FUNDED, IN PART, BY THE KANSAS WATER OFFICE, THE KANSAS DEPARTMENT OF TRANSPORTATION, AND THE KANSAS DEPARTMENT OF WILDLIFE AND PARKS.

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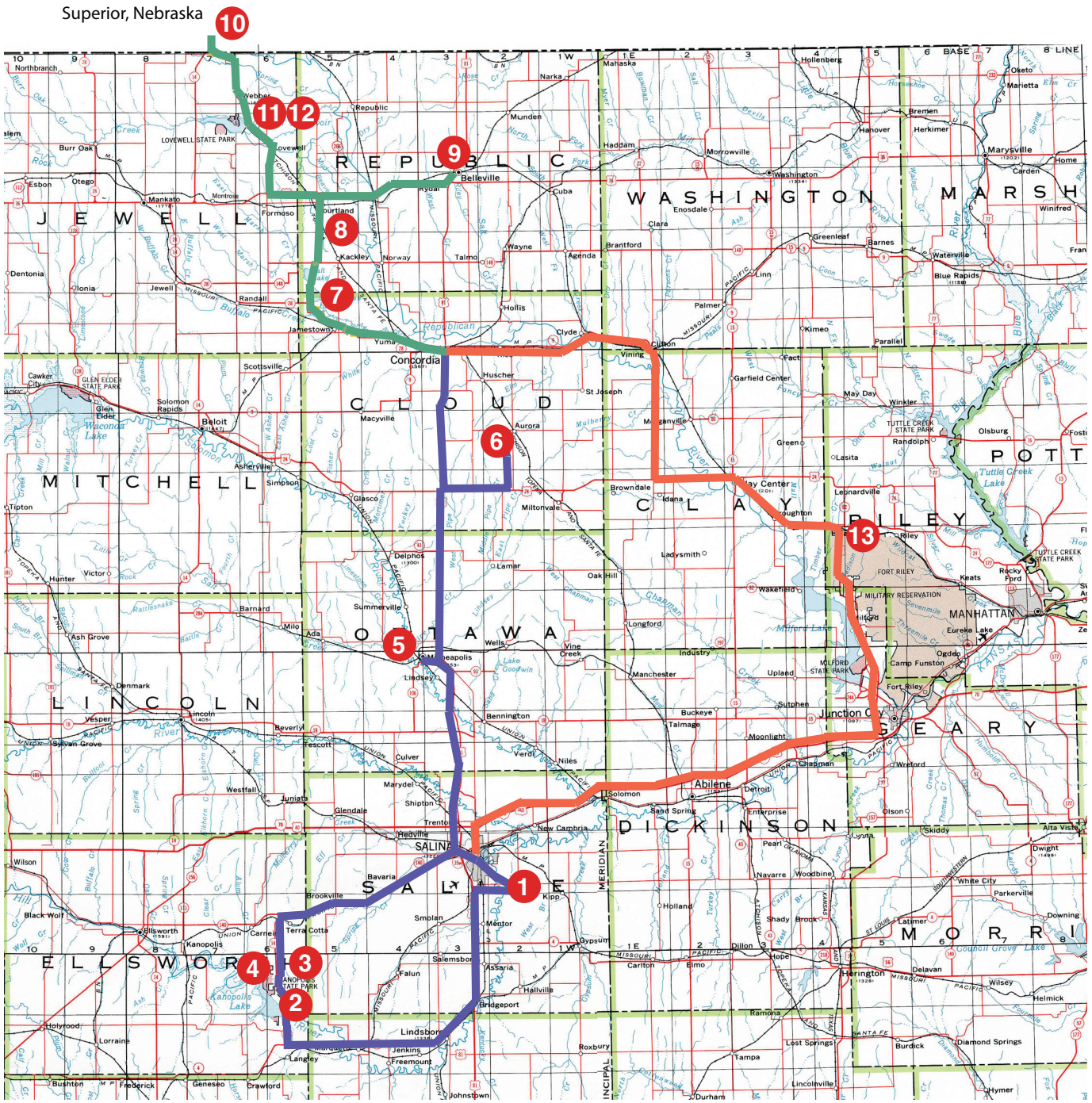
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Acknowledgments

We want to acknowledge graphic artists Patricia Acker and Mark Schoneweis for preparation of some of the figures; and Marla Adkins–Heljeson for preparation of the brochure and the Field Guide cover, and for editing and preparation of the Field Guide.

SMOKY HILL AND REPUBLICAN RIVER VALLEYS:
WATER, WIND, AND ECONOMIC DEVELOPMENT

2008 FIELD CONFERENCE
June 4-6, 2008

Welcome to the 2008 Field Conference, co-sponsored by the Kansas Geological Survey (a division of the University of Kansas), the Kansas Water Office, the Kansas Department of Transportation, and the Kansas Department of Wildlife and Parks. Previous Field Conferences have focused on specific topics, such as energy or water, or specific regions of the state. This year's Field Conference is centered around natural-resource and environmental issues in north-central Kansas, an area that is drained by the Smoky Hill and Republican rivers. While some of the issues we will consider are site specific, others (such as wind farms, conservation easements, aggregate resources, and water issues) have implications and applicability for the entire state and even the surrounding region.

A Preview

Day 1

We begin this year's Field Conference in Salina; with a population of about 45,000, it is the largest town in this area. Located at the crossroads of Interstate 70 and Interstate 135, Salina is the seat of Saline County and a regional center for shopping, medicine, and economic activity. Schilling Air Force Base was established on Salina's west edge during World War II; it is today home to Kansas State University–Salina. One of the leading employers in Salina is Tony's Frozen Pizza, but Salina is also home to the popular Cozy Inn, established in 1922 and purveyor of small hamburgers known colloquially as "sliders."

Our first stop will be at The Land Institute, which undertakes research in sustainable agriculture. Established by Wes Jackson, The Land Institute focuses on perennial crops that can be harvested without cultivating the soil to reduce soil erosion. The Institute has trained interns, supported research, and holds an annual festival in the fall that attracts hundreds of attendees from throughout the country. Currently the Institute is sponsoring a Climate and Energy Project that focuses on issues related to climate change, energy, and the environment.

Salina takes much of its water from a well field in the Smoky Hill River valley south of the city. In the summer of 2006, lack of flow in the river contributed to concerns about the city's water supply. We'll take a look at the Smoky Hill River and discuss work that the Survey is doing with the Kansas Water Office to model river flow and the impact of pumping on alluvial wells adjacent to the river. This stop will also include discussion of the Post Rock Rural Water District, the state's largest rural water district, which gets water supplies from Kanopolis Lake and has struggled financially.

Next we'll visit Kanopolis Lake, created by a dam on the Smoky Hill River. Kanopolis is among the oldest of the state's reservoirs, begun in 1948, and the area is a good place to see rocks of Cretaceous age, those deposited about 100 million years ago when an inland sea covered the country from here to the west. Sand deposited along the edge of that sea, and in the channels of rivers that drained to the west, is today consolidated into rock units called the Kiowa and Dakota Formations. Layers of red and orange sandstone are characteristic of these two rock units, which also include substantial amounts of clay, siltstone, and other rock types. We'll look at the Dakota and Kiowa along the edge of Kanopolis Lake, and collect rocks and fossils that are characteristic of these rock layers.

After a stop at Rock City near Minneapolis to see rock formations known as concretions—here among the largest and most numerous in the world—we will complete the day at the Median Way Wind Farm in Cloud County. This location is the site of a new wind farm development by Westar Energy, Horizon Wind Energy, and the Empire District Electric Company. Construction began in April 2008, with completion of the 67 turbines expected by the end of this year. The completed sites will produce about 200 megawatts of electricity.

Day 2

We will begin the second day bright and early at the Jamestown Wildlife Area, a large salt marsh that

provides habitat for birds, fish, and other animals. The marsh is one of a series of salt springs, seeps, and marshes that occur in a band southwestward along an outcrop of the Dakota Formation. The saline water evaporates here, forming a white, salty crust on the ground. It is a good place to see a variety of ducks, geese, shorebirds, and other animals. Kansas Department of Wildlife and Parks operates the area. To help in identifying local birds, we'll provide copies of the new book *Kansas Birds and Birding Hot Spots* by Bob Gress and Pete Janzen, published by the University Press of Kansas.

After the early-morning start, we will discuss issues related to Courtland Canal and the Kansas Bostwick Irrigation District. The Kansas Bostwick Irrigation work is one of several Federally constructed surface irrigation works that divert surface water from the Republican River for irrigation. Kansas Bostwick is part of a larger district which straddles the Nebraska and Kansas state line; its Nebraska counterpart is the Bostwick Irrigation District. Surface water for the Kansas Bostwick division is diverted from the Republican River near Guide Rock, Nebraska, and sent to Lovewell Reservoir for storage via the Courtland Canal. Releases from Lovewell are distributed to the valley below the reservoir by the Courtland Canal network.

Next we'll explore issues that affect bridge and infrastructure design with the Kansas Department of Transportation (KDOT) at Belleville. Soils in central Kansas have a high gypsum content and can form expansive soil when mixed with lime, a common road stabilizer. If severe swelling occurs, it leads to heaving and buckling, which causes design problems and additional costs for operation and maintenance. Sand, gravel, and limestone suitable for aggregate is common in eastern and south-central Kansas, but not in this part of the state, where it must be hauled in, adding to its expense. We'll discuss issues related to aggregate availability and look at the lifespan of some of KDOT's structures.

From here we will head into Nebraska to discuss the Republican River Compact between Kansas and Nebraska. **For this part of the trip, we will be joining a group from Nebraska: the Annual Water and Natural Resources Tour, a group somewhat similar to ours that is sponsored by the University of Nebraska's School of Natural Resources, particularly their Water Center and their Conservation and Survey Division. This tour occurs annually, and this year is working its way up the Republican River valley from the Junction City area on west. They will join us here for a panel discussion on the Republican River Compact, a discussion that will include representatives from both states.**

The Republican River Compact was signed in 1943 among Kansas, Colorado, and Nebraska. Following years of dispute over water delivery in the river, Kansas filed suit with the Supreme Court in 1998. That suit was settled in 2002, but the parties have since disagreed over Nebraska's delivery of water to Kansas, and the issues related to the suit and the Compact have led to disputes over remedies to reach compliance. After the panel session, we will hear from the University of Kansas law professor John Peck (a past presenter to the Field Conference) about water law in Kansas and Nebraska. We'll conclude the day with a barbeque at Lovewell Reservoir.

Day 3

On the final day of the trip, we will focus primarily on the issue of development around Fort Riley and the role of conservation easements in dealing with burgeoning growth here. Fort Riley is the largest military installation in Kansas and the headquarters of the Army's 1st Infantry Division. As the Army shifted away from providing base housing, and as the Fort has expanded, an increase in private housing in the Junction City area has occurred, which not only led to increased construction, but the possibility of conflict between the Army and homeowners located close to land on which the soldiers train. We'll look at this issue and the role of conservation easements in providing a buffer between the Army's activities and local residents.

About the Kansas Field Conference

Some issues are best understood by seeing them firsthand. The 2008 Field Conference marks the 14th year the Kansas Geological Survey (KGS) has worked with co-sponsors to develop this opportunity for policy-makers to see and experience some of the natural-resource issues with which they grapple. Participants have been selected to provide a range of legislative, governmental, education, and private-business expertise. Local and regional experts in natural-resource issues will meet us at each site and describe the location and the issues related to it. The objective is to let participants see the results of their decisions and to talk with local, State, and Federal governmental officials, environmental groups, business people, and citizens' organizations. The result should give participants a broader, more-informed perspective

useful in formulating policies. In addition, the Field Guide you are holding provides background on sites and issues and serves as a handy reference long after the Field Conference is over.

During the Field Conference, participants are expected to be just that—participants. We want you to contribute to the discussion, to ask questions, and to otherwise join in on deliberations. **The bus microphone is open to everyone, and we encourage everyone to participate.**

Please remember that in the course of the Field Conference, we do not seek to resolve policy or regulatory conflicts. We do try to provide opportunities to familiarize policy-makers with resource problems. By bringing together experts on the unique technical, geographical, geological, environmental, social, and economic realities of north-central Kansas, we hope to go beyond merely identifying issues. 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.

In doing this, we attempt to present, as nearly as possible, all sides of contentious issues. Please know that the opinions presented during the Field Conference are not necessarily those of the Kansas Geological Survey or Field Conference co-sponsors. Nonetheless, we do believe it is important for participants to hear various viewpoints on complex issues.

The Kansas Field Conference is an outreach program of the Kansas Geological Survey, administered through its Geology Extension program. Its mission is to provide educational opportunities to individuals who make and influence policy about natural-resource and related social, economic, and environmental issues in Kansas. The KGS'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 Field Conference was begun in 1995 with the support of Lee Gerhard, then the Survey's director and state geologist. The 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 KGS appreciates the support of Erling Brostuen, former Director of the Energy and Field Institute, in helping develop the Kansas project.

The KGS Field Conference has been recognized by

- The National Institute of Standards and Technology as among 50 Best Practices for Communication of Science and Technology for the Public, 2001; and

- The Division of Environmental Geosciences of the American Association of Petroleum Geologists, which presented the Field Conference with its Public Outreach Award in 1998.

The KGS appreciates your attendance at this year's Field Conference and your willingness to share your insights for its improvements. Your input has helped make the Field Conference a model that has been adopted by other state geological surveys.

Sponsors

Kansas Geological Survey

Since 1889, the Kansas Geological Survey (KGS) has studied and reported on the state's geology. Today the KGS 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.

By statutory charge, the Kansas Geological Survey's role is strictly one of research and reporting. The KGS has no regulatory function. 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. KGS programs can be divided by subject into water, energy, geology, and information dissemination.

Water*—Water issues affect the life of every Kansan. Western Kansas agriculture and industry rely heavily on ground water; in eastern Kansas, growing populations and industry generally use surface water. KGS water research and service include an annual water-level-measurement program (in cooperation with the Kansas Department of Agriculture, Division of Water Resources), studies of recharge rates, water quality in the Arkansas River, depletion of the Ogallala aquifer, the interaction between streams and aquifers, and a variety of other topics.*

Energy*—Kansas produces more than $4 billion worth of oil and natural gas each year. Because*

much of the state has long been explored for oil and gas, maintaining that production takes research and information. The KGS studies the state's coal resources and one newly developed source of energy, coalbed methane. The KGS does research on the state's petroleum reservoirs, new methods of providing information, and new methods of exploring for and producing oil. The KGS recently completed a multi-year study of the resources of the Hugoton Natural Gas Area and issues related to carbon-dioxide sequestration. The KGS also has a branch office in Wichita, the Wichita Well Sample Library, that stores and loans rock samples collected during the drilling of oil and gas wells in the state.

***Geology**—Much of the KGS'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 KGS 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; and studies specific resources, such as road and highway materials. The KGS reports on non-fuel minerals (such as salt, gypsum, aggregates, etc.) and is charged with studying geologic hazards, such as subsidence, earthquakes, and landslides.*

***Geologic Information**—To be useful, geologic information must be disseminated in a form that is most appropriate to the people who need it. The KGS provides information to the general public, policy-makers, 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 KGS), a data library, electronic publication, and Geology Extension.*

KGS staff participating in the 2008 Field Conference include the following:

Bill Harrison, Director and State Geologist
Rex Buchanan, Deputy Director, Outreach and Public Service
Cathy Evans, Writer/Editor, Public Outreach
Shane Lyle, Research Assistant, Geology Extension
Bob Sawin, Research Associate, Geology Extension

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Kansas Department of Transportation

The Kansas Department of Transportation (KDOT) was founded in 1917. It is charged with providing a statewide transportation system to meet the needs of Kansans. Its primary activities are road and bridge maintenance; transportation planning, data collection and evaluation; project scoping, designing, and letting; contract compliance inspection of material and labor; Federal program funding administration; and administrative support. In addition to dealing with roadways for automobile traffic, KDOT is responsible for other modes of transportation, including aviation, rail, and bicycles/pedestrians. The Department has more than 3,000 employees. KDOT's headquarters are in Topeka with six district offices, 26 area offices, and 112 sub-area offices across the state. KDOT is responsible for maintenance of about 9,600 miles of State highway.

The agency is organized into divisions of public affairs, administration, aviation, engineering and design, operations, and planning and development. Within the Division of Operations is the Bureau of Materials and Research. This Bureau is responsible for approved materials, pavement management, testing, and research. Within that Bureau is a geotechnical unit that includes a geology section. That section supplies information and recommendations regarding surface and foundation geology, hydrology, and bridge-deck conditions to the Bureau of Design for project-plan preparation; conducts special surveys on selected subjects such as soil shrinkage, rock expansion, and pile-foundation requirements; and constructs new water wells in rest areas and rehabilitates and maintains existing wells for all KDOT facilities. Because of its role within KDOT, the geology section has actively studied issues related to subsidence and its impact on roads in the state. Robert Henthorne is the chief geologist within the unit.

In 2006, the agency identified six critical areas for which to measure performance—safety, preservation and maintenance, program and project delivery, system modernization, workforce priorities, and economic impact. Because of concern about traffic fatalities and injuries, a special task force was established to develop recommendations about ways to lower the number of highway deaths and injuries. The agency's top priority is the completion of the 10-year Comprehensive Transportation Program (CTP), begun in 1999. In 2007, KDOT spent about $723 million on CTP-related construction contracts, spending that sustained about 30,000 jobs in the state. KDOT is now developing

a Long-Range Transportation Plan, information that will be used to chart a course for the agency over the next two decades. A draft of that plan is now available. The current Secretary of the Kansas Department of Transportation is Deb Miller, the first female director in the agency's history.

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Source: 2008 Annual Report, Kansas Department of Transportation.

Kansas Department of Wildlife and Parks

The Kansas Department of Wildlife and Parks is responsible for management of the state's living natural resources. Its mission is to conserve and enhance Kansas' natural heritage, its wildlife, and its habitats. The Department works to assure future generations the benefits of the state's diverse living resources; to provide the public with opportunities for the use and appreciation of the natural resources of Kansas, consistent with the conservation of those resources; and to inform the public of the status of the natural resources of Kansas to promote understanding and gain assistance in achieving this mission.

The Department's responsibility includes protecting and conserving fish and wildlife and their associated habitats while providing for the wise use of these resources, and providing associated recreational opportunities. The Department is also responsible for providing public outdoor-recreation opportunities through the system of State parks, State fishing lakes, wildlife-management areas, and recreational boating on all public waters of the state.

In 1987, two State agencies, the Kansas Fish and Game Commission and the Kansas Park and Resources Authority, were combined into a single, cabinet-level agency operated under separate comprehensive planning systems. The Department operates from offices in Pratt, Topeka, five regional offices, and a number of State park and wildlife area offices.

As a cabinet-level agency, the Department of Wildlife and Parks is administered by a Secretary of Wildlife and Parks and is advised by a seven-member Wildlife and Parks Commission. All positions are appointed by the Governor with the Commissioners serving staggered four-year terms. As a regulatory body for the Department, the Commission is a non-partisan board, made up of no more than four members of any one political party, advising the Secretary on planning and policy issues regarding administration of the Department. Regulations approved by the Commission are adopted and administered by the Secretary. Mike Hayden is the Secretary of Wildlife and Parks.

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Kansas Water Office

The mission of the Kansas Water Office (KWO) is to provide the leadership to ensure that water policies and programs address the needs of all Kansans. The KWO evaluates and develops public policies, coordinating the water-resource operations of agencies at all levels of government. The KWO administers the Kansas Water Plan Storage Act, the Kansas Weather Modification Act, and the Water Assurance Act. It also reviews plans of any State or local agency for the management of water and related land resources in the state. The KWO advises the Governor on drought conditions and coordinates the Governor's drought-response team. The Drought Monitoring Program collects climate data from a variety of sources, monitors drought activities, and publishes a weekly Drought Report during periods of drought.

The KWO develops the Kansas Water Plan, which is revised periodically and addresses the management, conservation, and development of water resources in the state. Numerous water-related public and private entities, as well as the general public, are involved in its preparation and planning. The Water Plan is approved by the Kansas Water Authority, a 13-member

board whose members are appointed, along with 11 non-voting *ex officio* members who represent various state water-related agencies. Besides approving the Water Plan, the authority approves water-storage sales, Federal contracts, administrative regulations, and legislation proposed by the KWO. Much of the input for the Water Plan comes from 12 Basin Advisory committees that are composed of volunteer members from each of the state's drainage basins. During this year's Field Conference, we will be in three basins: the Smoky Hill/Saline, the Solomon, and the Kansas/Lower Republican.

Current programs and projects at the KWO include

- The Upper Arkansas River Conservation Reserve Enhancement Program (we will have an update on this program, begun in 2007)
- Reservoir sustainability, which is studying issues related to sedimentation in the state's reservoirs
- Water conservation
- Water assurance
- Drought monitoring
- Water marketing
- Weather modification

As part of this process, the KWO has worked to develop concepts related to conserving and extending the life of the Ogallala/High Plains aquifer, to model streamflow and the impact of areawide pumping on streamflow (as we will discuss in the Smoky Hill River valley), and operated public forums on the impact of biofuels on water.

Tracy Streeter is the Director of the KWO.

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KANSAS FIELD CONFERENCE

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June 4–6, 2008

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Education
Augustana College – BA, 1967
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Experience
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Experience
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Education
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Experience
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Education
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Current Responsibilities
Administrator for Kansas agriculture regulation and policies; advocate for agriculture; works with legislature for agriculture

Experience
Owner, Polansky Seed; Director of USDA FSA; President, Ks. Crop Improvement Association; Chairman, U.S. Wheat Association

Education
Kansas State University – BS, Agronomy, 1972

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Experience
Speech/language pathologist
Education
University of New Mexico – BA, 1972
University of New Mexico – MS, 1973
Wichita State University – PhD, 1981

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Current Responsibilities
General Manager, Rural Water District; President, Kansas Rural Water Association; Member, Kansas Water Authority; Director; National Rural Water
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Experience
17 years at KGS, including 8 years as associate director
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Kansas State University – MS, 1969
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Experience
Executive Director, State Conservation Commission, 1995-2004; worked at SCC in other capacities from 1985–1995
Education
Highland Community College – AS, 1983
Missouri Western State University – BS, Ag. Economics, 1985
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Chair, The Nature Conservancy, Kansas Chapter; Executive Director, KACEE; Special Assistant for Environment and Natural Resources to Gov. 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, Forestry, 1957
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Experience
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Education
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Wilson & Company Eng. & Arch. for 28 years—design, construction & operation of water and wastewater systems
Education
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Experience
Research Attorney, Johnson County District Court, 2004–07
Education
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Current Responsibilities
Legislative staff; drafting legislation and giving legal advice; administration of office
Experience
Revisor of Statutes Office, 34 years
Education
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Current Responsibilities
In school district coordinate pre K-12 science, including grants from NSF and Kauffman Foundation. Geological Survey Advisory Council (GSAC) Member
Experience
Taught elementary level in Potwin, KS, and Jr. High Science in Olathe
Education
Bethel College, BS, 1983
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Experience
Kansas Geological Survey, 11 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
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Experience
Kansas Geological Survey, 30 years; University-Industry Research, University of Wisconsin, 3 years; Salina Journal, 4 years
Education
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Experience
Kansas Geological Survey; University Press of Kansas; Spencer Museum of Art
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Education
Kansas State University – BS, 1972
Kansas State University – MS, 1977

SCHEDULE AND ITINERARY

Wednesday, June 4, 2008

6:00 am	Breakfast at Holiday Inn, Salina
7:15 am	Conference Overview *Bill Harrison*, Director, Kansas Geological Survey
8:00 am	**Bus leaves Holiday Inn for Site 1**
8:15 am	**SITE 1** • The Land Institute, Salina *Wes Jackson*, President, The Land Institute
10:45 am	Bus to Site 2 and Site 3
11:30 am	**SITE 2** • KGS Smoky Hill River Ground-water Model, Kanopolis Lake *Blake B. Wilson*, Kansas Geological Survey
11:50 am	**SITE 3** • Post Rock RWD, Kanopolis Lake *David K. Bailey*, General Manager, Post Rock RWD
12:15 pm	Bus to Lunch
12:30 pm	Lunch at Kanopolis Lake
1:30 pm	Bus to Site 4
1:35 pm	**SITE 4** • Geology of the Kanopolis Lake Area, Kanopolis Lake *Bob Sawin*, Kansas Geological Survey
2:00 pm	Bus to Site 5
2:30 pm	**SITE 5** • Rock City, Minneapolis *Bob Sawin*, Kansas Geological Survey
3:00 pm	Bus to Site 6
3:45 pm	**SITE 6** • Meridian Way Wind Farm, Cloud County *Mark Lawlor*, Horizon Wind Energy *Greg Greenwood*, Westar Energy
4:30 pm	Bus to motel
5:00 pm	Arrive at Holiday Inn Express, Concordia
6:00 pm	Bus to dinner at Brown Grand Theatre
8:00 pm	Bus to motel
8:05 pm	Return to Holiday Inn Express, Concordia

The Land Institute

For 31 years, The Land Institute has worked for ecological sustainability through "Natural Systems Agriculture"—modeled on a natural ecosystem—by developing perennial grain crops of mixed species for farming. These perennial crops mimic natural ecosystems in their efficient use of water, capacity to protect soil, wildlife, and biodiversity, and potential to provide food without intensive use of agricultural chemicals—leading to a sustainable food supply.

Method

The first step in Natural Systems Agriculture is crossing high-yielding annual plants with deep-rooted perennials to obtain grain productivity from one parent and a perennial habit from another. This is possible because the world's major grain crops, including wheat, sorghum, corn, and rice, have wild, perennial relatives. Land Institute scientists are developing various hybrids with perennial traits.

Plant breeding for 2008 at The Land Institute includes work on small grains (wheat, triticale, and intermediate wheatgrass), sorghum, sunflowers, and a legume. Though most of the schedule depends on weather and time of planting, a second "season" to develop some hybrids is made possible with a greenhouse. All new crosses are evaluated for perennialism and fertility. Whenever a new hybrid with these traits is attained, subsequent generations are bred for such agronomic traits as yield, shatter resistance, and plant height that lends itself to mechanical harvesting.

Related research in agroecology/ecology also is being conducted that compares prairie meadows, farm fields, and the field plots of The Land Institute's hybrid crops. In these investigations, soil-nutrient cycling and water management are assessed and techniques are developed for growing new crops that will redefine agricultural sustainability.

Specifically, The Land Institute's research in Natural Systems Agriculture during 2008 includes

- Breeding perennial small grains (wheat, triticale, and wheatgrass species). In addition to strengthening perennial traits, The Land Institute's goal is to improve seed fertility, genetic stability, regrowth, and post-harvest survival in populations descended from crosses between wheat, triticale, and a perennial wheatgrass. Heat tolerance is a necessary trait for perennial wheat.

- Breeding perennial sorghum. The Land Institute continues to identify individual plants that are perennial and have desirable traits for future generations. For sorghum, this means the perennial plants will be uniform in height, produce early in the year, and have high-seed production, large seeds, semi-compact heads, and strong stalks. Winter survival and plants with superior agronomic characteristics are key to breeding the next generation.

- Breeding perennial sunflowers. With strong productivity in 2007, goals for 2008 are the combination of sunflower families with shorter stature, larger seed heads, larger seeds, and reduced shattering. Selecting progenies from hybrid crosses will focus on higher seed fertility and multiple-species hybrids that will generate new breeding populations.

- Breeding a perennial legume. Work continues to develop a perennial legume that fixes nitrogen in the root zone. Specifically, Land Institute scientists are investigating the possible domestication of Illinois bundleflower. Other work, in cooperation with the University of Minnesota, is testing the nutritional value of bundleflower in swine-feeding trials.

- Agroecology/ecology research. Perennial crop mixtures provide many of the benefits of natural ecosystems. The diversity helps make fields more resistant to pests and plant diseases. Inclusion of nitrogen-fixing plants—legumes—in the farm landscape provides natural fertilizer. Deep roots hold soil and manage water and nutrients more effectively than in monoculture fields.

To quantify the impact of perennial crops, The Land Institute studies different research plots, including ones with natural ecosystems, ones with native perennials that have been hayed or grazed, and others with traditional crops. This research includes a multi-year study of productivity in native meadows; agroecology studies; and soil-ecology research investigating links between soil biota and nutrient cycling. The latter is being conducted in cooperation with Washington State University, Stanford University, Agriculture and Agri–Food Canada, and USDA–ARS Southwest Watershed Research Center.

Results

Each generation of plant breeding brings The Land Institute closer to its goal of perennial crops. In a successful plant-breeding program, each year means additional plants to hybridize and grow. Continued completion of hybridization mileposts has necessitated a 20% increase in The Land Institute's budget this year.

The Land Institute Natural Systems Agriculture is designed to help farmers who will benefit from economies inherent in perennial crops. With a perennial system, they will not need to purchase and plant seed each year, will save fuel, and will see significant reduction in the need for agricultural chemicals (for pests and fertilizer). Because deep-rooted plants store and utilize water efficiently year-around, they are more resilient to climate change. An agriculture that is economical for farmers can revitalize rural communities.

In the long term, Natural Systems Agriculture is designed to benefit all consumers. With development of high-yielding perennial crops, food production becomes less dependent on fossil fuels and fertilizers. Perennial crops also absorb precipitation more efficiently.

Although The Land Institute's work is conducted in the heart of the Kansas grain belt, it has broad applicability for food production around the globe because Natural Systems Agriculture is founded in basic ecological principles.

Sources

Canine, C., 2005, Wes Jackson; *in*, 35 Who Made a Difference—Innovators of Our Time: Smithsonian, v. 36, no. 8, p. 81–82.

Glover, J. D., Cox, C. M., and Reganold, J. P., 2007, Future farming—A return to roots?: Scientific American, v. 297, no. 2, p. 82–89.

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Smoky Hill Ground-water Model

Introduction

The Kansas Water Office (KWO) contracted with the Kansas Geological Survey (KGS) in the spring of 2007 to develop a numerical ground-water model as a component of a larger, comprehensive review of the regional water supply in the Smoky Hill River basin. The objective of the model is to better understand the stream-aquifer interactions by simulating streamflow in the Smoky Hill River and ground-water levels in the surrounding alluvial deposits downstream of Kanopolis Lake. In addition, the model will be used to simulate climatic, streamflow, and pumping conditions and their effects on the surface- and ground-water supplies.

Since 1948, when construction on Kanopolis Lake was completed, the downstream reach of the Smoky Hill River and its hydrologically connected alluvium have seen extensive surface- and ground-water-right development, primarily for irrigation and municipal demands. The City of Salina, located just west of the confluence of the Smoky Hill and Saline rivers, owns the largest and some of the most senior water rights downstream of the reservoir.

Another significant component of the regional water supply in this area is storage in Kanopolis Lake. In 2002, the State purchased water storage through the KWO's Water Marketing Program for anticipated future municipal and industrial water supply needs. Currently, only the Post Rock Rural Water District has contracted for water from this supply. While releases from the reservoir for the Water Marketing Program are protected under State law, other releases—specifically, instream flow from Corps-owned storage—are not. Instream flow is subject to consumptive use by existing water rights, which can reduce the intended downstream benefit.

This regional water supply is sensitive to periods of extensive drought and extreme flooding conditions, both of which have taken place in recent years. As recently as July 2006, extended periods of below normal precipitation and resultant low streamflow in the Smoky Hill River prompted the City of Salina to seek protection of their water rights. The climatic conditions also affected lake levels in Kanopolis. Operating levels were far below normal in 2006 only to fill to flood-pool elevations in a matter of months during the spring of 2007.

The KGS model will assist in understanding the relationship between releases of water from Kanopolis, the interaction between streamflow in the Smoky Hill River and its connected alluvial ground-water system, and how existing water-right demands influence that connection. The model is being developed with input from a stakeholder advisory committee consisting of individuals from the Kansas Department of Agriculture's Division of Water Resources, the City of Salina, water users in the Smoky Hill River valley, and other interest groups.

Water Models

A numerical water model can be thought of as a water calculator that expresses water-behavior properties (e.g., flow tends toward the least resistance path) as mathematical equations to portray a natural environment. In essence, a water model computes how water behaves in a stream or aquifer.

Where a traditional calculator uses numerical input, a water model calculates water behavior based on hydrologic inputs (e.g., ground-water recharge) minus hydrologic outputs (e.g., ground-water pumping). The result is an estimate, calculated by the model, of stream or aquifer characteristics (e.g., projected water-table elevations).

Water models require a defined study area and assessment of aquifer properties within the study area before they can operate. For example, the base and surface of an aquifer, flow properties within the aquifer, and stream widths and depths are combined with other model parameters to simulate

the study area. These customizations make models site-specific so that a model developed for western Kansas is not suitable for eastern Kansas.

The information needed to create water models is complex and detailed. In some cases, data sets, such as annual water use and precipitation data, are relatively easy to quantify and provide relatively precise hydrologic estimates. Other parameters, such as annual ground-water recharge or aquifer permeability, are very difficult to quantify over large areas and, thus, have an inherent level of uncertainty.

After a model is constructed, it needs to be calibrated. Model calibration is done by comparing simulated values, such as water-level elevation, with field measurements. Hard-to-quantify parameters, such as annual ground-water recharge, are generally adjusted or "calibrated" until the simulated and observed values trend within a reasonable tolerance.

Once a model is constructed and calibrated, it becomes a powerful management tool with the capabilities to run "what if…" scenarios. Potential changes to water diversions, water uses, or climatic fluctuations can be simulated to estimate the impacts to water supplies over time.

The KGS Smoky Hill Ground-water Model

The KGS water model is an adaptation of MODFLOW, a popular and widely used modeling software developed by the U.S. Geological Survey (USGS). The study area includes the Smoky Hill River and its hydrologically connected alluvium from the Kanopolis outlet tubes to the Smoky Hill's confluence with the Saline River just east of Salina (fig. 3–1). The model is subdivided into 11,484 rectangular grid cells. Each 0.25-by-0.25-mile cell is assigned varying hydrologic properties to simulate differences in the aquifer from one area to another. The grid is somewhat comparable to a fishing net in that it is set for the size of "fish" or

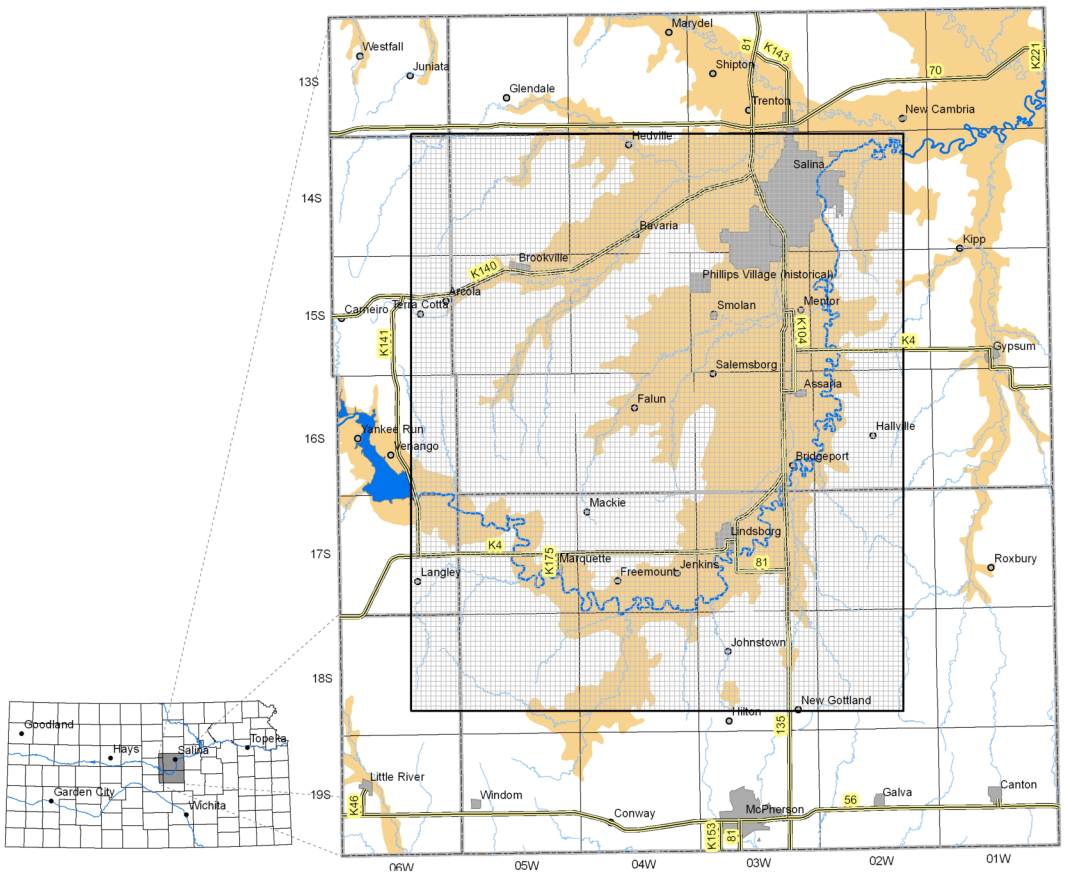

Figure 3–1. Study area for the Smoky Hill River Ground-water Model.

details that need to be captured. Smaller or more-dense grid patterns have more definition or detail than larger and less-dense grid patterns. In general, the model size and ground-water-flow properties dictate the cell size and density.

Hydrologic features assigned to the grid cells were estimated from driller logs, test-hole data, and literature references. This information was used to establish the bottom, top, and subsurface-flow characteristics of the alluvial aquifer.

The model has been calibrated to represent both a steady-state condition (predevelopment period of 1944 to 1947) and a transient condition (predevelopment period to the end of 2006). The transient portion models flow conditions that change over time and uses six-month time steps centered on the "growing" season (April to September) and "winter" (October to March). Each time step contains many inputs and outputs that estimate ground-water pumping, surface-water diversion, precipitation recharge, tributary streamflow, and releases from Kanopolis Lake, among others.

Model Results

The ancestral channel the Smoky Hill River is very different than its present channel location. Historically, the river flowed south between Marquette and Lindsborg into the Arkansas River. It is likely that headward erosion up from the Kansas River captured or cut off the Smoky Hill River, resulting in its present northward flow towards Salina. Geologic review indicates that the Arkansas River paleochannel hydrologically connects the Smoky Hill alluvium and the Equus Beds portion of the High Plains aquifer to the south. However, the connection appears to be very small and insignificant in terms of water movement between the two aquifer units.

Geologic review also shows much of the area contains a confining layer of less permeable material (silts and clays) sitting on top of the unconfined alluvial aquifer (sands and gravels). This indicates that stream-aquifer interactions, although present and statistically significant in the model, may not be as strong as other typical alluvial systems. In addition, the confining layer causes the aquifer to behave more like a confined aquifer in some places.

Steady-state or predevelopment results indicate that the river is primarily a gaining stream. That is, it receives flow from the underlying alluvial aquifer over the entire study area. Transient phase or post-development results indicate that the river is generally still gaining except in very dry years when less precipitation recharge and increased ground-water pumping cause ground-water levels to decline. Under these conditions, the river becomes a losing stream because ground-water flow is reversed and the aquifer receives flow from the river.

The KGS model does an excellent job simulating the surface flows in the Smoky Hill River at the two USGS gaging stations at Lindsborg and Mentor. The observed and model-simulated streamflow at Mentor is shown in fig. 3–2.

Site-wide simulations of ground-water elevations vary across the model with stronger replications in the mid to lower end of the valley. The narrow, linear shape of the valley and sporadic ground-water measurements cause variation between observed and model simulated ground-water elevations in some stretches. The observed and model-simulated water levels between Assaria and Lindsborg are shown in fig. 3–3.

At the time the KGS Field Conference notebook was being compiled, the formation and development of possible water-management scenarios was still under discussion. However, stakeholders agreed upon using an innovative and non-traditional management approach. The last 50+ years of climatic conditions would be forecast into the future and modeled with all the current water usages. The primary surface-water inflow to the model (e.g., releases from Kanopolis) would be systematically adjusted each year until a target flow rate in the Smoky Hill River was reached near Salina. With a range of necessary minimum releases under varying climatic conditions identified, the probability of Kanopolis meeting those releases for target flows at the lower end of the valley can be estimated.

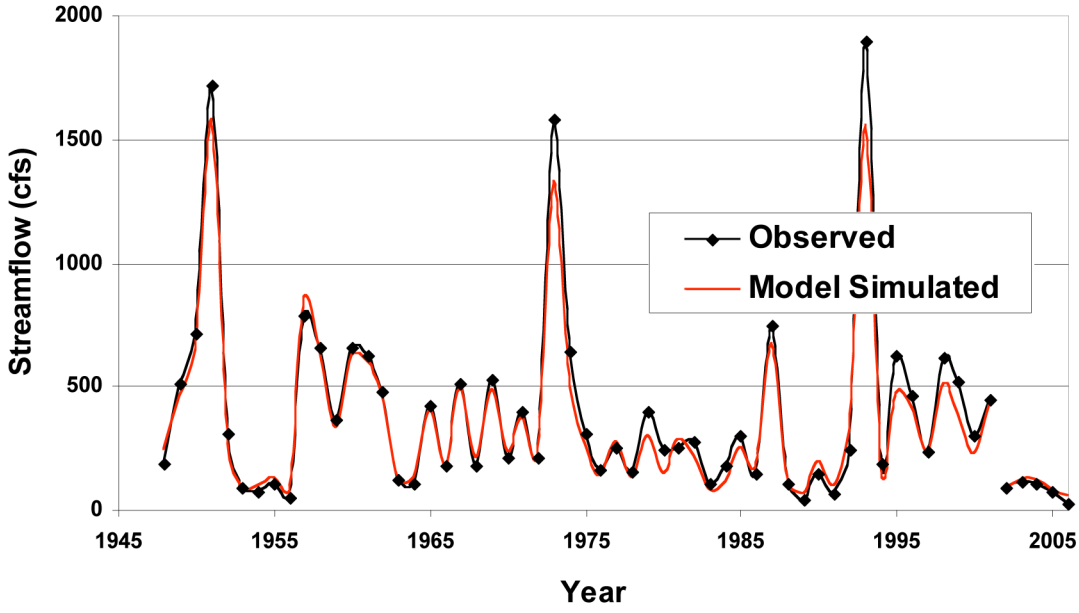

Figure 3–2. Streamflow at the Mentor gage, south of Salina, Smoky Hill River valley.

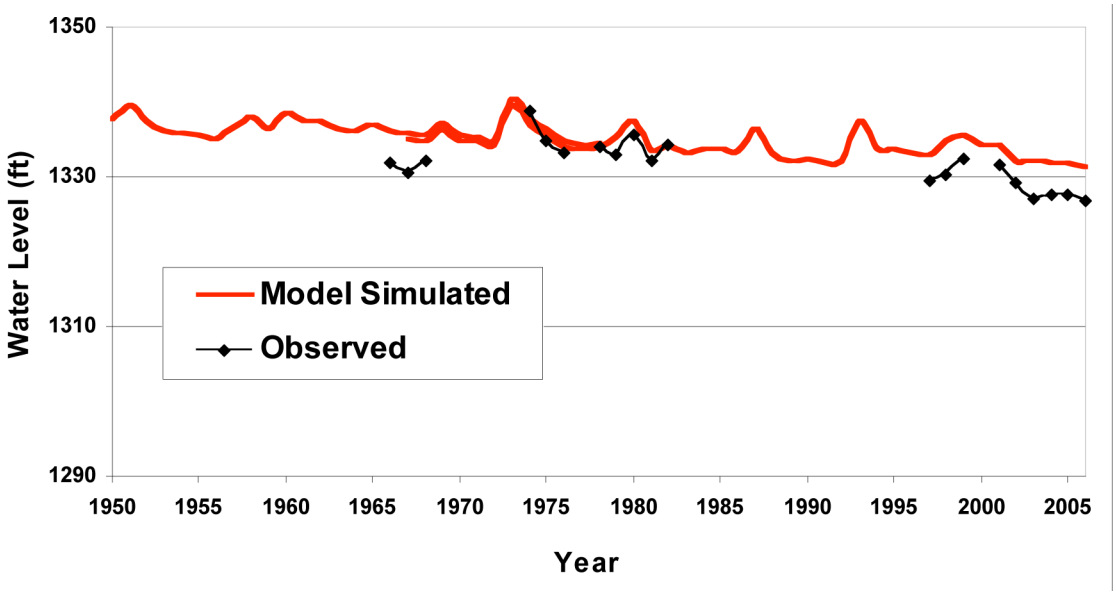

Figure 3–3. Water levels for wells between Assaria and Lindsborg, Smoky Hill River valley.

Resource Contacts

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Post Rock Rural Water District

Post Rock Rural Water District (RWD), the state's largest rural water district, was organized by a group of Wilson-area farmers with the help of then U.S. Senator Bob Dole to provide a safe and reliable source of water to rural communities in central Kansas. Post Rock now supplies water in parts of eight counties and wholesale customers transport water into two other Kansas counties.

The RWD supplies water to about 1,300 rural retail meters. Ten wholesale customers include the cities of Brookville, Dorrance, Ellsworth, Gorham, Luray, Paradise, and Waldo, and Osborne County Rural Water District # 2, Saline County Rural Water District # 7, and the development area of Wilson Lake Estates in Lincoln County.

Post Rock's sole source of water is Kanopolis Lake, which is fed by the Smoky Hill River. The major concerns for this water source are drought-induced fluctuations in reservoir storage, sedimentation, and eutrophication from nutrient-laden agricultural runoff. The protection and preservation of this resource is essential to Post Rock RWD.

Post Rock's treatment plant currently has the capacity to produce 1,224,000 gallons of water per day.

Water is held in a 200,000-gallon underground storage area for distribution to the system. The rural water is distributed to Post Rock's customers through about 1,600 miles of pipeline ranging from 1½ inch to 12 inches in diameter. The District has the following storage facilities:

1 – 500,000-gallon ground storage
1 – 300,000-gallon elevated tower
1 – 200,000-gallon elevated tower
1 – 100,000-gallon, 14 ft diameter x 90 ft tall stand pipe
1 – 58,700-gallon, 10 ft diameter x 100 ft tall stand pipe
2 – 61,635-gallon, 10 ft diameter x 105 ft tall stand pipe
1 – 50,000-gallon elevated tower

Post Rock's water infrastructure includes eight pumping stations to fill these towers and one to fill a tower for Osborne County RWD #2. Ten metering stations have controls to fill towers for Brookville, Ellsworth, Dorrance, Gorham, Luray, Waldo, Paradise, Wilson Lake Estates Lincoln County, and Saline County RWD #7 (which then sells water to Falun). Sixty-four pressure-reducing stations are on the main lines to control pressures as the pipes travel down through river and stream valleys.

All of the pumps and most of the towers are monitored and controlled through a complex system of radio and computer equipment. This allows operators to monitor system status as far as 90 miles from the plant and enables the distribution system to run while the plant is unmanned.

Resource Contact

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Geology of the Kanopolis Lake Area

Introduction

Ellsworth County lies within the Smoky Hills physiographic region and is drained by the Smoky Hill River, its tributaries, and tributaries of the Saline and Arkansas rivers. The Smoky Hills are mature dissected hills, many of which are capped by sandstones of the Cretaceous Dakota Formation. The hills and the river that drains them owe their name to the early morning haze that often hangs in the valleys. Kanopolis Dam impounds the Smoky Hill River about 25 miles southwest of Salina, Kansas.

Rocks exposed in the Kanopolis Lake area, mainly the Kiowa and Dakota Formations, are Cretaceous in age (about 100 million years old). The Cretaceous was a time of high global sea level, and much of the Western Interior of North America was periodically covered by oceans. During times of highest sea level, the Western Interior Seaway (fig. 3–4) stretched from the Gulf of Mexico to the Arctic Ocean.

Kiowa Formation

The Kiowa Formation is exposed in several places around Kanopolis Lake. The Kiowa is a heterogeneous unit made up of shale, siltstone, sandstone, and coquina limestone ("shell-beds"). The thickness of the Kiowa Formation in Ellsworth County ranges from 110 to 150 feet.

The lower part of the Kiowa Formation is a medium- to dark-gray, and black, shale that splits easily. Thin sandstone bodies are common throughout the unit, and a persistent, thick, light-colored sandstone occurs at the top. Beds of cone-in-cone, "quartzitic" sandstone, siltstone, and thin limestone are common. Pyrite, marcasite, gypsum crystals, ironstone concretions, lignitized wood fragments and logs, and marine invertebrates (mainly bivalves and gastropods) are found in the shales. Marine mollusks occur in the limestone.

Sandstone is a major component of the Kiowa Formation in the Kanopolis Lake area. The sandstones are very light gray to pale grayish orange, but in places, hematitic (iron) stain and cement color it reddish brown. Barite rosettes (barium sulfate), ripple marks, and crossbedding can be seen in the sandstones.

These rocks formed from sediments that were deposited in nearshore to coastal environments as the early Cretaceous sea spread northeastward across the gentle terrain of mainly older Permian rocks. The climate was probably warm and humid.

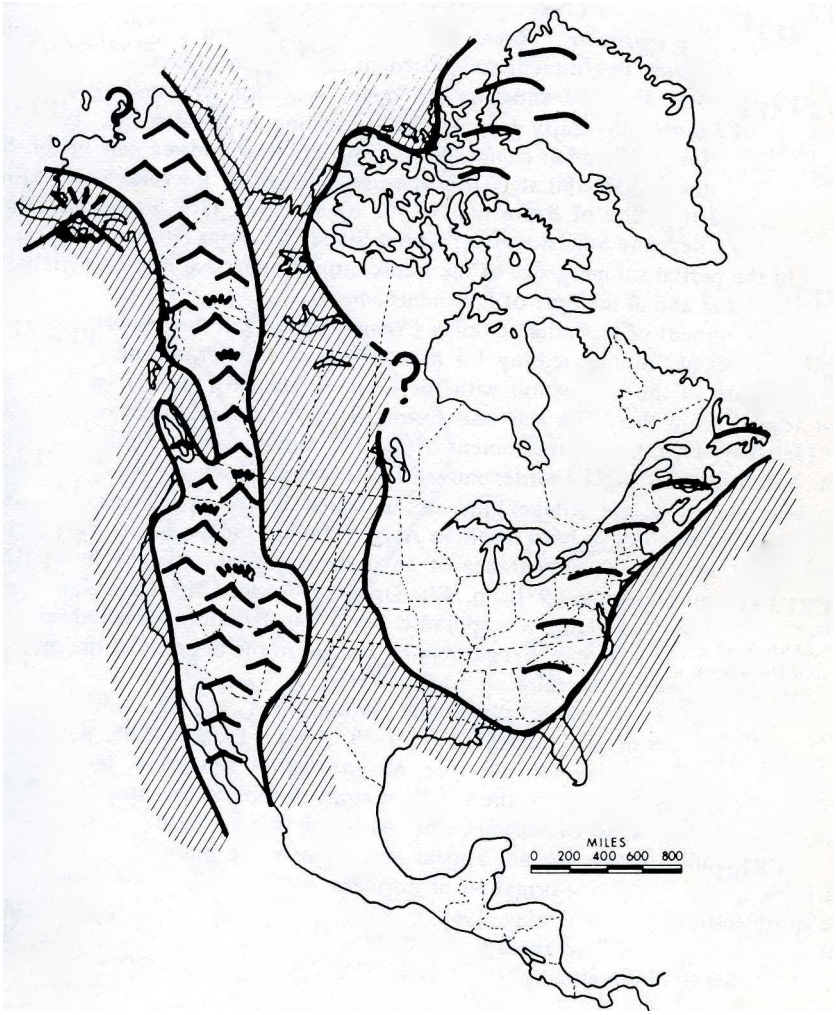

Figure 3–4. Paleogeographic map of North America during Lower Cretaceous times (from Williams and Stelck, 1975).

The shales were deposited in relatively quiet water where the bottom was only occasionally disturbed by currents and waves. Bottom-dwelling marine life inhabited bays or other places where salinity and current or wave activity were favorable. Stronger currents, waves, or storms destroyed and reworked some of these areas to form the coquina shell-beds.

The abundance of sandstone and associated organic material in the upper part of the Kiowa Formation is evidence that the seas were starting to recede and marked the beginning of deposition of the overlying, mostly non-marine Dakota Formation. Geologic features peculiar to the Kiowa Formation include:

Cone-in-cone. Cone-in-cone structure forms oval-shaped concretions and discontinuous lenses in the Kiowa Formation in many parts of Ellsworth County. Formation of cone-in-cone is attributed to precipitation and growth of fibrous crystals of calcite soon after sediments were deposited. A unique set of physical and chemical conditions was essential to the formation of cone structures in sediment. Decaying organic matter in sediments underlying a cone-in-cone may have lowered the pH sufficiently to cause recrystallization of the calcite. Gravity-induced stresses during compaction of the sediment may have been partly responsible for the near-vertical orientation of the calcite fibers and cone structures. Contortion of the shale beds around a cone-in-cone structure indicates that the cone-in-cone developed when the enclosing sediments were not yet firm and were still quite plastic.

Marcasite. Common in the dark-gray shales of the Kiowa, marcasite (iron sulfide) is distinguished from

pyrite by its pale-bronze color and flat or bladed crystals. Pyrite is darker in color and has cubic crystals.

Gypsum crystals. Gypsum (calcium sulfate) is a secondary product derived from the weathering of iron sulfide (mainly marcasite) in the shales within the Kiowa. Three varieties of gypsum are generally recognized in Kansas—rock gypsum, satin spar, and selenite. Rock gypsum is a massive-bedded, coarsely crystalline rock that is white to gray. Satin spar is white to pink and fibrous with a silky luster. It is found as thin layers in rock gypsum and shales. Selenite, the type most popular with collectors, has transparent, diamond-shaped crystals. Occasionally, two crystals grow together in a crystal habit known as a "fishtail twin." Other selenite crystals sometimes occur as a radial "gypsum flower" or "sunburst" crystal. Selenite is common in the dark-gray Kiowa shales that crop out around Kanopolis and litter the shale slopes with crystals up to 7 inches long.

Clay-Ironstone concretions. Composed mainly of very fine grained siderite (iron carbonate) and some clay, these concretions occur in thin discontinuous zones parallel to the bedding of the enclosing shale. On weathering, the concretions break into angular fragments.

Dakota Formation

The resistant, conspicuous beds of the Dakota Formation are the dark-brown sandstones cemented with iron oxide that cap the hills and produce the irregular topography so common in the Smoky Hills. The Dakota Formation is a thick, heterogeneous sequence of clay, siltstone, and sandstone. The sandstones are locally cemented with hematite (iron oxide with iron and oxygen molecules) and limonite (iron oxide with iron, oxygen, and water molecules). The Dakota also contains lignite (low grade or "brown coal") and, locally, beds of "quartzitic" sandstone concretions.

Although the Dakota is thought of as primarily sandstone, the dominate lithology is light-gray to light-greenish-gray siltstone or clay dappled with abundant red to reddish-brown mottles. Clay and siltstone compose as much as 70% of the thickness of the Dakota Formation in many areas. In Ellsworth County, the Dakota Formation ranges from 190 to 250 feet thick.

The Dakota Formation is generally thought to have been deposited during the retreat of the Kiowa sea under nonmarine conditions in a low-lying coastal or deltaic plain bordering the Cretaceous sea (fig. 3–5). The terrestrial nature of Dakota sedimentation can be inferred from the general absence of marine fossils, the abundance of leaf fossils, and the occurrence of lignitic beds (coal indicates swampy conditions). Sandstones in the Dakota Formation were deposited mainly by streams and rivers. Imprints of oak, willow, walnut, sycamore, magnolia, laurel, and sassafras leaves indicate the climate was mild.

Marine fossils in the upper part of the Dakota and the deposition of marine sediments of the overlying Graneros Shale mark the return of higher sea levels in central Kansas.

Sandstone Concretions. Sandstone concretions have been described in both the Kiowa and Dakota Formations. The concretions represent local features within the sandstone where the sand grains have been cemented together by lime (calcium carbonate) carried in solution and deposited by circulating ground water some time after the sandstone was deposited. The lime cement was deposited concentrically and grew outward from a nucleus. During the process of weathering and erosion, the softer sandstone has been removed, leaving behind the firmly cemented concretions. These hard, dense, light-gray sandstones are locally called "quartzite." The term "quartzite" officially refers to a metamorphic rock that was originally composed of sandstone but was changed into a much harder, denser rock through heat and pressure. Even though the Kansas "quartzite" sandstone is sedimentary instead of metamorphic, it is still hard and is mined today in a quarry south of Lincoln. In the past, it was also mined at other locations in central Kansas. Because it is hard, it is a valuable construction material and was used for riprap on Kanopolis Dam.

Crossbedding. Crossbedding is a series of thin, inclined layers in a bed of rock (usually sandstone)

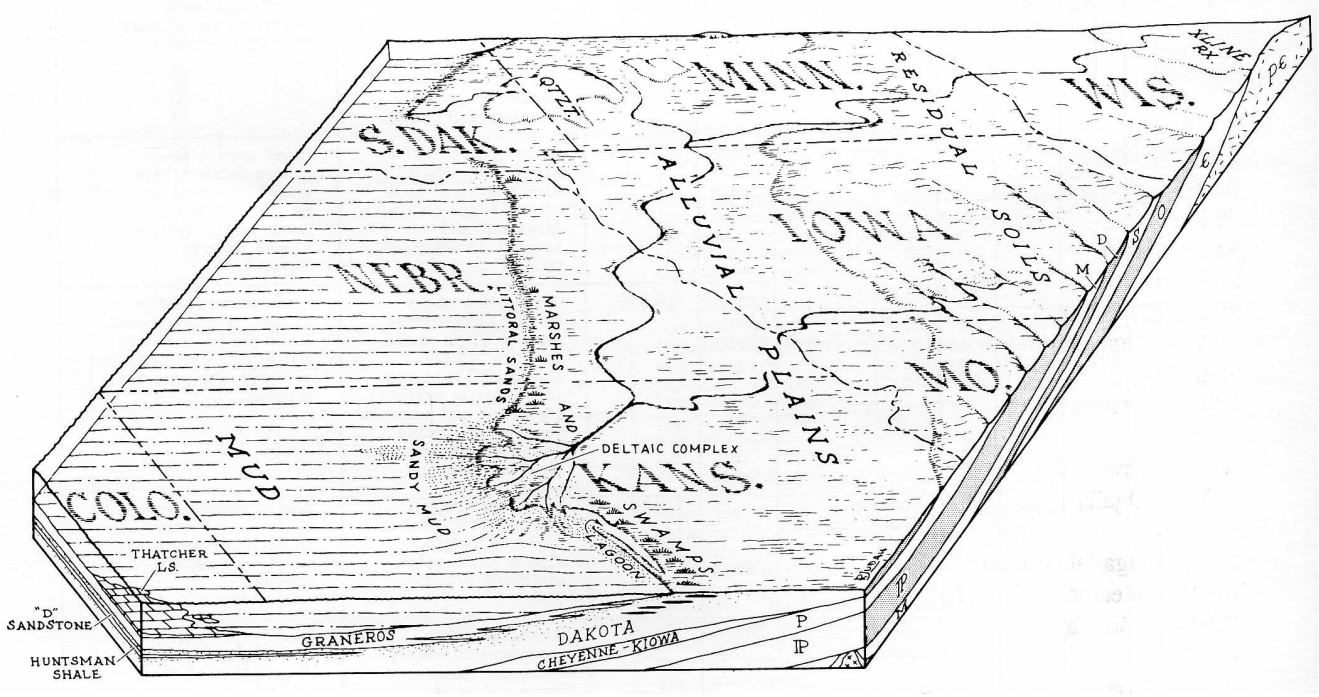

Figure 3–5. Paleogeographic reconstruction of central Kansas during deposition of the Dakota and Graneros Shale formations (from Hattin, et al., 1978).

that form a distinct angle to the principal horizontal bedding plane. Formed by currents of water or wind, crossbedding is found in dune, stream channel, or delta deposits. The direction in which the beds are inclined usually indicates the direction the current of water or air was flowing at the time of deposition.

The Dakota Aquifer

In recent years the Dakota and Kiowa formations have been the subject of particular interest because of their potential as a water source. With ground-water-level declines in the High Plains aquifer of western Kansas, underlying Cretaceous rocks may be an important source of water. Water specialists often refer to the Dakota, Kiowa, and underlying Cheyenne Sandstone formations as one unit—the Dakota aquifer. Their research has shown this aquifer is not capable of producing water in amounts as large as the High Plains aquifer, and water quality varies greatly from place to place. As a result, the Dakota aquifer will probably never be as important as the High Plains aquifer. However, with careful management, the Dakota could produce significant amounts of water.

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Rock City, Minneapolis, Kansas

In an area the size of two football fields, 200 rocks—some as large as houses—dot the side of a hill south of Minneapolis, Kansas (fig. 3–6). Known as concretions, these rocks were formed millions of years ago when the Dakota Formation was deposited in an inland sea that covered central Kansas during the Cretaceous Period.

Concretions are formed when sediment is deposited, shortly after deposition, or after the sediment has hardened. Ground water containing dissolved calcium carbonate circulated through the porous rock with ease and, in doing so, deposited calcium carbonate in the open spaces between the sand grains, thereby cementing them together. Instead of proceeding evenly, the precipitation of this natural cement began at a number of scattered points where, perhaps, a fossil or an extra large grain of sand served as a nucleus that the cement built outward around. The result was the formation of a number of spherical bodies of tightly cemented sand grains scattered throughout the sandstone mass. Had the cementation continued long enough, the spheres would have grown together and the rock would have become a single, homogenous mass.

Figure 3–6. Sandstone concretions at Rock City, near Minneapolis, Kansas.

At one time, the surface of the land at the park was higher than it is now. The space between the concretions was occupied by poorly cemented sandstone. Over time, erosion by wind, rain, and running water began to weather away the poorly cemented sandstone and erode the ground surface. Because the concretions are harder than the surrounding rock, the concretions resisted erosion, leaving them exposed on the hillside.

Kansas has many concretions. In the volcanic-ash deposits near Calvert in Norton County and south of Quinter in Gove County, concretions of ash are cemented with calcite. Windblown-loess deposits also have small calcite-cemented nodules, sometimes referred to by their German-derived classification, "loess kindchen" or loess dolls, because the concretion resembles the head of a child. The dark Cretaceous shales have a special type of concretion called septeria or septarian concretions (fig. 3–7). These concretions are cut by many veins filled with brown or yellow calcite. Small concretions are locally known as "thunder eggs" or "brains"; one of the best septarian locales is south of Hobbie Lake in Osborne County. Septarian concretions of Pennsylvanian age occur in eastern Kansas.

Figure 3–7. Septarian concretion.

Resources

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Wind Energy and the Meridian Way Wind Farm

Sometimes called the "Saudi Arabia of wind," Kansas—in terms of wind-energy potential—is ranked approximately third in the United States, and its wind resources are more uniformly distributed than any other state. In consideration of exhausting non-renewable energy resources, energy dependence, and the potential for new energy-related economic development, Governor Kathleen Sebelius, in her 2007 State of the State address, initiated a voluntary challenge to have 1,050 megawatts (MW) of wind-energy capacity installed in Kansas by 2010 and 2,100 MW installed by 2020.

According to a recent study completed for the Kansas Corporation Commission to assess wind energy as a renewable resource, wind, solar energy, and biomass- and/or biodiesel-fuel offer the greatest promise for generating renewable energy in Kansas. Among these, wind currently has the most potential for meeting renewable-energy initiatives. As of late 2007, Kansas had approximately 346 MW of wind generation connected to its power grid (Cita and others, 2008).

Many factors affect the viability of wind as a renewable-energy source. They include present and future installation costs, operation and maintenance expenses, equipment performance, hydrocarbon-fuel resources, the possibility of future carbon tax or regulation, electric transmission and storage, location-siting issues, and the developmental approach of private utility companies.

The Meridian Way Wind Farm in Cloud County offers an opportunity to examine some of the developmental and siting aspects that two utility companies, Horizon Wind Energy and Westar Energy, have utilized to construct and incorporate wind energy into the Kansas power grid.

Westar Energy

Westar Energy, the largest electric utility in Kansas, is involved in three wind projects in Kansas with combined electricity generation capacity of about 300 megawatts (MW), making Westar's wind-energy program the largest in Kansas. The three projects are

- **Meridian Way Wind Farm**, owned and operated by Horizon Wind Energy. Westar will buy 96 MW of electricity from that facility. The Empire District Electric Company, based in Joplin, Missouri, will purchase the remaining 105 MW.
- **Central Plains Wind Farm**, a 99-MW project in Wichita County between Leoti and Scott City. The developer is RES America Developments, Inc. Westar will own the generation at this wind farm.
- **Flat Ridge Wind Farm**, a 100-MW project in Barber County. BP Alternative Energy Inc. is developing the project through its Flat Ridge Wind Energy, LLC subsidiary. Westar will own 50 MW of power generation and will buy the remaining 50 MW through a power purchase agreement.

When completed, the output from these wind projects will represent about 5% of Westar's current overall capacity of 6,100 MW. All three projects are expected to be operational by the end of 2008. Westar estimates that adding the wind farms to its system will increase the average residential customer's bill by $2.00–$2.50 per month, but ultimately, wind resources should lower the long-term costs of energy. The wind farms have allowed Westar to defer the need to build another coal-fired power plant.

Meridian Way Wind Farm

Kansas' largest wind farm to date, Meridian Way Wind Farm, is being constructed 8 miles south of Concordia, Kansas, in Cloud County by Horizon Wind Energy. The 201-MW project—enough energy to power 45,000 average Kansas homes—is being constructed on the highest topographic point in the region, with drainage from the watershed flowing to the Republican River to the north and Solomon River to the south. Ecologically, Cloud

County is located in the central mixed-grass prairie. The wind farm is being constructed on approximately 20,000 acres of privately owned land under long-term lease agreements. Land uses within and surrounding the project area include cattle ranching, gravel quarrying, and farming. The wind farm will consist of 67 Vestas V90-3.0 MW turbines, the largest onshore wind turbines currently being installed. When completed, the project will connect to Aquila's Concordia–East Manhattan 230-killivolt transmission line.

Horizon Wind Energy spent several years searching for a site in Kansas that would provide the best combination of wind resource, transmission capabilities, and community acceptance. In addition to using traditional wind industry site-selection methods, Horizon consulted with the Kansas Biological Survey, and employed geographic information systems (GIS) analysis, along with satellite and remote sensing data, to locate the Meridian Way Wind Farm. The Cloud County site, according to Horizon Wind Energy, has many advantages as a location for a modern wind-power project, including:

- A strong, proven wind resource
- Excellent access to electric-transmission lines
- Compatibility with existing land uses
- Proximity to power market
- Community support

It is projected that Meridian Way Wind Farm will replace the annual emission of approximately 600,000 tons of carbon dioxide, nearly 1,200 tons of nitrogen oxide, and over 1,600 tons of sulfur dioxide. This is equivalent to taking 60,000 cars off the road.

Horizon Wind Energy develops, constructs, owns, and operates wind farms throughout the United States. Horizon is based in Houston, Texas, with regional offices in New York, Oregon, Illinois, California, Colorado, and Minnesota. Horizon, which is currently developing more than 10,500 MW in over 15 states, is owned by Energias de Portugal (EDP), the largest utility in Portugal. Energias de Portugal, S.A. is active in the electricity and gas industries—generation, distribution, and supply—and is one of the leading generators of electricity from renewable sources globally. Worldwide, EDP has more than 14 gigawatts (GW) of estimated capacity in Portugal, Spain, Brazil, and the United States.

Prior to 2005, Horizon Wind Energy was known as Zilkha Renewable Energy. The Field Conference visited their Rosalia Wind Project in the Flint Hills in Butler County during the 2004 conference.

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Brown Grand Theatre

Concordia was a regular stop for professional actors and entertainers by the turn of the 20th century. To provide a performance venue, colorful Concordia businessman Colonel Napoleon Bonaparte Brown built the Brown Grand Theatre. The self-entitled Colonel had arrived in Concordia in from Missouri in 1876 with a rumored suitcase full of money and his Bostonian bride. Napoleon, who served terms in both the Missouri and Kansas legislatures, established a bank in Concordia and awaited the arrival of settlers who needed to borrow money.

In November 1905, Colonel Brown announced plans to build the fully outfitted opera house. His generosity may have been prompted, in part, by the news that nearby Beloit and Lincoln were planning to build large ones of their own. The construction of the theater was under the direction of Brown's son, Earl Van Dom Brown. Ground-breaking ceremonies took place on April 3, 1906. Costing $40,000, the Brown Grand Theatre was 60 feet high and 120 feet long.

The formal opening of the Brown Grand Theatre, hailed as the most elegant theater between Kansas City and Denver, took place September 17, 1907, with New York's Joseph M. Gaites Company presenting the musical play *The Vanderbilt Cup*. In the words of Carl "Punch" Rogers who was in attendance on opening night, "The firemen who were at the doors were in full uniform and the ushers at the door wore white gloves. I'll tell you, that night society sort of quivered. It was all beautiful…yes it was." Fatefully, both Colonel Brown and his son Earl were dead within four years of the celebrated opening. Subsequently, the ownership of the theater was passed to their widows, Katherine and Gertrude, who were reportedly not fond of each other.

From 1915 to 1925, the Brown Grand Theatre played host to a variety of entertainments. Famous stars who came through with road shows included Bohemian songstress Madam Ernestine Schumann Heink, New York actress Laurette Taylor, and dancers Ruth St. Denis and Martha Graham. In 1925, the Brown Grand became a movie house, and in 1955 it was painted pink and blue with silver accents. The last picture show, on September 10, 1974, was a premier screening of *The Devil and Leroy Basset*, written and directed by Concordia filmmaker Robert Pearson.

On July 26, 1973, the Brown Grand Theatre was recognized as a National Historic Building and was listed in the National Historic Register. Recognized as a National Historic Site, the theater's restoration was selected as a Concordia community Bicentennial Project. Funds were raised, and the theater was purchased and given to the City of Concordia, which then leased it to the newly formed Brown Grand Opera House Inc., to restore and operate.

The reopening event was a restaging of the original opening night play, *The Vanderbilt Cup*. Three women, Winifred Hanson, Pauline Kennett, and Verl Turner, who had attended the opening of the theater in 1907, sat front-row center for the reopening. Today restored to its 1907 splendor, the theater has two balconies, eight box seats, and a grand drape featuring a reproduction of a Horace Vernet painting titled, "Napoleon at Austerlitz Today." It serves as a tourist attraction and performing arts/community center for Concordia and north-central Kansas.

Source

The Brown Grand Theatre, 2008, http://browngrand.org/index.htm (verified May 12, 2008).

SCHEDULE AND ITINERARY

Thursday, June 5, 2008

6:30 am	**Bus to Jamestown Wildlife Area and breakfast**
6:45 am	**SITE 7** • Jamestown Wildlife Area, Jamestown *Secretary Mike Hayden*, Kansas Department of Wildlife and Parks *Rob Unruh*, Wildlife Area Manager, Kansas Department of Wildlife and Parks
7:45 am	Breakfast at Jamestown Wildlife Area
8:45 am	Bus to Site 8
9:00 am	**SITE 8** • Courtland Canal, Kansas Bostwick Irrigation District, and Republican River Valley, Courtland *Kenny Nelson*, Kansas Bostwick Irrigation District
9:45 am	Bus to Site 9
10:00 am	**SITE 9** • Gypsum-rich Soils, Belleville *Bob Henthorne*, Kansas Department of Transportation
10:45 am	Bus to Site 10
11:30 am	**SITE 10** • Republican River Compact panel discussion, Superior, Nebraska *Sen. Janis Lee*, Kansas District 36 *Sen. Tom Carlson*, Nebraska District 38 *David Barfield*, Chief Engineer, Division of Water Resources, Kansas Department of Agriculture *Jim Williams*, Republican River Coordinator, Nebraska Division of Natural Resources
2:30 pm	Bus to Site 11 and Site 12
2:45 pm	**SITE 11** • Lovewell Reservoir *Secretary Mike Hayden*, Kansas Department of Wildlife and Parks *Rick Cleveland*, Park Manager, Kansas Department of Wildlife and Parks
3:15 pm	**SITE 12** • Kansas–Nebraska Water Law Review, Lovewell Reservoir *John Peck*, Connell Teaching Professor of Law, University of Kansas
4:00 pm	Barbeque supper, Lovewell Reservoir *Secretary Mike Hayden*, Kansas Department of Wildlife and Parks *Rick Cleveland*, Park Manager, Kansas Department of Wildlife and Parks
5:30 pm	Bus to motel
6:30 pm	Return to Holiday Inn Express, Concordia

Jamestown Wildlife Area

Tied into the lower Republican River basin, Jamestown Wildlife Area (fig. 4–1) is a significant resource for migratory birds in the Central Flyway. Besides providing a stopover between northern breeding grounds and southern wintering grounds, regionally Jamestown links the Nebraska Rainwater Basin with Cheyenne Bottoms, Quivira National Wildlife Refuge, and McPherson Valley Wetlands. More than 200 bird species, including waterfowl, shorebirds, wading birds, raptors, and songbirds, have been recorded along Marsh Creek, the main waterway running through the wetlands.

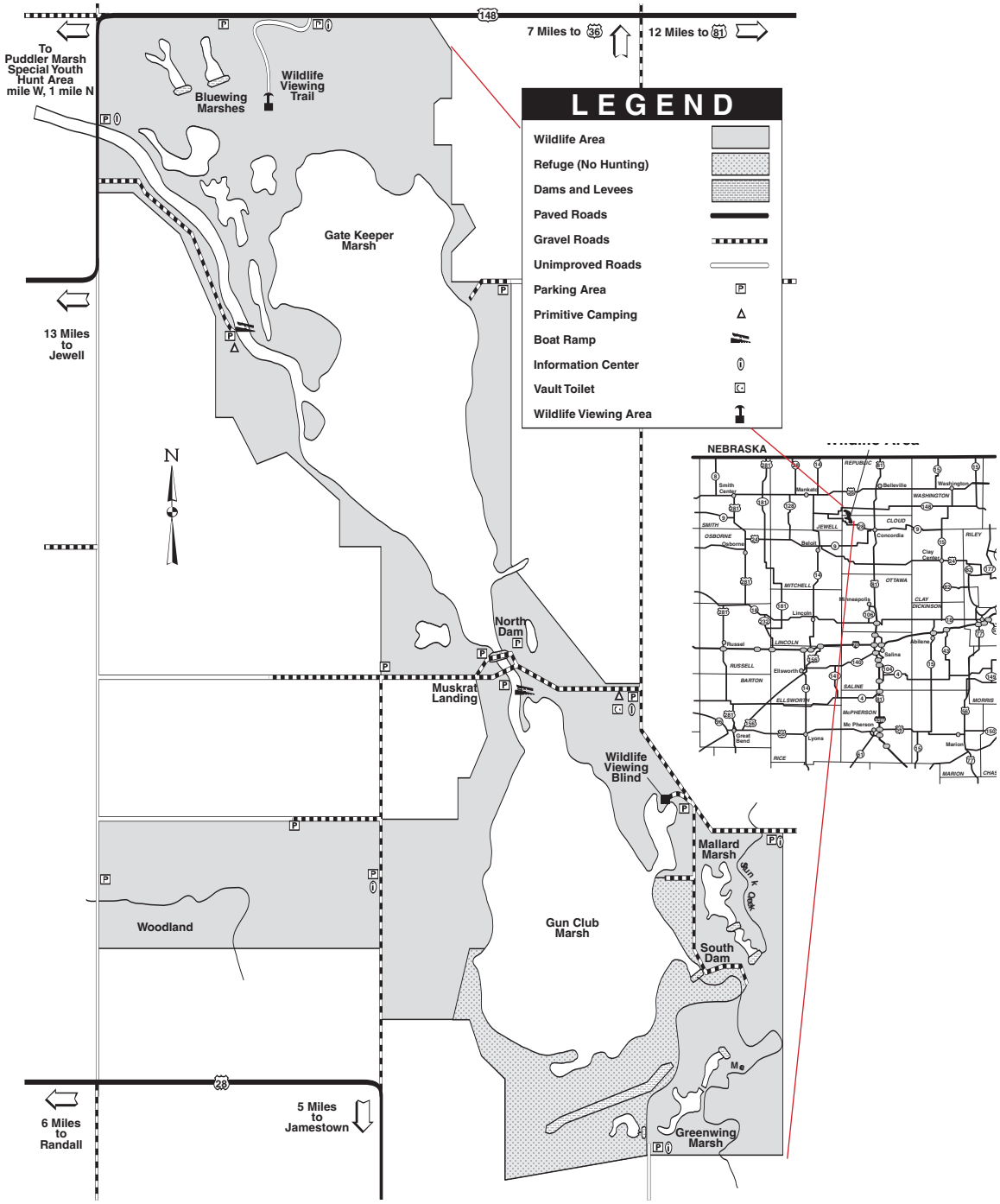

Figure 4–1. Jamestown Wildlife Area (courtesy of the Kansas Department of Wildlife and Parks).

Four high-priority waterfowl species and more than 20 other high-priority birds use the marshes as migration and wintering habitat.

The Jamestown wetlands complex is a series of marshes, salt flats, and riparian areas. Nearly 80 years ago, dams were built to create two main marshes—Gun Club Marsh and Game Keeper Marsh. Previously, the saline marshes had been a source of salt for bison and other wildlife, Native Americans, and early settlers during dry seasons when the water evaporated and salt encrusted the ground. After the dams were built, the marshes remained wet year-round, changing many aspects of their environment.

The two larger marshes were more advantageous for hunting than an assortment of smaller ones, but the human modifications diminished the intermittent nature of the wetlands, altered Marsh Creek, and affected the lower Republican River basin. Today, the marshes are shallow, having accumulated silt from the Marsh Creek watershed. Gun Club Marsh is perpetually wet and choked with sediment and cattails. Marsh Creek is consistently dry.

Kansas Department of Wildlife and Parks (KDWP), which manages Jamestown, enforces wildlife-management practices and special restrictions to help preserve the wildlife environment. Agricultural fields on the site are planted using only sustainable agriculture methods. Land is leased annually to farmers for a share of the crop, and the KDWP share of fall crops are left standing. Revenues generated by managing croplands for wildlife are used to operate and maintain the area.

Restoration and Land Acquisition

At the turn of the 21st century, local, private, and State support for restoration of the Jamestown marshes and the surrounding environment came together. Phase I of a multiple-phase project began as numerous government and private partners signed on to help KDWP and major partner Ducks Unlimited with technical and financial support.

The goal of the restoration project was to provide optimum wildlife habitat, restore wetland function and water quality, acquire and restore additional wetlands and grasslands along Marsh Creek and its tributaries, and restore minimum streamflows to the lower Republican River.

A consulting engineering firm, Schwab–Eaton, was hired to do a feasibility study, and the Jamestown Task Force, made up of government and private natural resource specialists who reviewed plans and selected alternatives, was formed. The project was broken into phases with the first focusing on Gun Club Marsh.

Partners who have joined Ducks Unlimited and KDWP on the project are Pheasants Forever, Inc., The Nature Conservancy, Westar Energy, CloudCorp, Cloud County Board of Commissioners, City of Jamestown, Cloud County Tourism Committee, Republic County Board of Commissioners, Jewell County Board of Commissioners, Kansas Wildlife Federation, Kansas Alliance for Wetlands and Streams, and U.S. Fish and Wildlife Service.

Phase I

As Phase I was set in motion, an application was made for a North America Wetlands Conservation Act (NAWCA) grant. The 1989 Act provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico for the benefit of wetlands-associated migratory birds and other wildlife. In March 2006 a grant of nearly $1 million was approved for the Jamestown project. The partners provided additional funding of nearly $2.2 million.

The goal of Phase I was to enhance Gun Club Marsh, restore adjacent grasslands and wetlands along Marsh Creek, and seed adjacent croplands with native warm-season grasses. Partners were to acquire 440 additional acres to add to the State's previous 270-acre purchase. By completion of Phase I, KDWP owned and managed 4,650 acres of wetlands and associated grasslands.

Phase II

In September 2007 the project received a second NAWCA grant of nearly $500,000. Ducks Unlimited, KDWP, and their partners provided additional funding of nearly $1 million.

This phase is designed to restore the wetland quality and function of Gun Club and Game Keeper marshes and other wetlands along Marsh Creek and its tributaries south to Buffalo Creek. Land in the area acquired from willing sellers will be returned to public ownership. Partners will restore wetlands and associated grasslands on the acquired properties, which will help restore minimum streamflows to the lower Republican River. Work on Phase II continues.

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Courtland Canal, Kansas Bostwick Irrigation District, and Republican River Basin

Increased surface-water and ground-water demands in the Republican River basin have led to a decline in the surface-water capacity of the Republican River and its tributaries (USBOR, 2008). Effective water-policy management of the basin requires basic knowledge of the basin, the hydrologic interconnection between its surface water and its aquifer, and the aquifer's response to pumping withdrawals.

The approximately 24,900-square-mile Republican River basin drains 7,700 square miles in Colorado, 9,700 square miles in Nebraska, and 7,500 square miles in Kansas (USBOR, 2008). Its headwaters originate in northeastern Colorado. Downstream tributaries in both Kansas and Nebraska combine at the conflux of the Arikaree and North Fork Republican rivers to form the Republican River in Nebraska (fig. 4–2). From there, it flows east before turning and entering Kansas near Superior, Nebraska. It continues past Concordia and Clay Center towards its conflux with the Smoky Hill River where they form the Kansas River near Junction City.

Water supply and allocation are governed by different legislative acts and interagency agreements. In 1942, Kansas, Nebraska, and Colorado formed the Republican River Compact to allocate water among the three states (Hansen, 1998). The river basin contains a system of federally developed water supplies that consist of nine reservoirs and associated surface-water canals that serve approximately 136,528 acres of farmland (USBOR, 2008). The U.S. Bureau of Reclamation (BOR) and U.S. Army Corps of Engineers (Corps) constructed the dams and canals in response to the droughts and floods of the 1930s (Hansen, 1998). Water-service contracts to six irrigation districts were established under the Reclamation Project Act of 1939. The 1939 Act was re-supplemented by the Reclamation Project Act of 1956. The 1956 Act allows conversion of water service acts to repayment contracts (USBOR, 2008). Minimum desirable streamflow in the Republican River was set at Concordia by Kansas law in 1982 (Hansen, 1998).

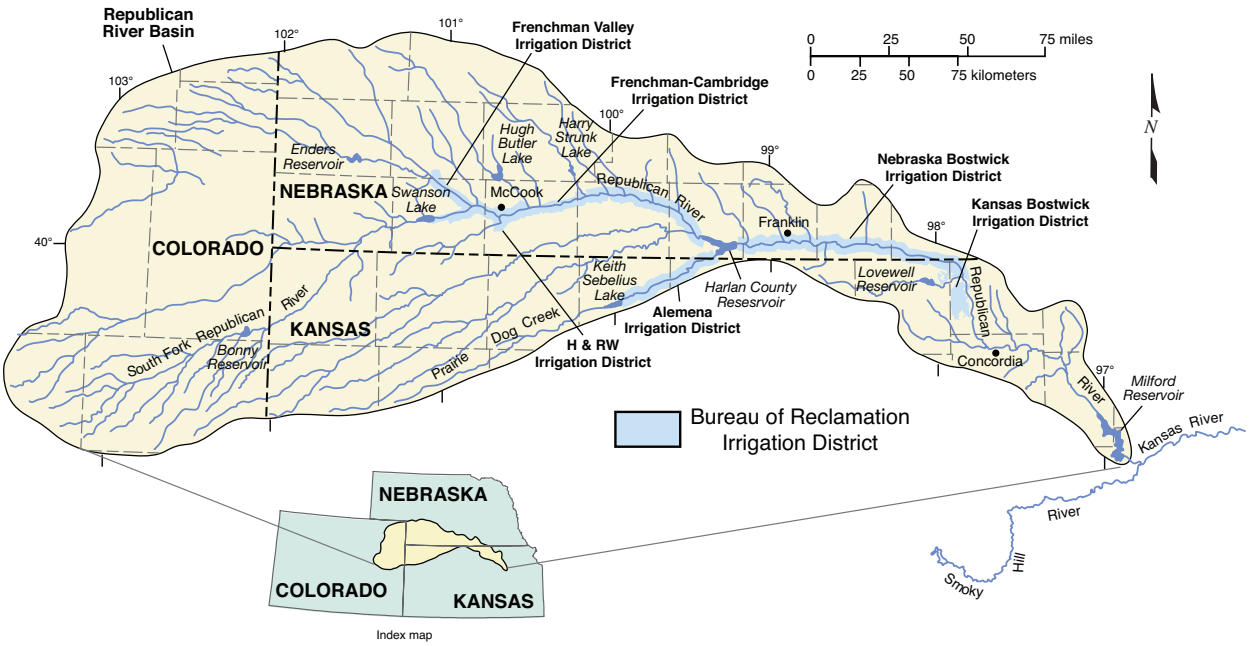

Figure 4–2. Republican River basin and Bureau of Reclamation irrigation districts (modified from Juracek and Ziegler, 1998).

Operating and field-working agreements between BOR and the Corps at seven of the nine basin reservoirs mandate storage and operation for flood control, irrigation, and, in some cases, public health, recreation, and fish and wildlife preservation (USBOR, 2008). Bonny and Milford reservoirs are not managed primarily for irrigation (fig. 4–2). In 1982, Colorado purchased the conservation space in Bonny Reservoir for fish, wildlife, and recreational use (USBOR, 2008). The Corps operates Milford primarily for flood control in the Kansas and Missouri River basins, but water is also released for downstream municipal and industrial needs, navigation, agricultural, and to enhance downstream water quality (USACE, 2008).

Six irrigation districts in Kansas and Nebraska receive surface water from the Republican River, its tributaries, and off-season reservoir storage (fig. 4–2). USBR water-service contracts allocate water among the Frenchman–Cambridge, H & RW, Frenchman Valley, and Nebraska Bostwick Irrigation districts in Nebraska and the Almena and Kansas Bostwick Irrigation District in Kansas.

Kansas Bostwick Irrigation District

The Kansas Bostwick Irrigation District (KBID) was built by the BOR and began full operation in 1958. The KBID consists of 42,500 irrigatable acres.

KBID receives most of its water from requested releases at Harlan County Lake in Nebraska (fig. 4–3). Reservoirs in the BOR network store water up to the conservation-pool elevation, if possible, which is set just below the reservoir space reserved for flood control. Most water is captured during the non-irrigating season and peak releases typically occur in July and August when demand is greatest (Hansen, 1998). The BOR coordinates surface-water requests between the different irrigation districts and canal systems that gravity-feed water to the different districts in the basin.

Water released from Harlan County Lake for KBID flows down the Republican and is diverted near Guide Rock, Nebraska, into the Courtland Canal, which transports the release to Lovewell Reservoir for storage in Kansas (fig. 4–3). The Courtland Canal and several other canal branches distribute Lovewell releases downstream for irrigation.

Several government and private entities manage the reservoirs and irrigation networks. The Corps operates Harlan County Dam. The BOR operates Lovewell Reservoir. The KBID operates the Superior–Courtland Diversion Dam at Guide Rock and the Courtland Canal System.

Because the BOR canal systems must use gravity to distribute irrigation water, the overall extent of land it can irrigate is somewhat limited (fig. 4–4). Starting in the 1960s, however, center-pivot irrigation allowed for greater consumptive use of water, crops, and land (Hansen, 1998).

Hydrologic System

In general, reservoir inflow has declined at a greater rate because of center-pivot irrigation. Surface-water diversions, conservation practices, and upstream irrigation development have further contributed to surface-water declines (USBOR, 2008).

Effective management of surface-water resources requires an understanding of the interconnection between surface water and an aquifer and their response to pumping (Heath, 1983). The basin aquifer system is largely composed of river-valley alluvial sediments that are connected to the regional High Plains aquifer (Miller and Appel, 1997).

The hydrologic system includes both surface and ground water (fig. 4–4). Precipitation is the main input into the system. Evapotranspiration, surface-water diversion, and ground-water pumping are the main outputs and affect the amount of water in storage within the aquifer.

Under natural conditions (i.e., without pumping), the amount of water in storage is somewhat static—inflow equals outflow. That is, there is a balance between infiltrating recharge

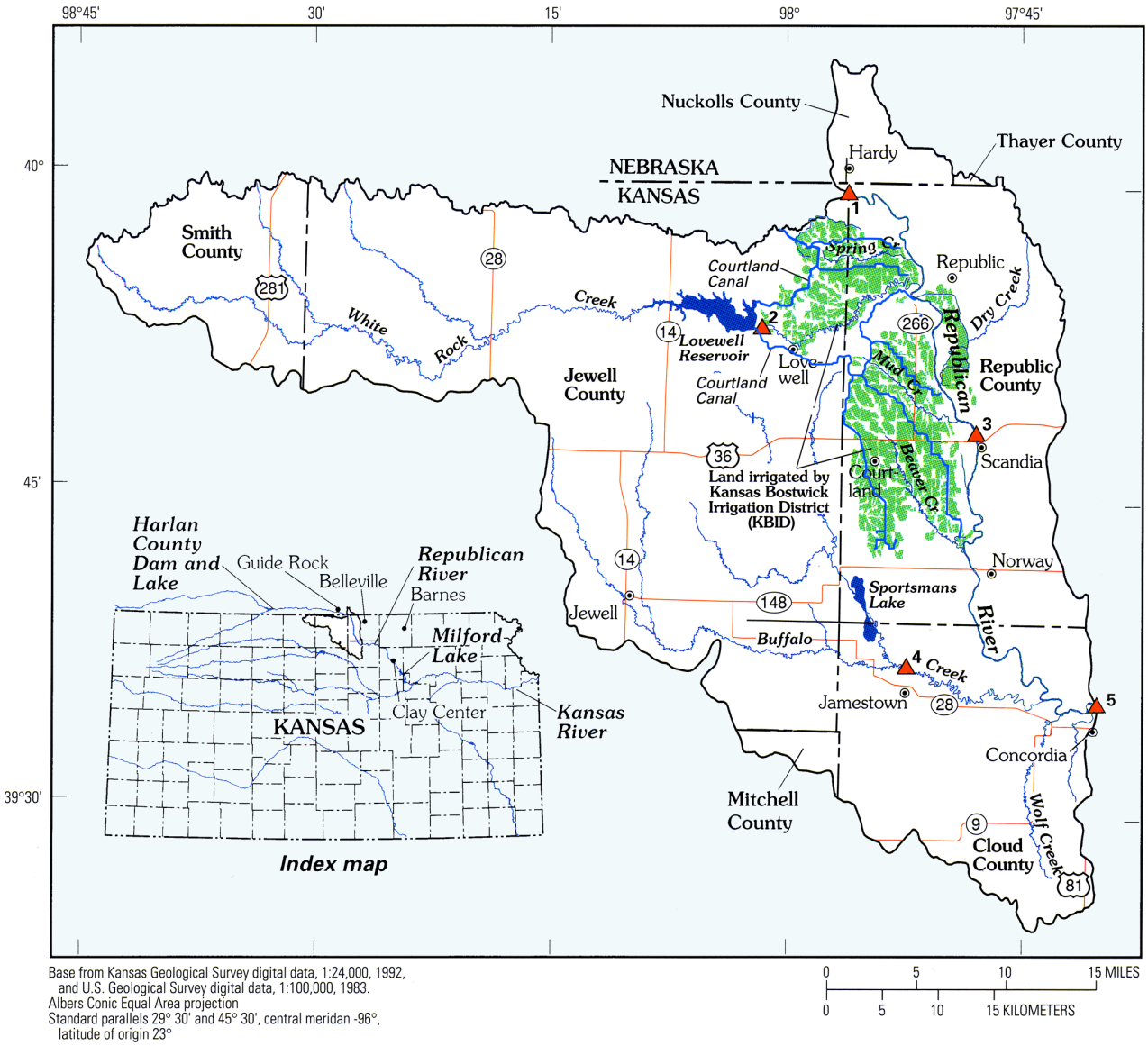

Figure 4–3. Lovewell Reservoir and land irrigated by the Kansas Bostwick Irrigation District (modified from Hansen, 1998).

and discharge at a stream, making the stream the surface expression of the aquifer (fig. 4–5A). In general, when recharge exceeds discharge, water in storage can increase and, conversely, when discharge exceeds recharge, water in storage can decrease. Reaching equilibrium between the two is a slow process that may take years or centuries to establish (Heath, 1983).

Pumping from a well affects local aquifer storage, causing a decline, or cone of depression, first in the well and then in the aquifer around the well as water moves out of storage into the well (fig. 4–5B). If the cone of depression from a well (or multiple wells) reaches a stream, discharge will be reduced (fig. 4–5C). If pumping wells are located near a stream or if pumping continues long enough, aquifer discharge to a stream may cease

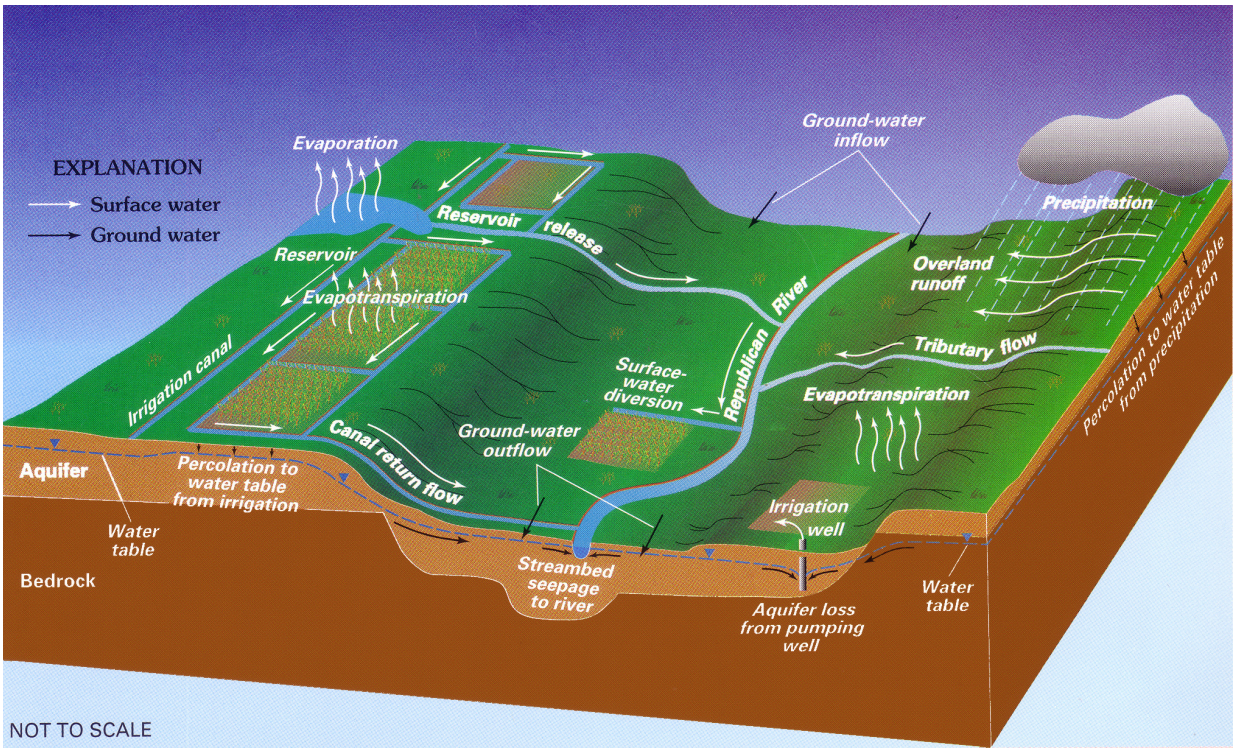

Figure 4–4. Conceptualized hydrologic system (modified from Hansen, 1998).

and water may instead move from the stream into the aquifer (Heath, 1983). The water flow to or from a stream is often referred to as "seepage" and represents gaining or losing reaches where an aquifer may alternately discharge to or receive recharge from the stream (fig. 4–5D). If local storage reductions occur long enough without balancing recharge, a stream may transition from gaining, to losing, to finally dry if the water level in the aquifer is drawn below the stream-bed elevation.

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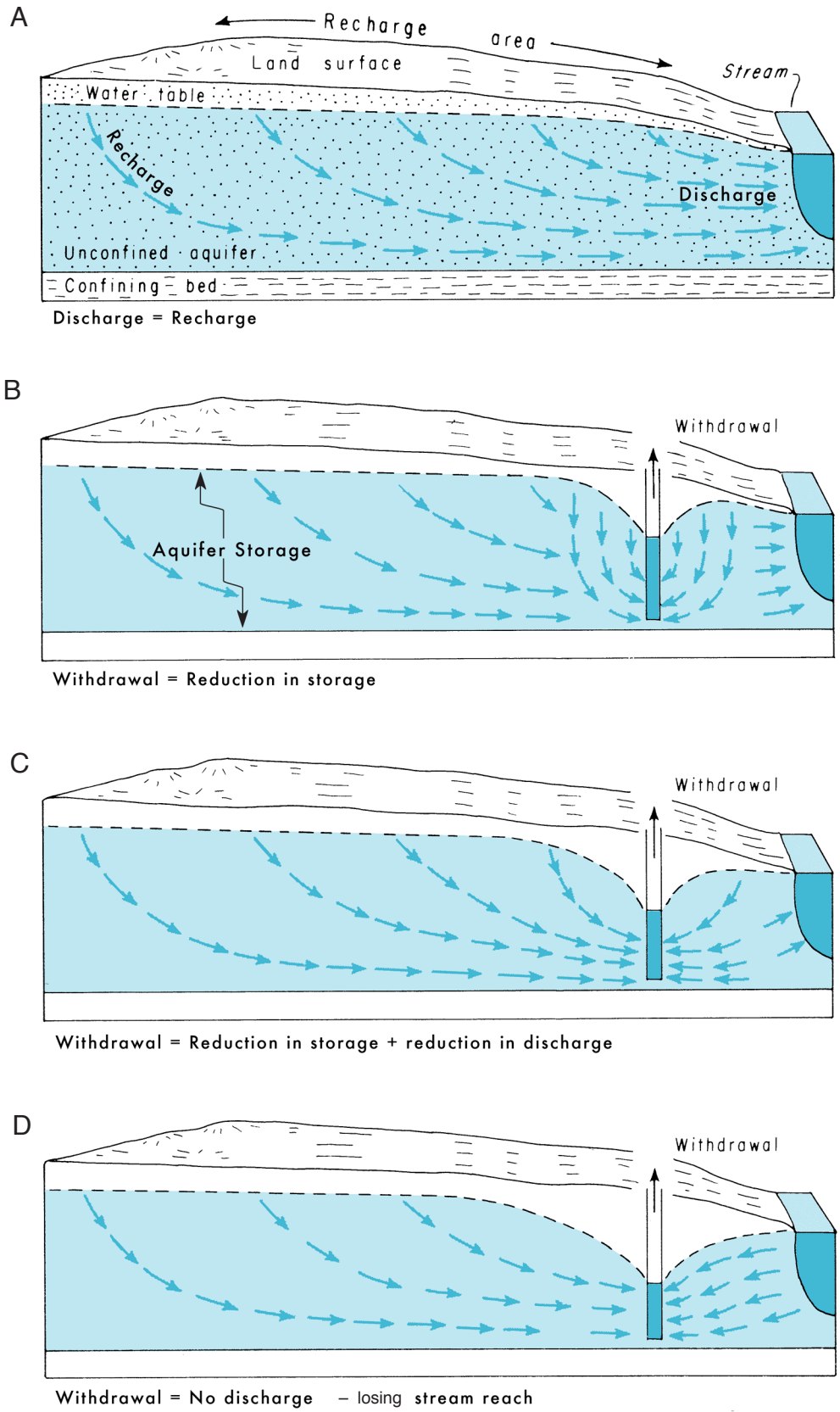

Figure 4–5. Source of water derived from wells (modified from Heath, 1983).

The Impact of Gypsum-rich Soils on Road Design and Construction

Many shales in central and western Kansas contain gypsum. As was discussed on Day 1 of the Field Conference, the dark-gray Cretaceous shales around Kanopolis contain an abundance of the mineral gypsum. The mineralogical occurrence of gypsum in Kansas can have profound effects on transportation-infrastructure design, construction, and operational maintenance due to the presence of sulfate, which is derived from gypsum-rich soils.

Gypsum belongs to the sulfate mineral group, which includes minerals composed of an element, such as barium or strontium, combined with a sulfur and oxygen molecules. Gypsum ($CaSO_4 \cdot 2H_2O$) is a calcium sulfate containing water. In Kansas gypsum occurs in three primary forms: rock gypsum, satin spar, and selenite (figs. 4–6 to 4–8).

Gypsum is common through the central portion of the state, and its mineralogical occurrence is a primary source of sulfate in many Kansas sediments (fig. 4–9 and 4–10). A common beneficial additive to Portland cement, gypsum acts as a set retarder and a bonding agent. An extreme chemical reaction occurs in cement when gypsum reacts with calcium, aluminum, and water to form ettringite (calcium sulfoaluminate). Ettringite molecules are approximately 250 times larger than gypsum molecules and can cause severe swelling and expansion that may be detrimental to road construction if not properly controlled. In concrete, this reaction and expansion takes place when the concrete is still plastic, so the changes are not detrimental to the concrete. However, if ettringite forms after the concrete dries or during lime treatment of a soil subgrade, the consequences can be severe in terms of construction costs and operational maintenance.

Figure 4–6. Rock gypsum is found in white, gray to black, and red variations.

A lime-treated subgrade is often used to stabilize soil and provide a solid base prior to laying pavement. Lime treatment is commonly used to improve the geotechnical properties of expansive clays and soft clays. Lime treatment, however, has a detrimental effect if too much sulfate is present in the soil causing ettringite formation and soil heave (fig. 4–11). During lime treatment, lime is spread over the soil and water is added. It is then mixed with a large construction implement known as a "Bomag," which is essentially a large self-propelled roto-tiller. This mixing stage is the point where ettringite begins to form in gypsum-rich soils and can cause soil heave and expansion.

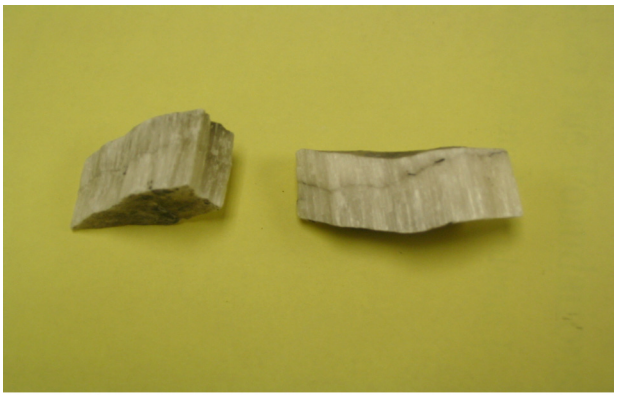

Figure 4–7. Satin spar.

Figure 4–8. Selenite.

Figure 4–9. Gypsum crystals in soil.

Figure 4–10. Gypsum crystals in sand.

It is extremely important to identify the gypsum-rich soils prior to bid letting of any road-construction project to prevent potential cost overruns and ensure proper design. If gypsum-rich soils are identified prior to construction, remediation and prevention measures can be taken. The Kansas Department of Transportation (KDOT) has two preferred methods:

Figure 4–11. Lime-treated subgrade showing ettringite swells.

1) Over-excavating the gypsum-rich material and replacing it with an aggregate base;

2) The double-lime method, where lime treatment is divided into two phases. First, a portion of lime is added and allowed to set and react with the gypsum in the soil. Then a second portion of lime is applied to stabilize the soil after the ettringite reaction has been completed.

Gypsum-rich soils pose challenges to both past and future KDOT transportation projects. The presence of gypsum-rich soils increases the cost of investigation, construction, and operational maintenance of road infrastructure in parts of Kansas that contain these soils (fig. 4–12).

Figure 4–12. US–56 concrete pavement cracks after ettringite formation.

Republican River Compact

The Republican River, named for a branch of the Pawnee Indians, rises on the plains of eastern Colorado. One of the river's tributaries, the South Fork of the Republican, flows through northwestern Kansas before entering southwestern Nebraska. Several other tributaries, such as Beaver Creek, Prairie Dog Creek, and Sappa Creek, also run through northwestern Kansas before emptying into the Republican, the main stem of which flows through southern Nebraska before crossing back into Kansas just south of Superior, Nebraska. The river then joins the Smoky Hill River at Junction City, Kansas, thus creating the Kansas River.

In 1942, Kansas, Colorado, and Nebraska signed the Republican River Compact. Its purposes are to 1) provide for equitable division of such waters; 2) remove all causes of controversy; 3) promote interstate reciprocity; 4) promote joint action by the states and the United States in the efficient use of water and the control of flooding; and 5) provide for the most efficient use of waters in the Republican River basin. The Compact also allowed for the Federal government to develop water projects in the basin. Today there are seven Bureau of Reclamation reservoirs, two Corps of Engineers reservoirs, and six irrigation districts. Under the Compact agreement, approximately 49% of the water in the river was to go to Nebraska, 40% to Kansas, and 11% to Colorado. The Republican River Compact Administration was created in 1959 to arbitrate disputes among the three states.

After a number of years of disagreements over the delivery of water in the river, Kansas filed a complaint in 1998 with the U.S. Supreme Court, saying that Nebraska had breached the terms of the Compact by allowing alluvial-well proliferation that, in effect, reduced streamflow from the river. The two states resolved the 1998 complaint in 2002, but in 2007, the disagreement flared up again when Kansas said that Nebraska had overused its share of surface water, not leaving enough water for a downstream irrigation district and mainstream Republican River users. To mitigate the 2007 disagreement, Kansas has asked that Nebraska shut down wells within 2.5 miles of the river and its tributaries and has asked for a payment of $72 million to compensate the state for its losses. Nebraska officials responded that they have taken steps to reduce their use, and has rejected the Kansas damage claim as too high.

The 2007 Nebraska Unicameral enacted LB 701, which authorized each Natural Resources District (NRD) in the Republican River watershed to sell revenue bonds as a means to finance one-year purchases of stream and reservoir diversion rights held by irrigation districts, thereby slowing Nebraska's consumptive use. According to the legislation, repayment of the bonds was to come from property taxes levied by the NRDs against irrigated land and all real property within each NRD.

With property taxes pledged as security, the NRDs intended to raise diversion-rights funds by selling bonds to Wall Street lenders. After assuring the bonds would be sold and payments to them would be made before the end of 2007, the irrigation districts agreed not to divert any water. (Because consumption in Nebraska's portion of the watershed was thereby reduced, Nebraska officials later reported compliance with Compact limitations in 2007.)

Early last fall, a group of local property owners filed a lawsuit challenging the constitutionality of LB 701. Their claim noted Nebraska's Compact obligations to Kansas and Colorado, and after citing a precedent-setting school finance case, characterized the NRDs' collection of property taxes as an unconstitutional delegation of responsibility to governmental subdivisions. Given the uncertainty posed by the pending litigation, the Wall Street lenders canceled sale of the bonds. Consequently, the NRDs were left without a means of paying the irrigation districts. The lawsuit remains pending. Lancaster County District Court heard oral arguments in January, but a ruling has not been announced. Regardless of the outcome, an appeal to the Nebraska Supreme Court is expected.

Notwithstanding constitutional uncertainties related to the NRDs' collection of property taxes to help meet Nebraska's Compact obligations, members of the Legislature, knowing that the irrigation districts had not been paid, passed (and the Governor signed) LB 1094 in April 2008. Principally, LB 1094 appropriated $9 million from the State's Cash Reserve Fund to pay the irrigation districts for not diverting or consuming water in 2007. The irrigation districts are now seeking payment from that funding source. To date, neither the Department of Natural Resources or any of the NRDs have agreed to pay any of the irrigation districts not to divert water in 2008.

As things now stand, Kansas and Nebraska currently disagree about the amount of reduction necessary to bring Nebraska into compliance. The two states met recently in Kansas City to discuss a resolution. If they fail to come up with an agreement, they will begin an arbitration process.

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Lovewell Reservoir

Lovewell Dam and Reservoir is a U.S. Bureau of Reclamation (USBOR) facility on the White Rock Creek tributary to the Republican River. It stores water from White Rock Creek and the Republican River, which is diverted near Guide Rock, Nebraska, and carried to the reservoir by the Courtland Canal.

Constructed primarily for irrigation, Lovewell Reservoir also provides flood control, sediment control, fish and wildlife enhancement, and recreation opportunities for north-central Kansas.

Lovewell is unique in that archeological research has documented seven mammoth sites along the north shore of Lovewell Reservoir, which is an unusual concentration for the Great Plains region. Radiocarbon dating of bone and organic material dates the mammoths to between 18,000 and 21,000 radiocarbon years before the present (rcybp) during the glacial and inter-glacial period of the late Pleistocene. Researchers believe that White Rock Creek supported lush vegetation during this otherwise relatively dry period and attracted large and diverse fauna, such as the mammoths. Other recorded species include bison, camel, dire wolf, horse, llama, and sloths. Smaller mammals, reptiles, fish, and birds have also been found. Spiral fracture patterns and "stacked" mammoth bones at some locations suggests that mammoths were either killed or scavenged by humans between 19,500 and 20,430 rcybp, making Lovewell Reservoir an important site for understanding early human migration onto the Great Plains (Holen, 2007).

Post-Civil War westward settlement and railroad construction promoted rapid settlement along the principal river valleys in the Republican River basin. The adjacent flat-topped hills were homesteaded somewhat later in the late 1880s (USBOR, 2008). Floods, droughts, insect infestations, and intervals of economic depression made life in the agriculture-based Republican River basin difficult in the early 19th century. After a 1935 flood killed 110 people and caused more than $9 million in damages, area residents requested Federal government assistance.

In response to these problems in north-central Kansas and throughout the Missouri River basin, the Departments of the Interior, Agriculture, and War conducted comprehensive studies, and in 1944 the Pick–Sloan Missouri Basin Program (PSMBP)—formerly the Missouri River Basin Project—was authorized by the Flood Control Act of 1944. The 1944 Act put into motion a general comprehensive plan for the conservation, control, and use of water resources in the Missouri River basin.

In the mid-1950s, Lovewell Reservoir and Dam were constructed by the USBOR in the PSMBP's Bostwick Division. The Bostwick Division is divided into two general areas—the Bostwick in Nebraska and the Kansas–Bostwick. Besides Lovewell, the Bostwick Division includes Harlan County Lake and Dam in Nebraska, one existing and one proposed diversion dam, six pumping plants, and canals, laterals, and drains necessary to serve approximately 104,240 irrigable acres.

Lovewell Dam is a 3-million-cubic-yard earth-fill structure that is 8,500 feet long. The total capacity of the reservoir is approximately 180,276 acre-feet. Of that, 24,022 acre-feet is allocated for conservation and the remainder is used for flood control and inactive and dead capacity (fig. 4–13).

Most of the Kansas–Bostwick area is served by the Courtland Canal and several other canals that branch off of it. The Courtland Canal system originates at Superior–Courtland Diversion Dam just west of Guide Rock, Nebraska, and also provides water to 1,980 acres in Nebraska. About midway along its length, the canal discharges into Lovewell Reservoir, which regulates the combined flows of the canal and White Rock Creek. The lower end of the canal system diverts from Lovewell Reservoir and heads southwest to near Courtland, Kansas. In all, the system and its components, which are operated by the Kansas–Bostwick Irrigation District, run approximately 114 miles.

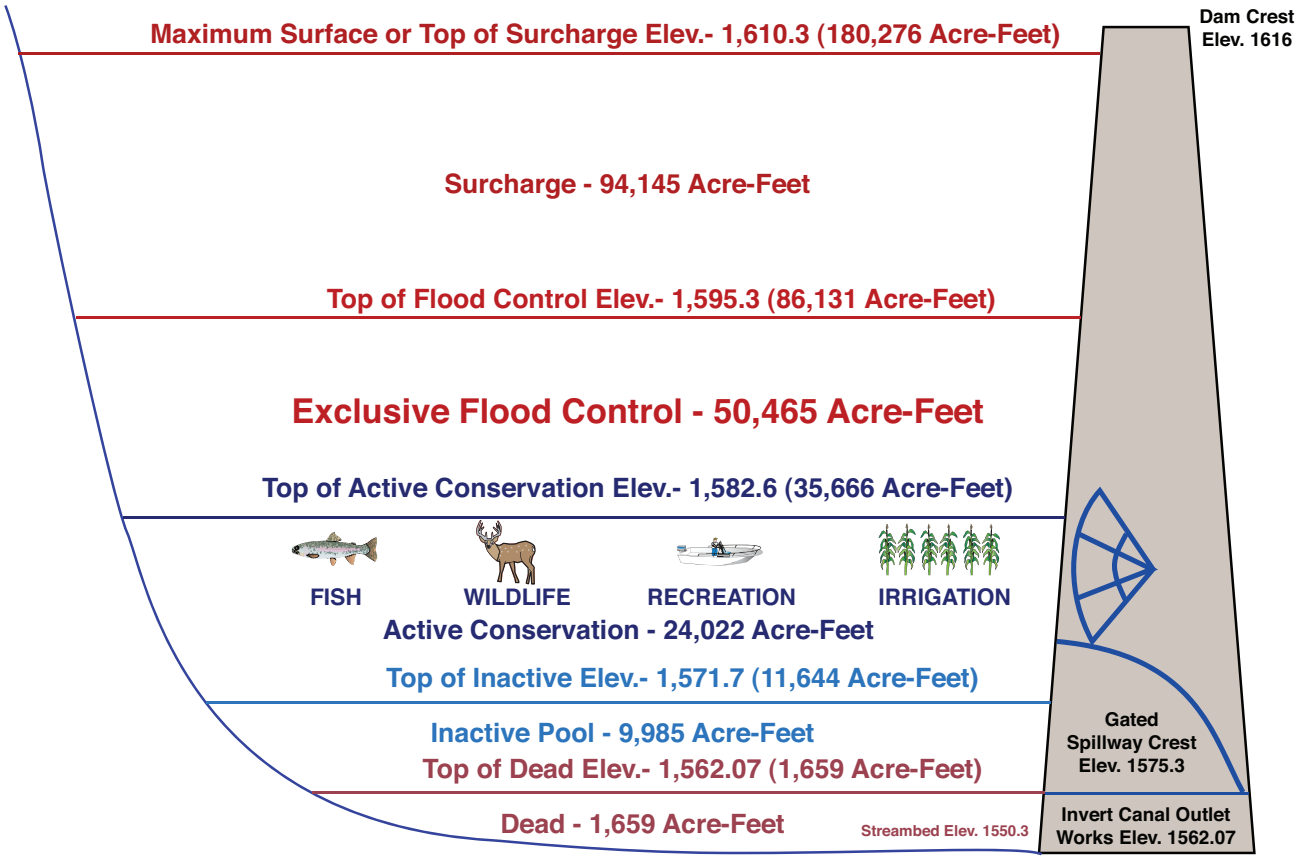

Figure 4–13. Lovewell Reservoir surface-water allocation as of 07/18/06 (modified from U.S. Bureau of Reclamation, 2008).

Lovewell State Park and Wildlife Area

Managed by the Kansas Department of Parks and Wildlife, Lovewell State Park provides diverse opportunities for outdoor recreation. Principal activities include utility and primitive camping, fishing, wildlife viewing, swimming, boating, and water skiing. Six camping cabins are available for rental year-round at the 1,160-acre park.

In 1959, the 4,625-acre Lovewell Wildlife Area was leased to the Kansas Forestry, Fish, and Game Commission under an agreement with the U.S. Department of Interior. In 1972, the Kansas Fish and Game Commission (KFG) purchased 200 acres for the State, and eventually, land leased by the Kansas Park Authority from the Bureau of Reclamation was transferred to the KFG, which increased the Commission's total wildlife management area to 5,215 acres.

Lovewell Wildlife Area has 2,215 acres of public hunting area, and Lovewell Dam impounds approximately 3,000 surface acres of water. The area is used heavily for hunting and fishing. The Wildlife Area is managed for deer, turkey, waterfowl, and upland game such as pheasant, quail, rabbit, and squirrel. Management focuses on an ecological-based approach.

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Kansas and Nebraska Water Law

Kansas and Nebraska differ fairly dramatically in terms of water law. By Kansas law, water is a public resource and belongs to the people of the state. Individuals, companies, municipalities, and other entities can obtain permission to use water for beneficial purposes if they obtain a water right. In general, all beneficial uses of water, except most domestic use, must obtain a water right. 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 also are subject to local control and management. Five Groundwater Management districts have been created in Kansas to provide local management of the resource within the framework of the State's water laws.

Nebraska water law makes a distinction between surface water and ground water. For surface water, the law is the rule of priority. That is, first in time is first in right, as in Kansas law. Regulation here is provided by the Nebraska Department of Natural Resources. However, for ground water Nebraska follows the rule of correlative rights, meaning that each landowner has the right to a reasonable share of the water beneath the surface, regardless of when use was started. In the case of shortages, each user can be required to reduce use proportionally until the shortage is ended. Ground water is regulated by local Natural Resources districts. For many years, Nebraska treated ground water and surface water as separate and distinct, though that is now changing.

Sources

Aiken, J. David, 2006, The Republican, the Platte and Pumpkin Creek—Current Nebraska Water Policy Issues: Faculty Publications from the Water Center, University of Nebraska–Lincoln, http://digitalcommons.unl.edu/watercenterpubs/1.

Buchanan, Rex, and Buddemeier, Bob, 2001, The High Plains aquifer: Kansas Geological Survey, Public Information Circular 18, 6 p., http://www.kgs.ku.edu/Publications/pic18/pic18_1.html.

SCHEDULE AND ITINERARY

Friday, June 6, 2008

6:00 am	Breakfast at Holiday Inn Express, Concordia
8:00 am	**Bus to Site 13**
9:00 am	**SITE 13** • Fort Riley Development and Conservation Easements *Craig Phillips*, Branch Chief, Environmental Division, Fort Riley
11:00 am	Bus to motel
12:30 pm	Return to Holiday Inn, Salina

Fort Riley Development and Conservation Easements

The re-stationing of the U.S. Army's 1st Infantry Division has prompted the rapid expansion of housing and economic growth in the area surrounding Fort Riley military post, including Junction City and Manhattan. Sudden increases in military activity and economic development have raised concerns associated with the need to create buffer zones around military installations and the local desire to preserve open spaces. In addition to providing economic benefits for the region, the growth has lead to the rapid increase of agricultural and grass-prairie land lost to development and encroachment around Fort Riley. Without appropriate buffer zones, development and encroachment could potentially impact habitat for endangered species, agricultural land, and jeopardize the training mission of the U.S. Army at Fort Riley.

Fort Riley is home to more than 10,200 soldiers, and training of these soldiers is a primary mission. Fort Riley training cycles are designed to integrate individual and unit-level military skills. Crews, sections, and squads are integrated into platoon, company, and battalion-sized training exercises. Battalions frequently participate in tactical problems at the brigade and division level.

Of the 100,671 acres of land at Fort Riley, 70,926 are contiguous. This amount of contiguous space can handle battalion task-force level maneuvers and allows soldiers to fire every weapon system in a heavy military division's inventory. There are two state-of-the-art Multi-Purpose Range Complexes (MPRC) on Fort Riley. The primary facility is the Staff Sergeant David Q. Douthit MRPC, which is where the majority of tank, Bradley-fighting-vehicle, and aviation-gunnery training takes place on the post. The MPRC presents a variety of crew, section, and platoon tactical-gunnery scenarios in a safe, efficient environment and ensures uninterrupted training rotations for weeks at a time.

To address encroachment and protect its training mission, Fort Riley classifies and establishes buffers around the post through its Army Compatible Use Buffer (ACUB) program. The Army does not want to purchase additional land for training, and the ACUB program allows the Fort to maximize use of its land while minimizing the impact on surrounding communities. Buffer areas are zoned according to noise, dust, smoke, and training activities to decrease community and military conflicts that might lead to local complaints, which would in turn hamper the Fort's military-training cycle.

ACUB is also intended to support conservation of various plant and wildlife species dependent on the grassland ecosystem of the area. The ACUB program allows the Kansas Land Trust (KLT) to preserve about 50,000 acres surrounding the installation. Through ACUB, KLT-secured, and State-legislative funding, willing landowners surrounding the Fort may secure their land through conservation easements. Conservation easements allow priority land around the Fort to be preserved for ecological, scenic, historic, agricultural, or recreational purposes. Under this voluntary program, landowners are paid not to build on property next to the post. With the exception of building a home within an easement, landowners retain rights to ownership, crop or livestock use, and normal management of the land.

At the same time that Fort Riley's training mission is expected to intensify, communities surrounding the post are expected to grow. To address some of the ensuing issues, a collaborative planning effort of County and Municipal governments and Fort Riley representatives produced the 2005 Flint Hills Joint Land Use Study (JLUS). The JLUS was an area-wide effort to increase the awareness of development plans to minimize conflict between the Fort, surrounding landowners, and local governments. Junction City served as the lead agency for contractual and project-management purposes. The U.S. Department of Defense's Office of Economic Adjustment provided technical expertise and the primary funding. The JLUS included a land-use-compatibility analysis that organized the area into regions related to ACUB buffer zones to address expected growth across many different community boundaries (Flint Hills Joint Land Use Study, fig.

1). The JLUS also presented compatibility tools or strategies that government entities could adopt to address encroachment issues. While the JLUS identified potential growth and sensitive areas and provided a framework for future growth, total consensus was not reached on all matters and local jurisdictions may still act in accordance with their best interests if in conflict with the JLUS.

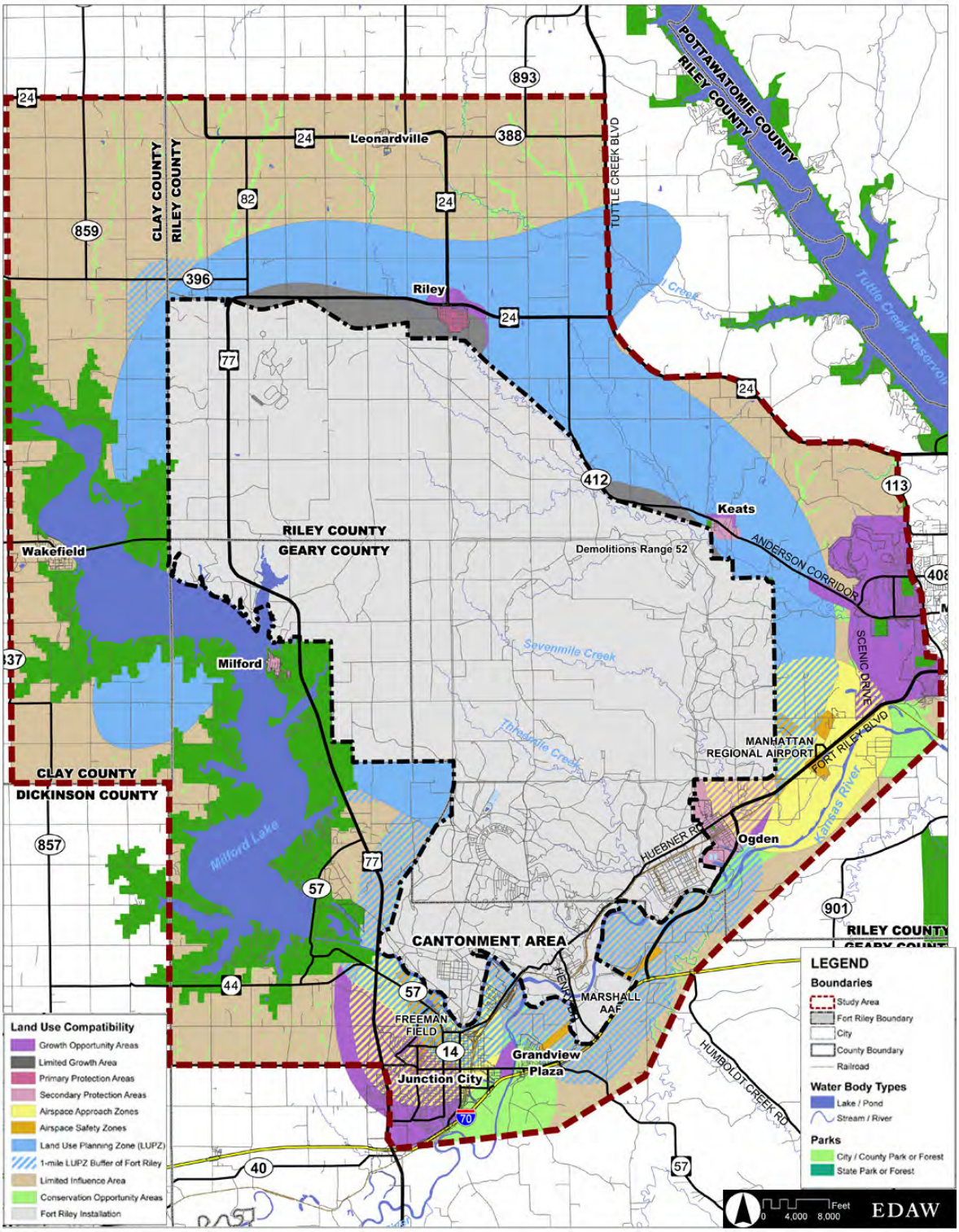

Figure 5–1. Land-use compatibility map, Flint Hills Joint Land Use Study.

Resource Contact

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Sources

1st Infantry Division & Fort Riley, Kansas, 2008, http://www.riley.army.mil/ (viewed May 9, 2008).

Flint Hills Joint Land Use Study, 2005, prepared by EDAW, http://ks-manhattan.civicplus.com/index.asp?NID=214 (viewed May 14, 2008)

Perrin, Stephanie, 2006, Buffer zone requested around Fort Riley: Fort Riley Public Affairs Office News Release, January 17, 2006, Rel. No. 1–39–2006.