Approved: March 11, 2003
Date

MINUTES OF THE HOUSE COMMITTEE ON ENVIRONMENT.

The meeting was called to order by Chairperson Representative Joann Freeborn at 3:30 p.m. on February 6, 2003 in Room 231-N of the Capitol.

All members were present except: Representative Tom Sloan - excused

Committee staff present: Raney Gilliland, Legislative Research
Mary Ann Graham, Secretary

Conferees appearing before the committee: Dr. Lee Allison, State Geologist, Kansas Geological Survey, University of Kansas, Lawrence, KS 66047

Others attending: See attached sheet

Chairperson Joann Freeborn called the meeting to order at 3:30 p.m. She announced that there will be a revised agenda for next Tuesday, February 11, and Thursday, February 13, bills just read in on the House Floor and assigned to the committee will be added.

The Chairperson welcomed Dr. Lee Allison, State Geologist, Kansas Geological Survey, University of Kansas, to the committee. Dr. Allison reviewed the status of the High Plains Aquifer and other issues with overhead slides. The High Plains aquifer, which includes the well known Ogallala aquifer, is the most important water source for much of western and central Kansas, supplying 70 percent of the water used by Kansans each day. Water from the High Plains aquifer supports the region's cities, industry, and much of its agriculture. However, large volume pumping from this aquifer has led to steadily declining water levels in the western portion of the region, and the area faces several critical water related issues. The attached Public Information Circular describes the High Plains aquifer, the effect of decades of large volume pumping, and some responses to water issues in central and western Kansas. (See attachment 1)

Individuals, governmental agencies, and private organizations are all attempting to address issues related to the High Plains aquifer. In addition, several new institutions have recently been proposed to deal with issues concerning the aquifer on a regional basis. Irrigators have implemented a number of techniques that have improved the efficiency with which they use water, using low pressure application methods on center-pivot systems, for example, instead of spraying water high into the air. Among the more far reaching proposals for extending the life of the aquifer is the idea of sustainable development. This is the concept of limiting the amount of water taken from the aquifer to no more than the amount of recharge, and perhaps less, depending on the impact on water quality and minimum stream flows. This level of use is the target of the safe yield management policies currently in effect in the Big Bend and Equus Beds Groundwater Management Districts in the eastern part of the High Plains aquifer. Adoption of a similar policy in other areas of the High Plains aquifer would require a substantial decrease in the amount of water currently used. This would have an impact on the type and amount of crops grown in western Kansas and, in turn, on a variety of economic activities. Because many of the water rights in the High Plains aquifer were established long ago and thus have priority, the implementation of sustainable development approaches to water resources has serious legal implications. Other methods for dealing with the High Plains aquifer are being proposed, discussed, and implemented. All are aimed at extending the life of this crucial resource. A copy of "Kansas Geological Survey Activities in the High Plains Aquifer"was provided. (See attachment 2) Committee questions and discussion followed.

Don Whittemore, Kansas Geological Survey, was in attendance to answer committee questions. Brownie Wilson, Kansas Geological Survey, demonstrated using the internet to obtain information for researchers and the public. Data base interfaces and on-line tools provide means to analyze, visualize, modify, and obtain aquifer related datasets.

Dr. Allison discussed budget cuts and how they will affect the Kansas Geological Survey department.

Chairperson Freeborn thanked Dr. Allison and staff for their presentation.

The meeting adjourned at 4:50 p. m. The next meeting is scheduled for Tuesday, February 11, 2003.

HOUSE ENVIRONMENT COMMITTEE GUEST LIST

DATE: February 6, 2003

NAME	REPRESENTING
Pat Lehman	GMD #4
Andy Shaw	SWKHA
Janet McPherson	Ks Farm Bureau
Carole Jordan	KDA
[illegible]	KS Dairy Assoc.
Kristen Wheeler	observing (KU Student)
Charles Benjamin	KS Sierra Club
JoAnn Habeeb	KS Sierra Club
Scott Rothchild	Lawrence Journal-World
Don Whittemore	Kansas Geological Survey
[illegible]	KGS
Brownie Wilson	KGS
Susan Stover	KWO

Kansas Geological Survey

Public Information Circular 18 September 2001

The High Plains Aquifer

Rex Buchanan
Public Outreach, Kansas Geological Survey

Robert Buddemeier
Geohydrology, Kansas Geological Survey

Introduction

The High Plains aquifer, which includes the well-known Ogallala aquifer, is the most important water source for much of western and central Kansas (fig. 1), supplying 70 percent of the water used by Kansans each day. Water from the High Plains aquifer supports the region's cities, industry, and much of its agriculture. However, large-volume pumping from this aquifer has led to steadily declining water levels in the western portion of the region, and the area faces several critical water-related issues. This Public Information Circular describes the High Plains aquifer, the effect of decades of large-volume pumping, and some responses to water issues in central and western Kansas.

[The authors thank Dave Young and Bob Sawin, Kansas Geological Survey, for their help in the preparation of this circular.]

The High Plains Aquifer Defined

Aquifers are underground deposits containing permeable rock or sediments (silts, sands, and gravels) from which water can be pumped in usable quantities. The High Plains aquifer is a regional aquifer system composed of several smaller units that are geologically similar and hydrologically connected—that is, water can move from one aquifer to the other. The High Plains aquifer system lies beneath parts of eight states in the Great Plains, including about 33,500 square miles of western and central Kansas (see fig. 1).

Aquifer characteristics are determined in large part by geology. The High Plains aquifer is composed mainly of silt, sand, gravel, and clay—rock debris that washed off the face of the Rocky Mountains and other more local sources over the past several million years. The aquifer varies greatly from place to place: thick in some places, thin in others; permeable (able to transmit water easily) in some places, less so in others. Where the deposits are thick and permeable, water is easily removed and the aquifer can support large volumes of pumping for long periods. In most areas, this water is of good quality.

The most important component of the High Plains aquifer is the Ogallala aquifer. In some locations (such as Lake Scott State Park in Scott County), the Ogallala Formation crops out at the surface, forming a naturally cemented rock layer called mortarbeds.

The High Plains aquifer lies beneath parts of eight states in the Great Plains, including about 33,500 square miles of western and central Kansas.

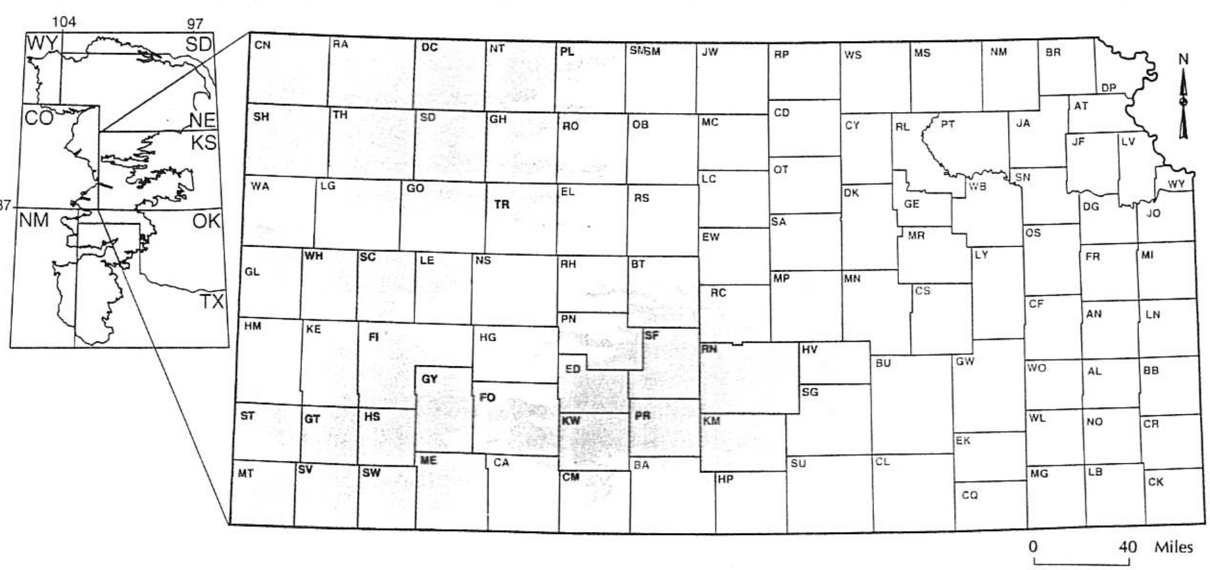

Figure 1—*Extent of High Plains aquifer in Kansas.*

House Environment 1
2-6-03
Attachment 1

In the subsurface, the Ogallala consists of silt and clay beds that are interlayered with sand and gravel that is mostly unconsolidated, or not naturally cemented together.

The eastern extension of the High Plains aquifer is composed of younger sediments that are similar to the Ogallala. These younger sediments, deposited during the Pleistocene Epoch, or Ice Ages, include the "Equus beds" aquifer (in McPherson, Reno, Harvey, and Sedgwick counties) and the "Great Bend Prairie aquifer" (in Stafford, Edwards, Pratt, Kiowa, and other counties). Also lying above the Ogallala Formation are other Pleistocene deposits and other younger deposits in the valleys of modern streams. Where these stream deposits (known as alluvium) are connected to the Ogallala or Pleistocene aquifers, the alluvial aquifers are considered part of the High Plains aquifer (see fig. 2).

Beneath the High Plains aquifer is much older, consolidated bedrock, usually limestone, sandstone, or shale (see fig. 3). In some places this bedrock holds enough water to be called an aquifer, and it may be connected to the overlying aquifer. Layers of permeable sandstone in the Dakota Formation, for example, are connected to the High Plains aquifer in parts of southwestern or south-central Kansas. Some layers of the underlying bedrock contain saltwater; where these are directly connected to the High Plains aquifer, they pose a threat to water quality.

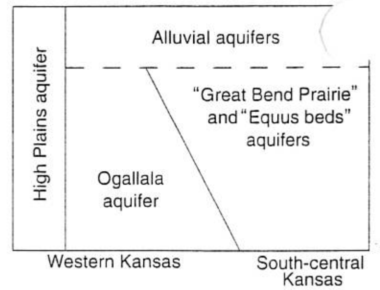

Figure 2—*Aquifers that make up the High Plains aquifer.*

In 1990, an estimated 15.7 million acre-feet of ground water was removed from the High Plains aquifer across the eight-state region

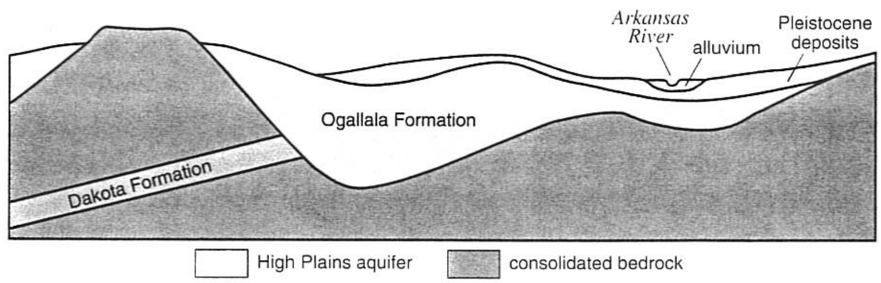

Figure 3—*Generalized cross section showing the High Plains aquifer and underlying bedrock. The Ogallala Formation, Pleistocene deposits, and alluvium combine to form the High Plains aquifer.*

Water Resources in the High Plains Aquifer

Usable water in the High Plains aquifer is in the pore spaces between particles of sand and gravel. This water (called ground water) accumulated slowly—in some of the deeper parts of the aquifer, over tens of thousands of years. In the subsurface, water in the aquifer generally moves slowly from west to east, usually at the rate of tens of feet per year.

Recharge is the natural movement of water into an aquifer, usually from precipitation. Natural recharge to the High Plains aquifer from precipitation is low, in part because much of the rain falls during the growing season, when plant roots intercept the soil moisture. In western Kansas, where precipitation is scant and the water table is relatively deep (several hundred feet) in many places, recharge occurs infrequently and the long-term average is less than an inch per year. In central Kansas, where the aquifer is closer to the earth's surface, where soils are sandier, and precipitation amounts greater, recharge can be significant, as much as 4 to 6 inches per year.

Water volumes and use are measured in various ways. One measure is an acre-foot, or the amount of water necessary to cover an acre of ground (a parcel about the size of a football field) with a foot of water. An acre-foot equals 325,851 gallons of water. In 1990, about 15.7 million acre-feet of ground water was removed from the High Plains aquifer eight-state region. In Kansas, the High Plains aquifer yielded 4.4 million acre-feet, of which 3.6 million acre-feet came from the Ogallala aquifer. Estimated average annual natural recharge to the Ogallala in Kansas is 0.72 million acre-feet.

Another measure of ground water is saturated thickness—the thickness of the sands, gravels, and other materials that are saturated with water. Saturated thickness is commonly measured in feet, but "feet of saturated thickness" is not the same as feet of actual water. Only about 10 to 25 percent of the aquifer volume is pore space that can yield extractable water. Therefore, in an aquifer with 17 percent pore space, removing 1 acre-foot of water causes the water table to drop by about 6 feet. In Kansas, saturated thickness in the High Plains aquifer is generally greatest in the southwestern part of the state (see fig. 4). There, saturated thicknesses of 300 feet were common before the onset of large-scale irrigation, a time that is often called "pre-development."

1-2

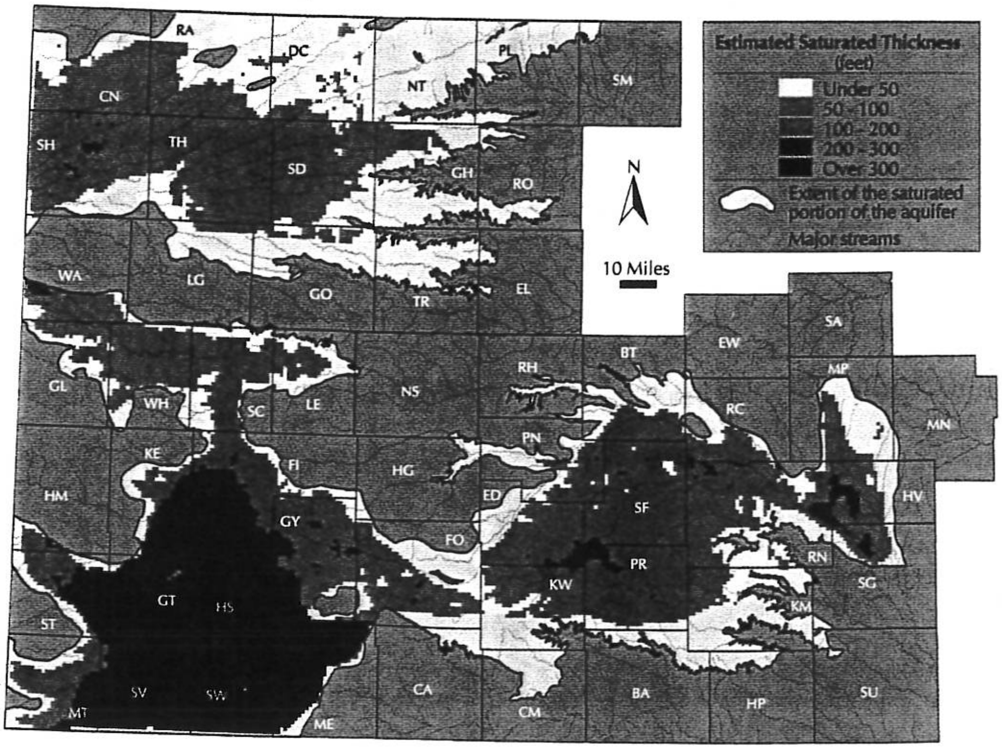

Figure 4—*Predevelopment saturated thickness for the High Plains aquifer in Kansas.*

Ground water can also be measured in terms of its availability: how much water can be removed by a well over short periods. Large volumes of water can be pumped rapidly (1,000 gallons or more per minute) from the High Plains aquifer in many locations. This contrasts with much of the rest of the state, where wells generally produce smaller amounts (less than 100 gallons per minute). By way of comparison, a good household well produces 5 to 10 gallons per minute, although many household wells produce less.

Water-level Declines in the Aquifer

Large-scale irrigation began in western Kansas in the late 1800's, with the use of ditches to divert water from the Arkansas River. As technology improved, ground water became the major irrigation source because surface water (lakes, rivers, and streams) is relatively scarce in western Kansas. With the advent of large-capacity pumps that were capable of drawing several hundred gallons of water per minute, people began to exploit that ground water. Using a technique called flood irrigation, water was pumped through long pipes or ditches along the edges of a field, then out onto rows of crops (fig. 5A).

In the 1950's and 1960's, technological developments led to a dramatic increase in large-scale pumping. In particular, center-pivot irrigation systems—large sprinklers that roll across the land on wheels—allowed people to irrigate uneven terrain, thus opening up large new areas for irrigation (fig. 5B). These irrigation methods led to the cultivation of crops, such as corn, that could not previously be grown reliably in the area. That grain production led, in turn, to large feedlots and packing plants and a boom in the economy of much of western Kansas, all largely dependent on ground water. One study estimated that the economic impact of

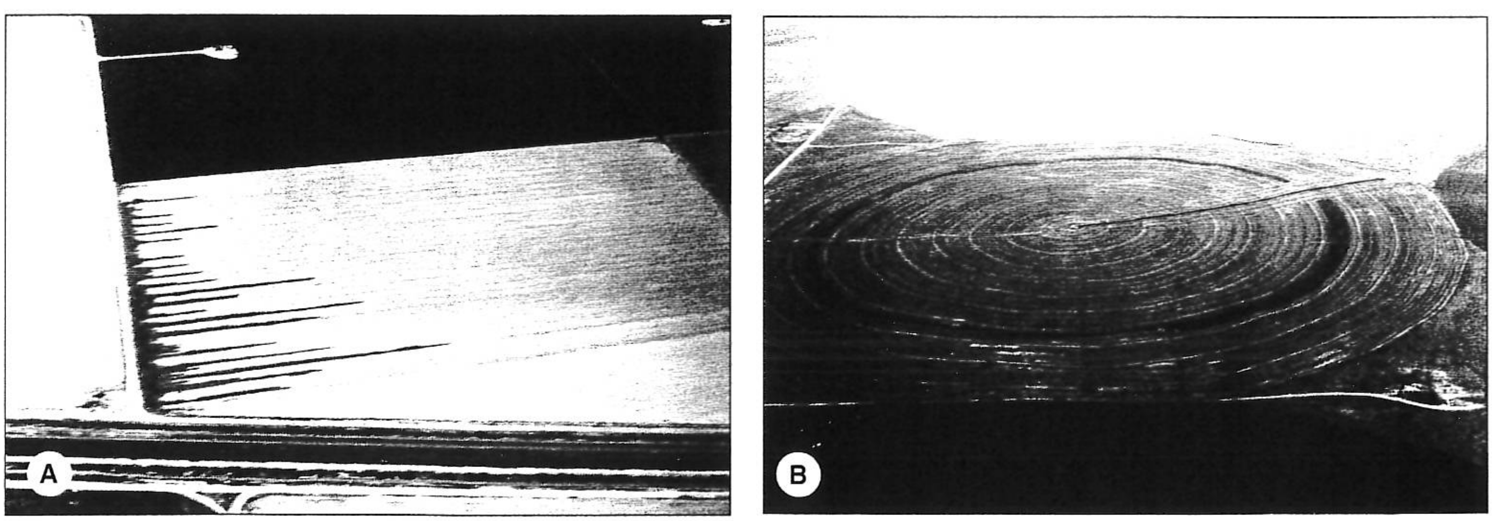

Figure 5—*Aerial photos of (A) flood and (B) center-pivot irrigation (photos courtesy of Tom Schmiedeler, Washburn University).*

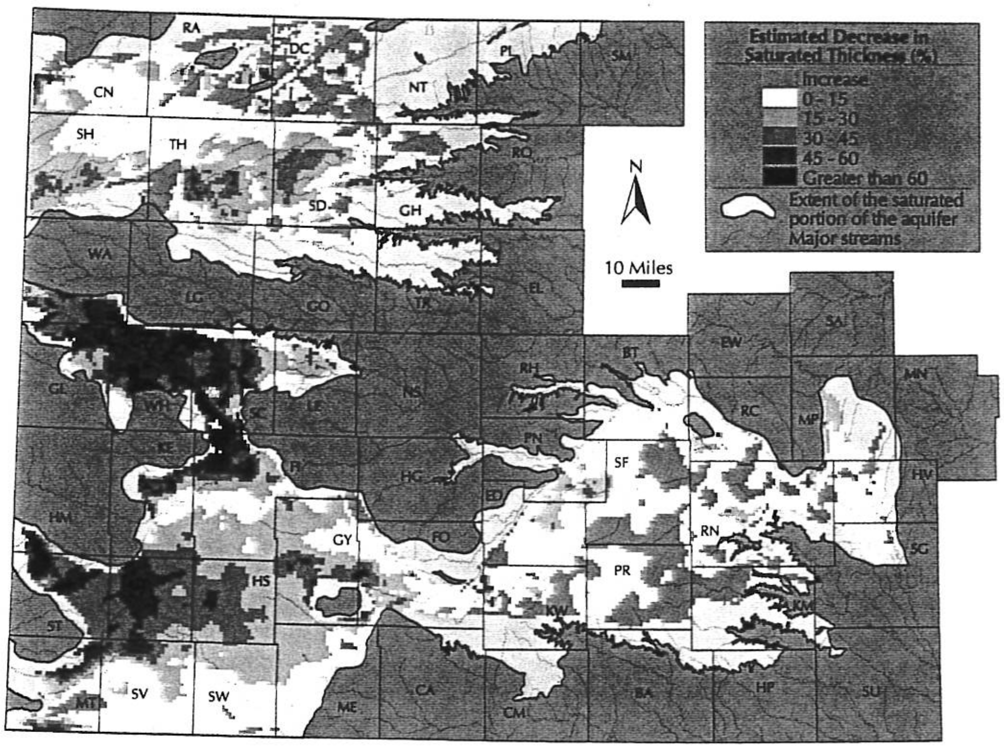

Figure 6—*Percent change in saturated thickness for the High Plains aquifer in Kansas, predevelopment to 1997–99.*

irrigation in southwestern Kansas alone amounts to more than $188 million annually.

For many years, people believed that the High Plains aquifer contained an inexhaustible amount of water. However, large-volume pumping (mostly for irrigation) eventually led to substantial declines in the water table, and people realized that the amount of water in the aquifer was finite and could be exhausted. Much of the Ogallala portion of the High Plains aquifer has declined since predevelopment, with some areas having declines of more than 60 percent (fig. 6).

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

Much of the Ogallala portion of the High Plains aquifer has declined since predevelopment, with some areas having declines of more than 60 percent

When Will the Aquifer Run Dry?

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

With those qualifications in mind, researchers at the Kansas Geological Survey have made projections about the aquifer, based on past trends in water-level declines. Obviously, the actual future use of water will be affected by commodity prices, energy prices, climate, and management policies. In addition, relatively little data are available for some parts of the aquifer, and projections are not practical in those areas. Assuming a saturated thickness of 30 feet as the minimum amount necessary to support large-scale pumping, researchers concluded that parts of the aquifer are effectively exhausted in Greeley, Wichita, and Scott counties (fig. 7). Other parts of the aquifer, in areas such as southwestern Thomas County, are predicted to have a lifespan of less than 25 years, based on past decline trends. However, the biggest share of the aquifer would not be depleted for 50 to 200 years. It is important to remember that these projections are based on past trends, and future changes could alter the actual depletion rate.

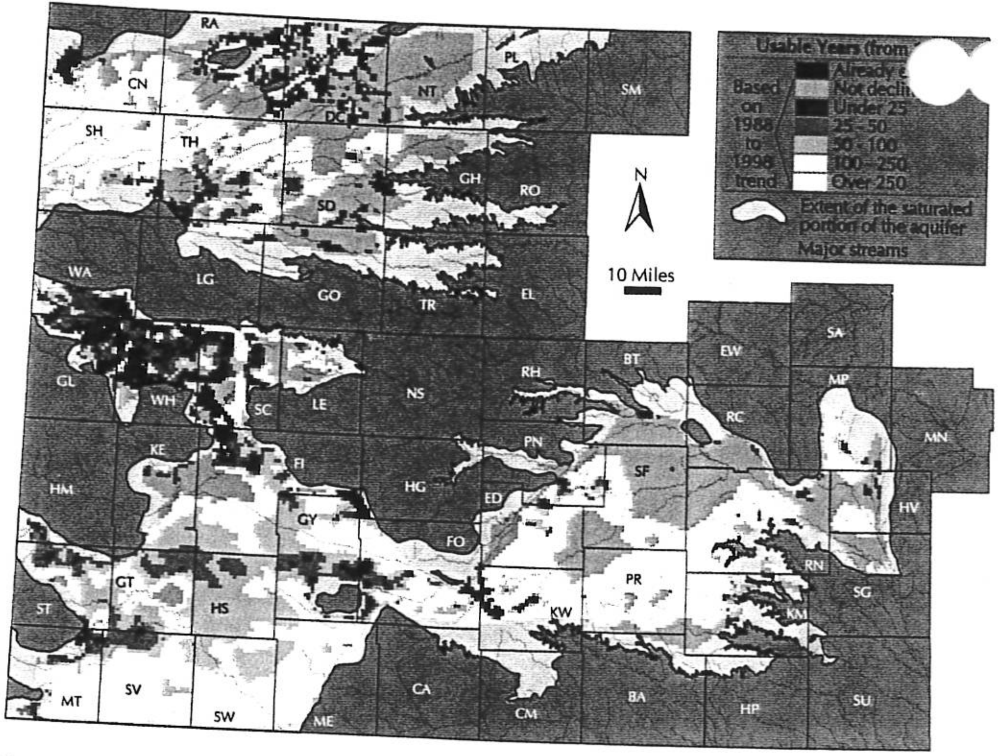

Figure 7—*Estimated usable lifetime (1988–1998) trend for the High Plains aquifer in Kansas.*

By Kansas law, water is a public resource and belongs to the people of the state

Managing Water in the Aquifer

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. Together, they cover nearly all of the state underlain by the High Plains aquifer (fig. 8). Groundwater management districts, through staff and an elected board, develop and implement policies and rules and regulations to manage and protect the quality of water, undertake educational

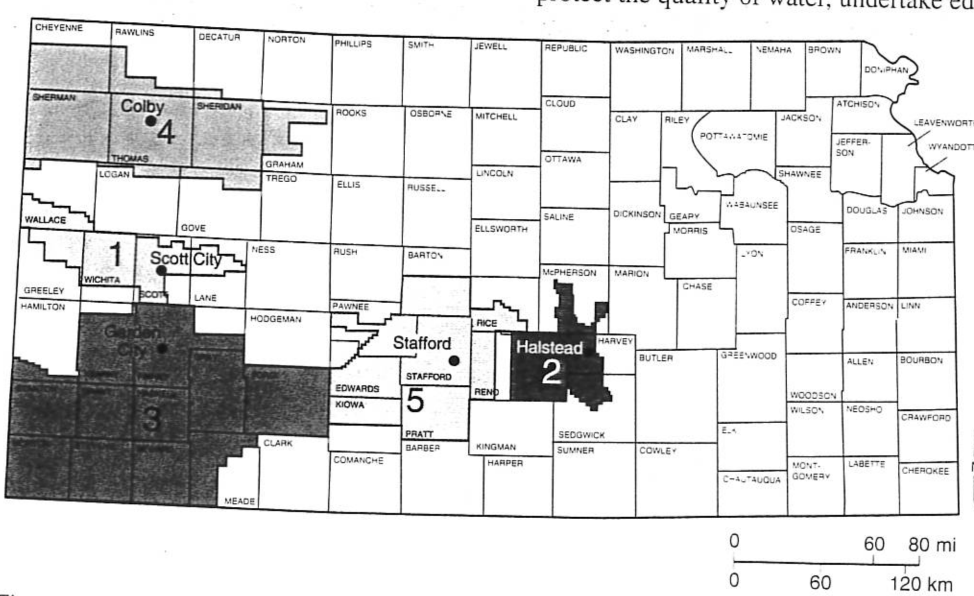

Figure 8—*Groundwater management district boundaries in Kansas.*

activities, and work with state and federal water-related agencies to regulate and manage the High Plains aquifer.

A variety of other agencies deal with other aspects of water in the state. The Kansas Geological Survey, for example, is a research and service division of the University of Kansas and undertakes a variety of water-related activities, but has no regulatory responsibility. The Kansas Department of Health and Environment monitors water-quality issues. The Kansas Water Office, working with the Kansas Water Authority, is responsible for water pla[illegible] t planning is according to drainage basi[illegible] s that are drained by a common stream, such as the Cimarron River or Neosho River. Each of those basins is represented by a volunteer basin advisory committee. The Kansas Department of Wildlife and Parks, Kansas State University's Extension program, the Kansas Biological Survey, the U.S. Geological Survey, and other state and federal agencies have various responsibilities for water.

Where Do We Go From Here?

Individuals, governmental agencies, and private organizations are all attempting to address issues related to the High Plains aquifer. In addition, several new institutions have recently been proposed to deal with issues concerning the aquifer on a regional basis. Irrigators have implemented a number of techniques that have improved the efficiency with which they use water—using low-pressure application methods on center-pivot systems, for example, instead of spraying water high into the air.

Among the more far-reaching proposals for extending the life of the aquifer is the idea of sustainable development. This is the concept of limiting the amount of water taken from the aquifer to no more than the amount of recharge, and perhaps less, depending on the impact on water quality and minimum streamflows. This level of use is the target of the safe-yield management policies currently in effect in the Big Bend and Equus Beds Groundwater Management Districts in the eastern part of the High Plains aquifer. Adoption of a similar policy in other areas of the High Plains aquifer would require a substantial decrease in the amount of water currently used. This would have an impact on the type and amount of crops grown in western Kansas and, in turn, on a variety of economic activities. Because many of the water rights in the High Plains aquifer were established long ago and thus have priority, the implementation of sustainable-development approaches to water resources has serious legal implications. Other methods for dealing with the High Plains aquifer are being proposed, discussed, and implemented. All are aimed at extending the life of this crucial resource.

Additional Reading

Buchanan, Rex, and Buddemeier, Robert, comps., 1993. Kansas Ground Water: Kansas Geological Survey, Educational Series 10, 44 p.

Kahl, Daniel W., and Powell, G. Morgan, 2001, Agency Authority and Responsibilities for Water in Kansas: Kansas State University Agricultural Experiment Station and Cooperative Extension Service, MF-2503, 4 p.

Kromm, David, and White, Stephen, 1992, Groundwater Exploitation in the High Plains: Lawrence, Kansas, University Press of Kansas, 240 p.

Opie, John, 1993, Ogallala—Water for a Dry Land: Lincoln, Nebraska, University of Nebraska Press, 412 p.

Schloss, Jeffrey, Buddemeier, Robert, and Wilson, Blake, eds., 2000: An Atlas of the High Plains Aquifer: Kansas Geological Survey, Educational Series 14, 92 p.

Sophocleous, Marios, ed., 1998. Perspectives on Sustainable Development of Water Resources in Kansas: Kansas Geological Survey, Bulletin 239, 239 p.

Web Sites

Kansas Geological Survey
http://www.kgs.ukans.edu/

Information about water-levels in specific wells is available at **http://magellan.kgs.ukans.edu/WaterLevels/index.html** and can be searched by legal description or county.

More information on the High Plains Aquifer is available at **http://www.kgs.ukans.edu/HighPlains/index.html**

Kansas Department of Agriculture, Division of Water Resources
http://www.ink.org/public/kda/dwr/index.html

Kansas Water Office
http://www.kwo.org/

U.S. Geological Survey's Water Resources Division Office, Lawrence
This site includes current streamflow information:
http://www-ks.cr.usgs.gov/

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

The Geology Extension program furthers the mission of the KGS by developing materials, projects, and services that communicate information about the geology of Kansas, the state's earth resources, and the products of the Kansas Geological Survey to the people of the state.

Public Information Circular 18
September 2001

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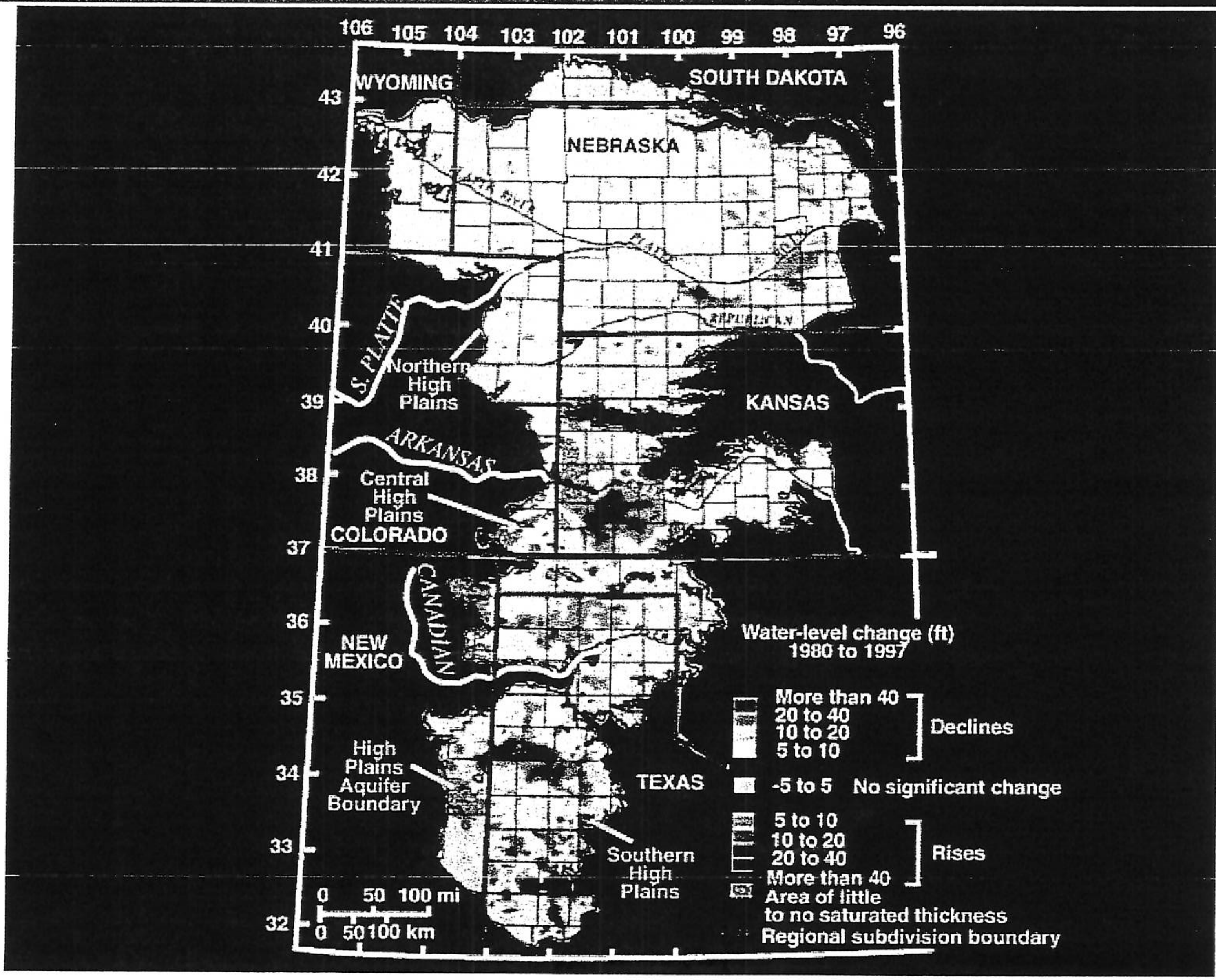
Kansas Geological Survey Activities in the High Plains Aquifer

2003 Kansas Legislature
House Standing Committee on the Environment

Dr. Lee Allison
State Geologist and Director
Kansas Geological Survey
University of Kansas

House Environment
2-6-03
Attachment 2

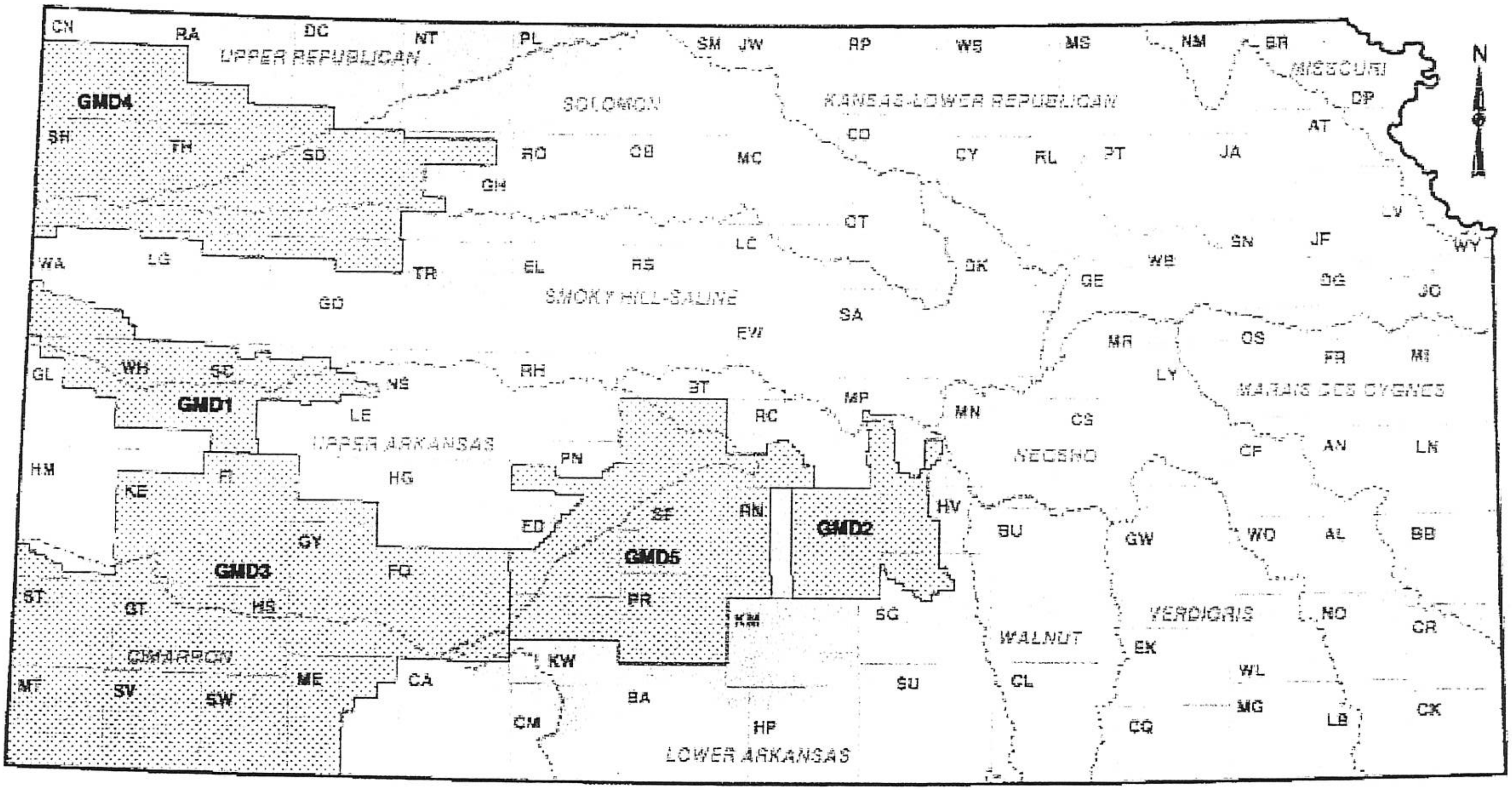
The High Plains Aquifer



2-3

The Kansas High Plains Aquifer, GMDs, and KWO Planning Basins

High Plains Aquifer Extent, Groundwater Management District Boundaries, and Kansas Water Plan Basin Boundaries



Saturated Portion of the High Plains Aquifer, U.S. Geological Survey, 1995
Groundwater Management District, Kansas Department of Agriculture, 1998
Kansas Water Plan Basin Boundary, Kansas Water Office, 1998

0 20 40 Miles

2-4

Mean Annual Runoff in Kansas

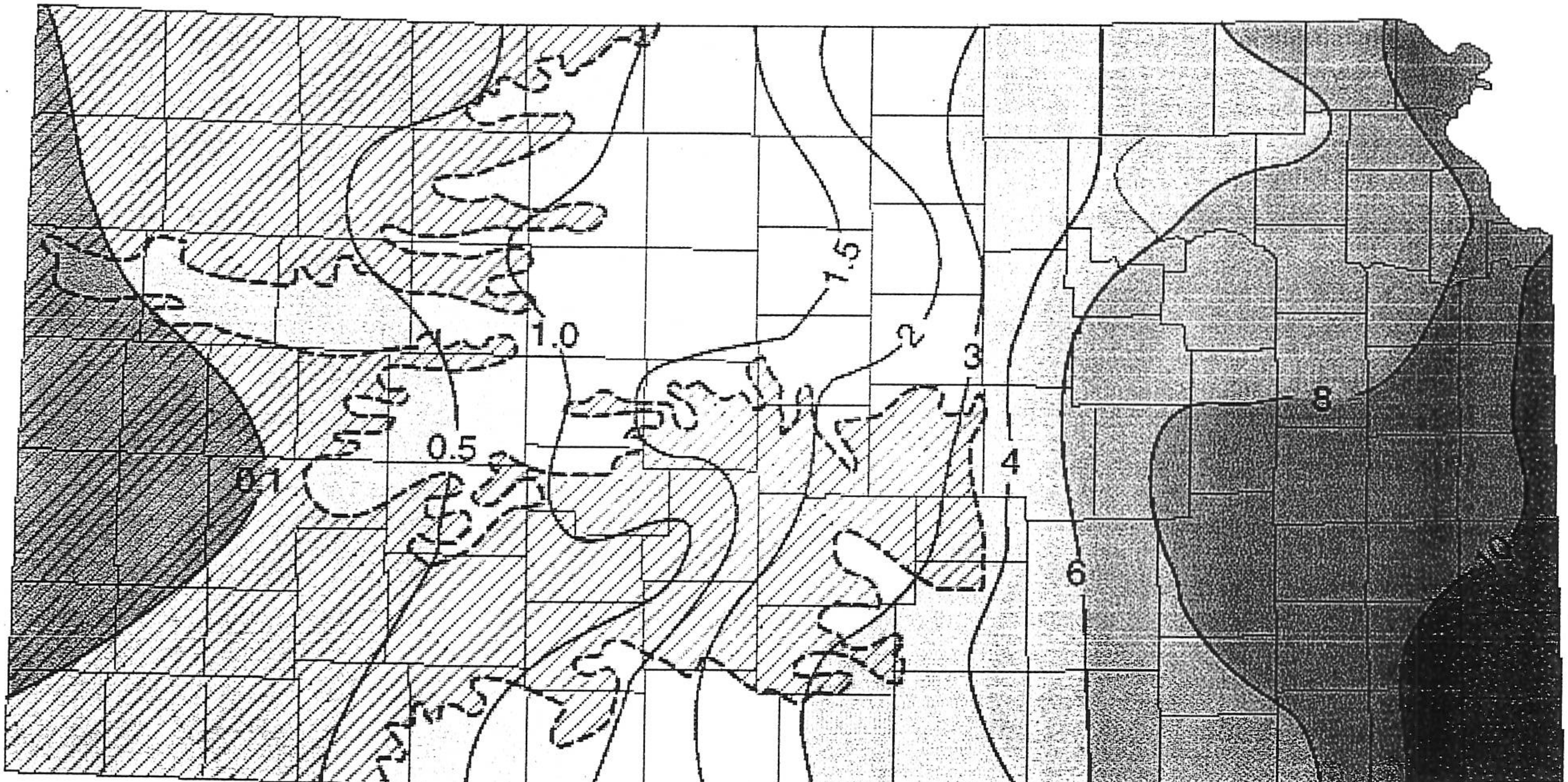
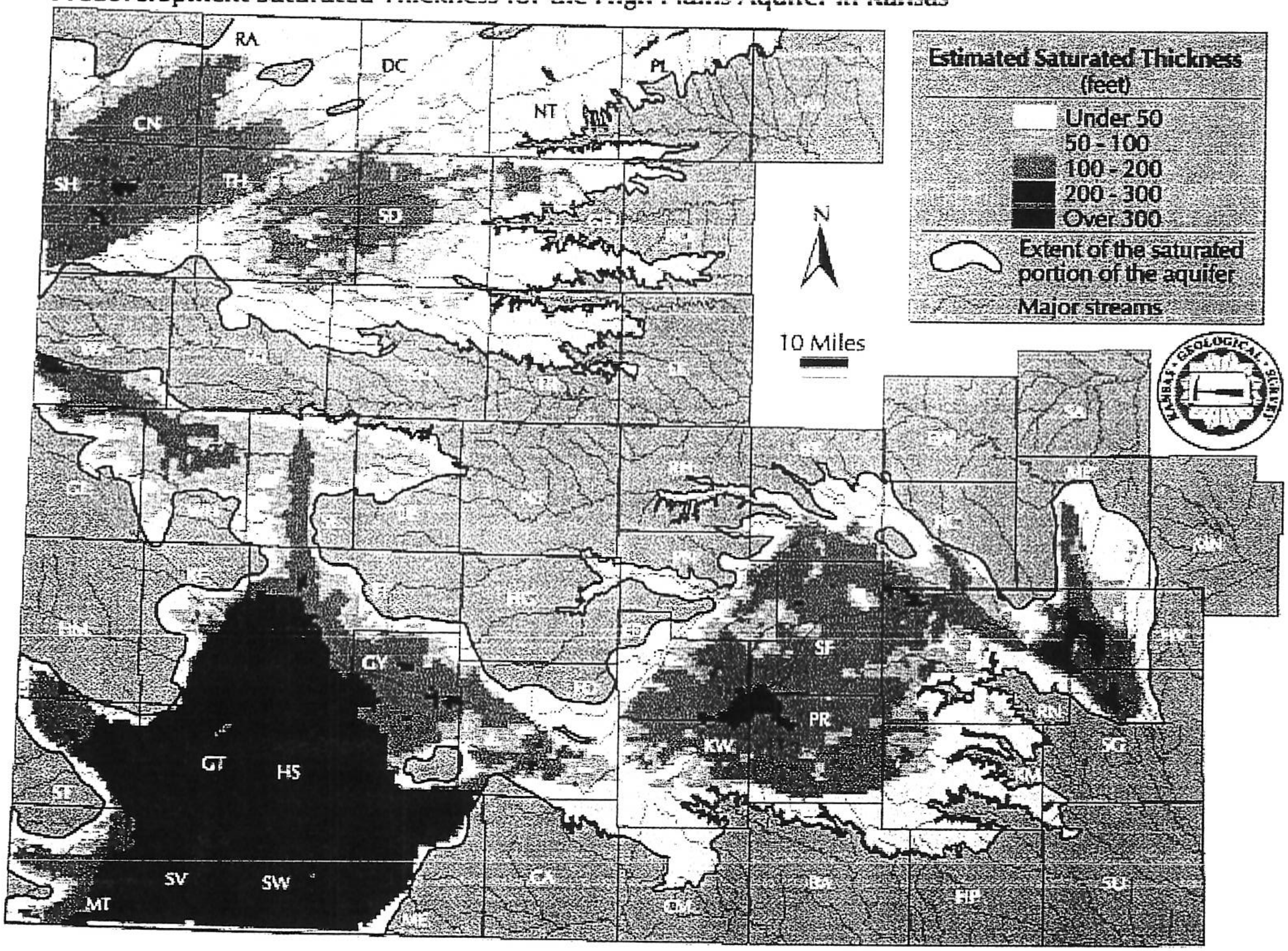


Figure 4. Mean annual runoff (in inches) in Kansas. The areas west of the dashed line shows the extent of the High Plains aquifer in Kansas (Adapted from Wetter, 1987).

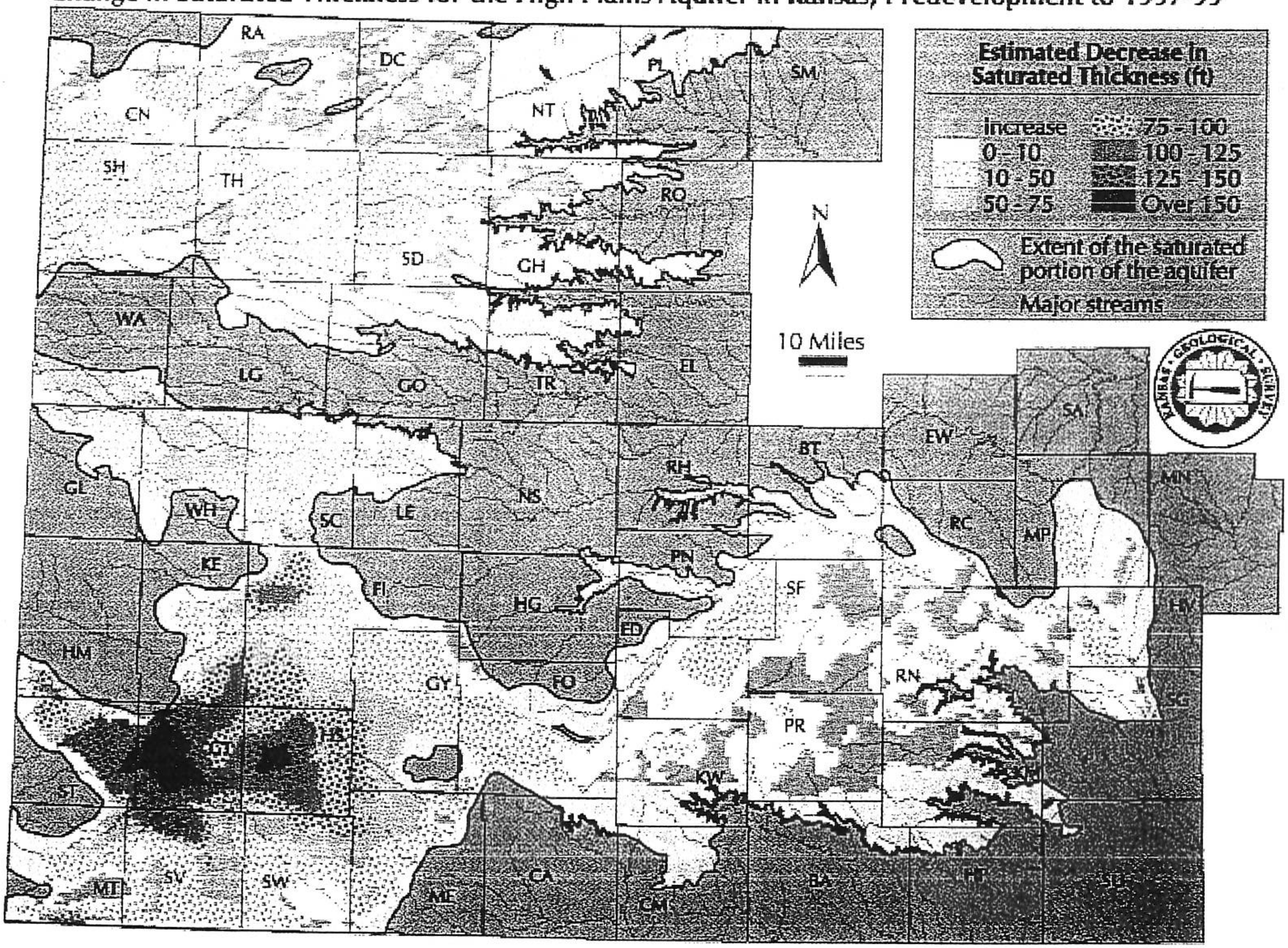
Predevelopment Saturated Thickness for the High Plains Aquifer in Kansas

Predevelopment Saturated Thickness for the High Plains Aquifer in Kansas



Change in Saturated Thickness from Predevelopment to 1997-1999

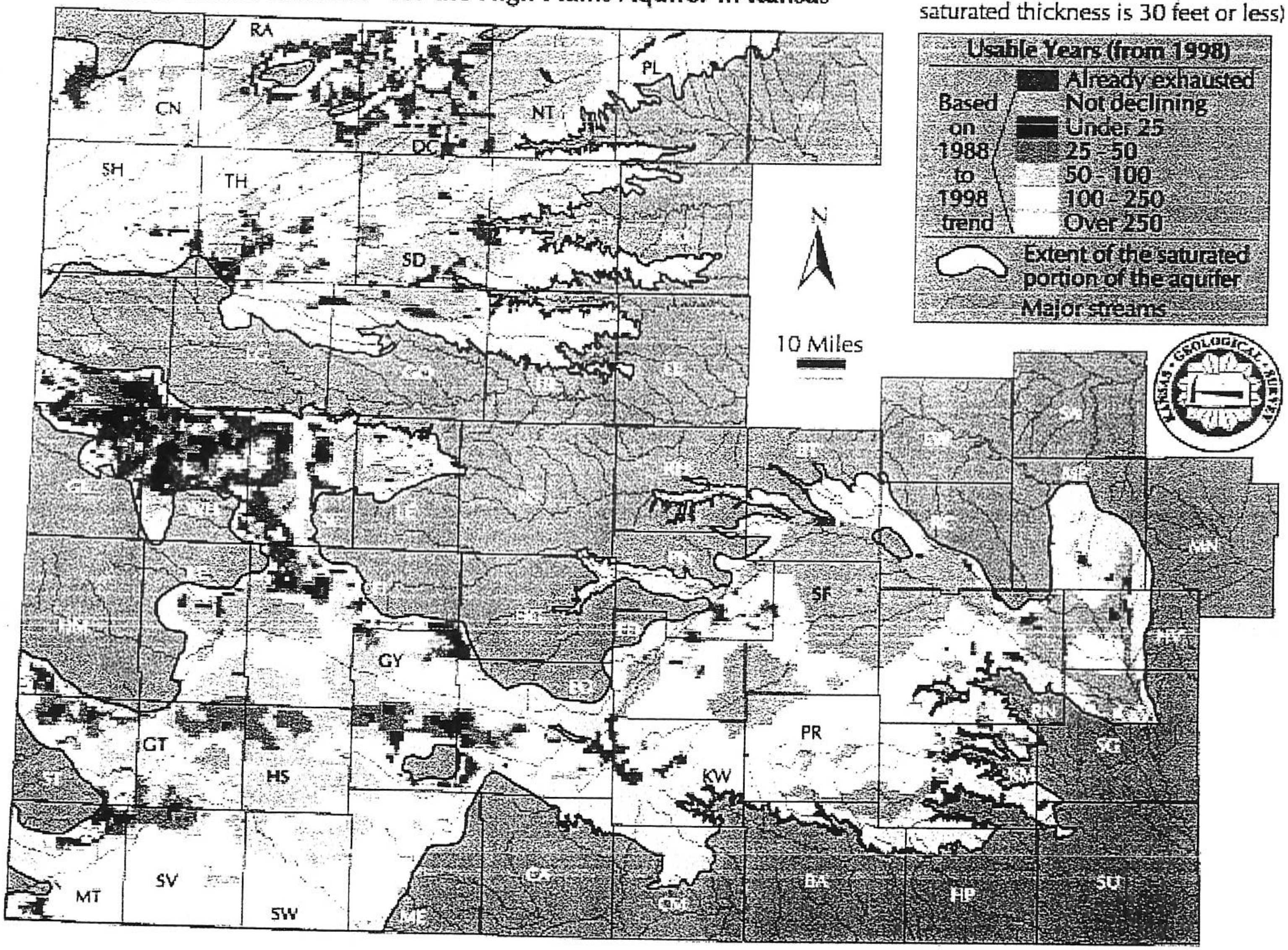
Change in Saturated Thickness for the High Plains Aquifer in Kansas, Predevelopment to 1997-99



Estimated Usable Life

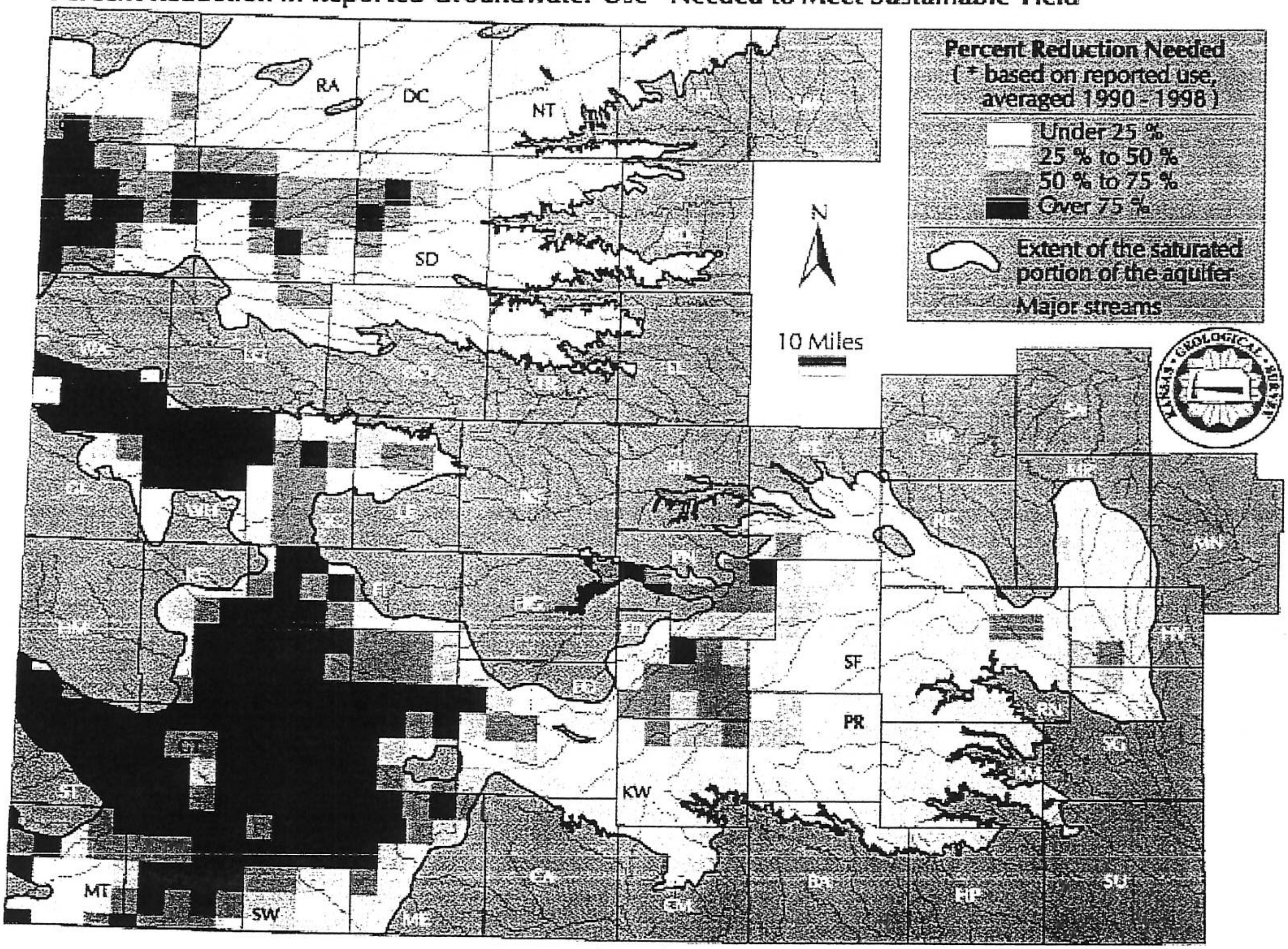
Estimated Usable Lifetime* for the High Plains Aquifer in Kansas

(* Usable lifetime is exhausted when saturated thickness is 30 feet or less)

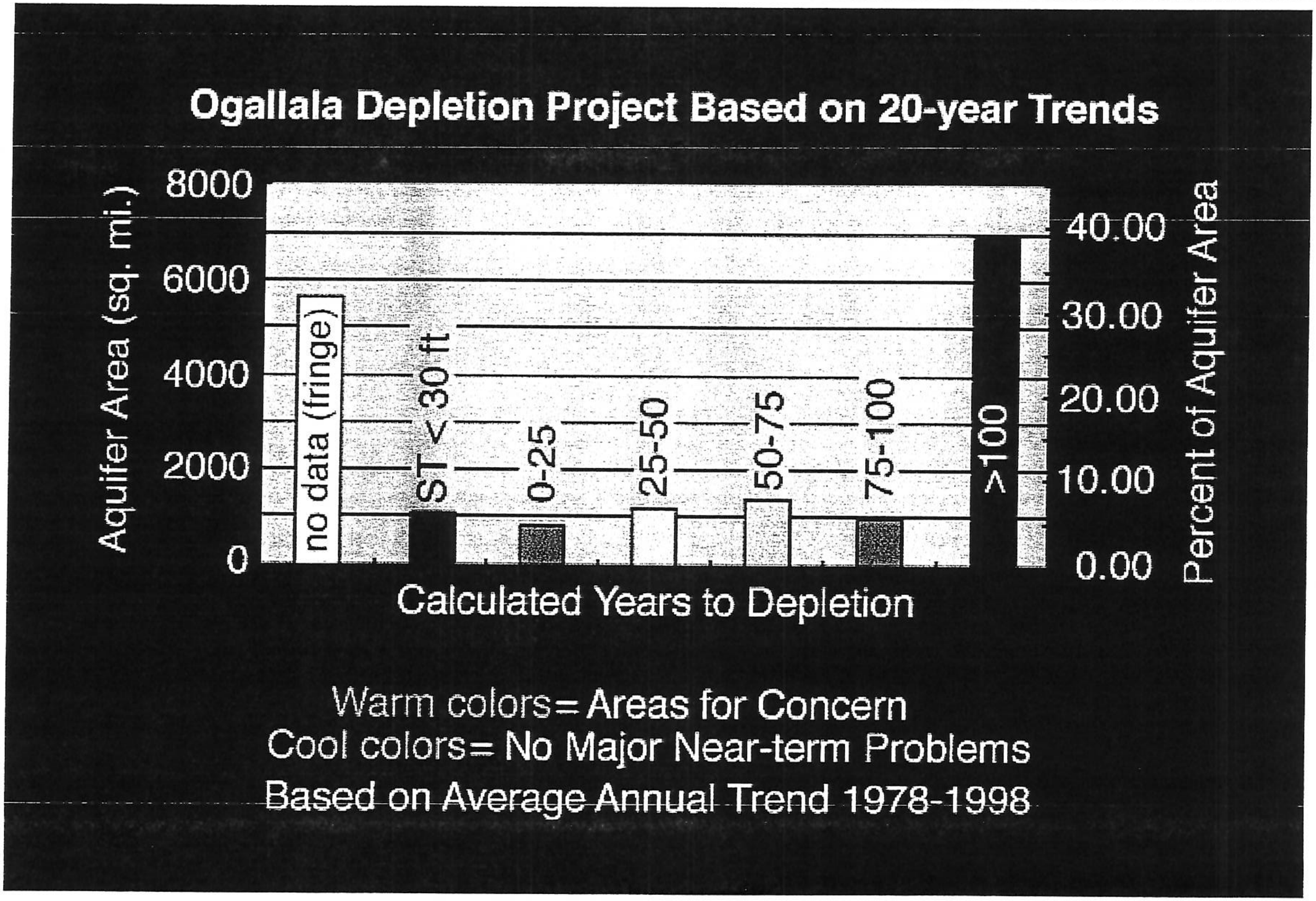


Percent Reduction of Reported Use to Meet Sustainable Yield

Percent Reduction in Reported Groundwater Use* Needed to Meet Sustainable Yield



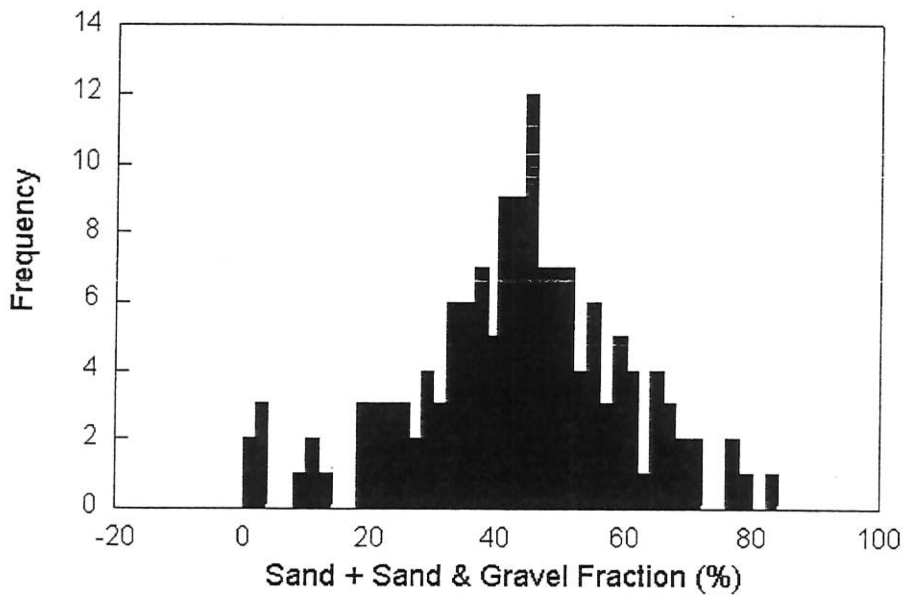
Ogallala Depletion Trends



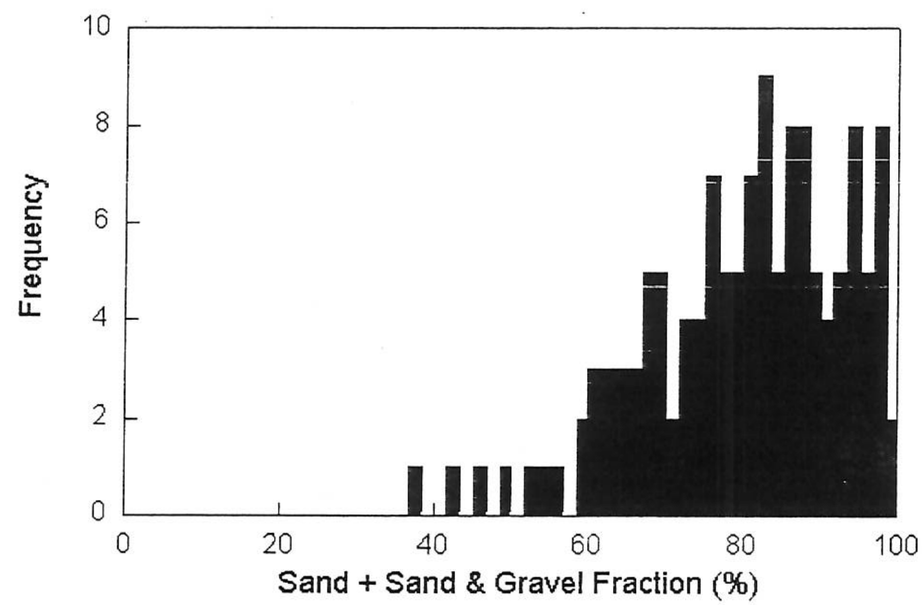
2-10

Lithologic Investigations to Characterized Geologic Framework and Hydrogeology

GMD 4 Safe Area, Upper Half of the Ogallala



GMD 4 Safe Area, Lower Half of the Ogallala



Lithology of upper and lower parts of the High Plains aquifer in northwestern Kansas from water well logs

West to East Cross Section of the High Plains Aquifer Along the Arkansas River

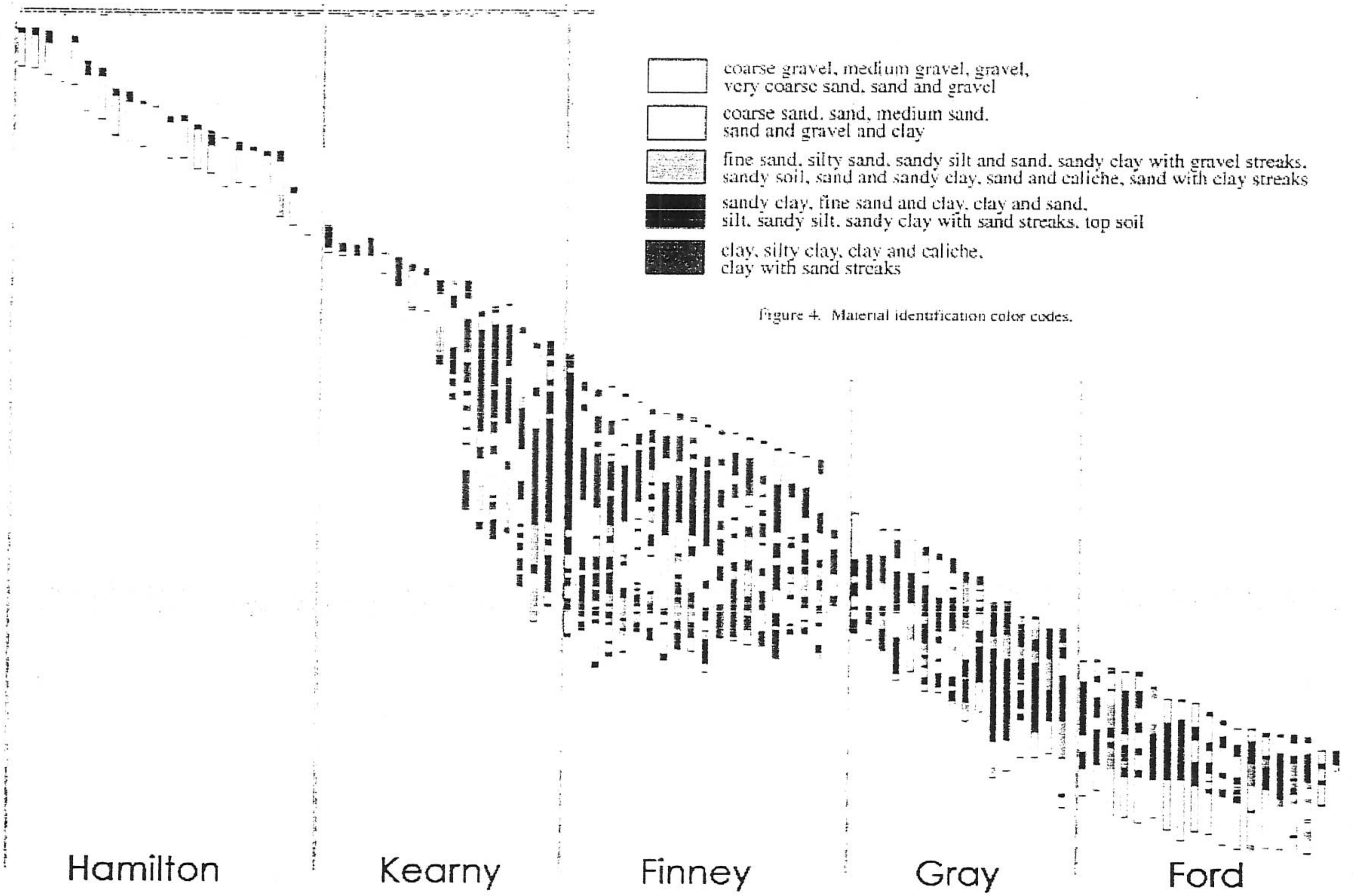
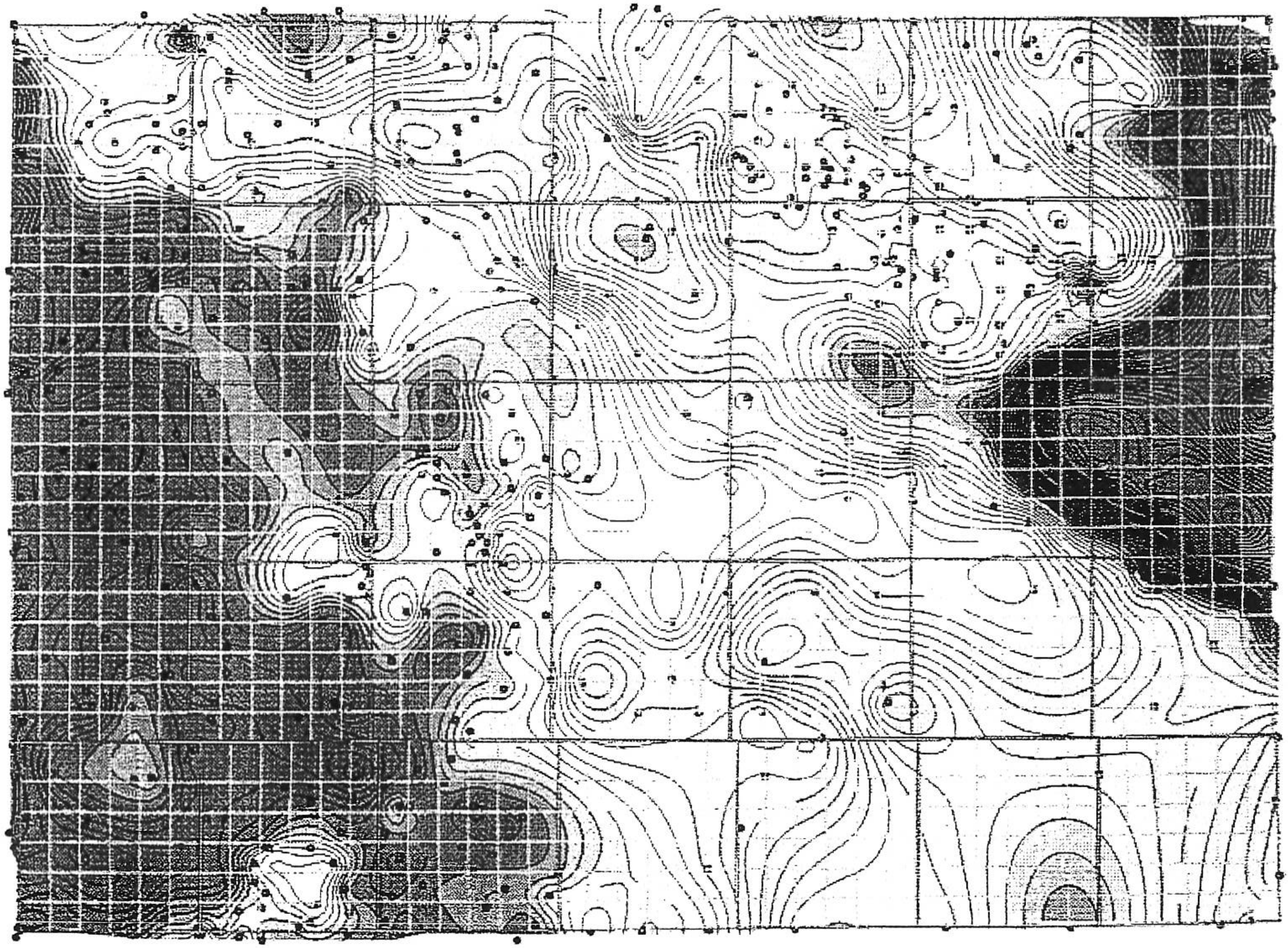


Figure 4. Material identification color codes.

2-12

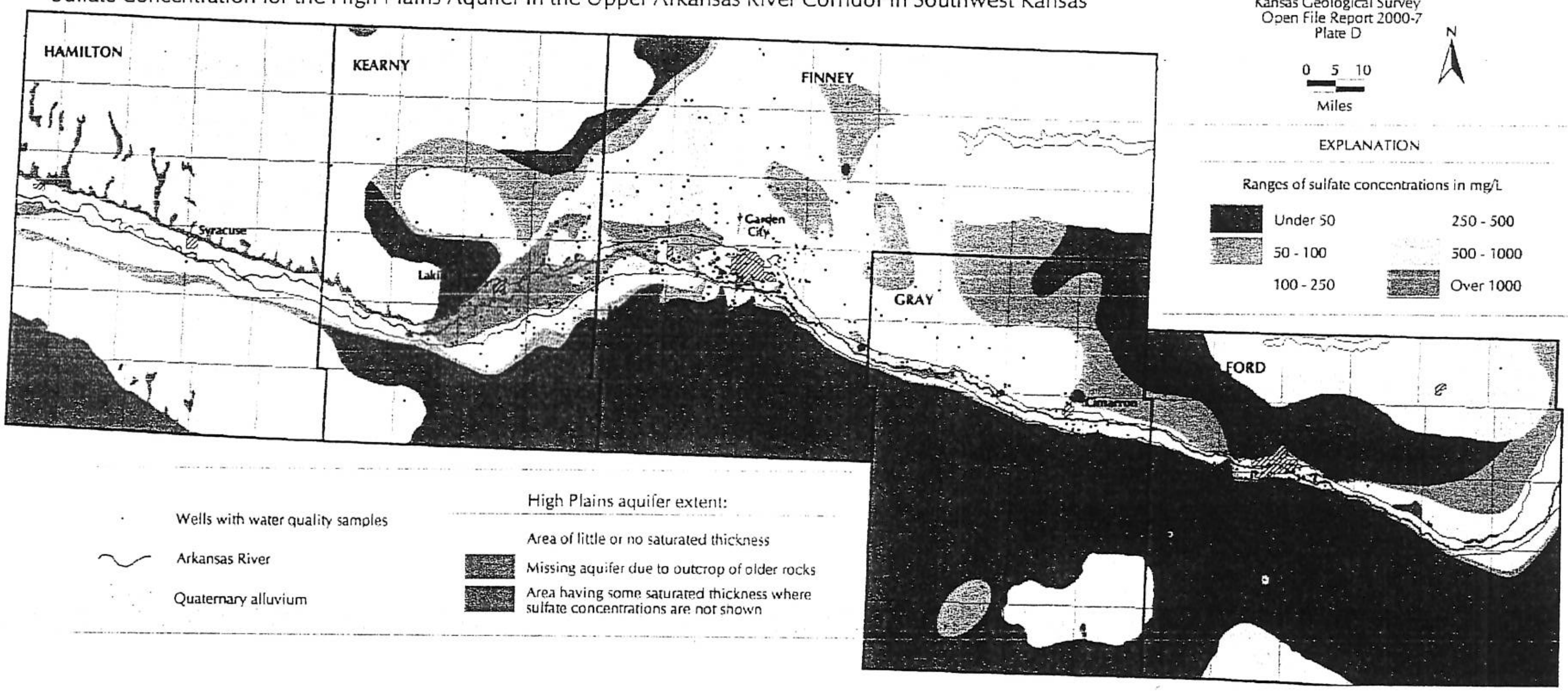
Top of Permian Bedrock/Base of Equus Beds Aquifer, Reno County



Contour interval 10 ft, blues and purples are lower, reds are higher elevation

Water Quality

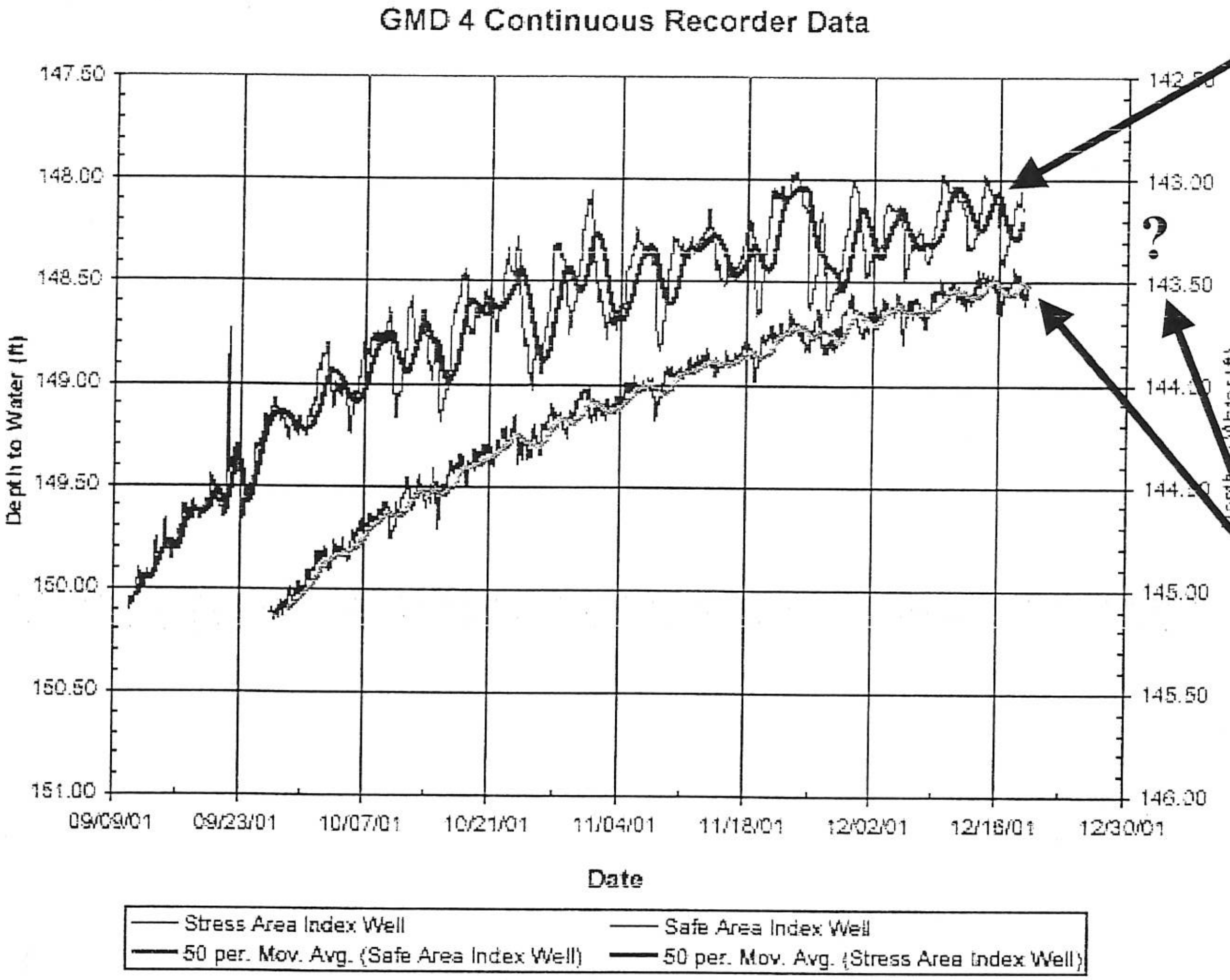
Sulfate Concentration for the High Plains Aquifer in the Upper Arkansas River Corridor in Southwest Kansas



Impact of Infiltration of Saline Arkansas River Water on Quality of Water in Underlying High Plains Aquifer in Southwestern Kansas

Case-study approach to significance and uncertainty in water level determination

“Safe” and “Stressed” areas in NW Kansas



Barometric fluctuations show confined aquifer behavior – casting doubt on the traditional models of the Ogallala, and introducing substantial uncertainty into single-point measurements

Recovery curves will test the degree of water table equilibration at the standard annual survey measurement time in early January

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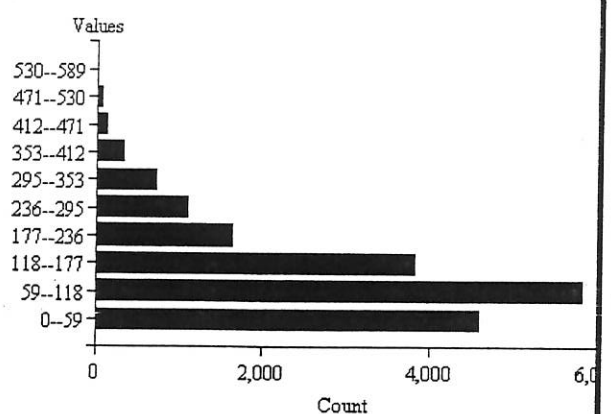
Information for researchers and the public

Saturated thickness, 1998,	Local Value
Local Average	128.58
Local Minimum	0
Local Maximum	589
Local Standard Deviation	95.29
Number of Non-Null Selected Cells	18488
Total Number of Selected Cells	25342
Percentage of Non-Null Cells	72.95

Histogram of data



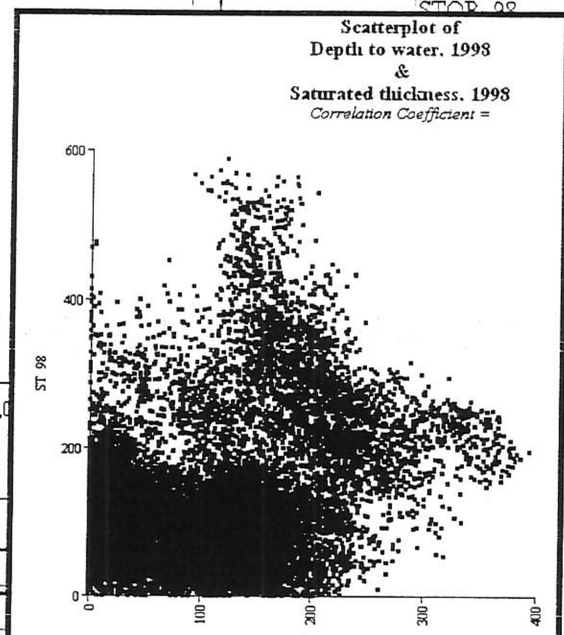
Number of Classes: 10

Minimum Value for Histogram: 0

Maximum Value for Histogram: 589

Apply Transform: no transform

Recreate histogram



Database interfaces and on-line tools provide means to analyze, visualize, modify, and obtain aquifer-related datasets

VARIABLE	FILTER	CRITERIA	TRANSFORMATION	EXCLUDE NULL
DTW_98	none	none	none	NO
ATREND_88_98	none	none	none	NO
ST_98	none	none	none	NO
STOR_98	none	none	none	NO

CORRELATION MATRIX

	DTW_98	ATREND_88_98	ST_98	STOR_98
DTW_98	1	-.5428	.2654	.2129
ATREND_88_98	-.5428	1	-.5342	-.4892
ST_98	.2654	-.5342	1	.9490
STOR_98	.2129	-.4892	.9490	1

View or download variable correlation file

Interactive links to other sites provide additional capabilities

Overview of Kansas Water Levels

- Kansas Cooperative Water Level Measurement Program has been operated since 1996

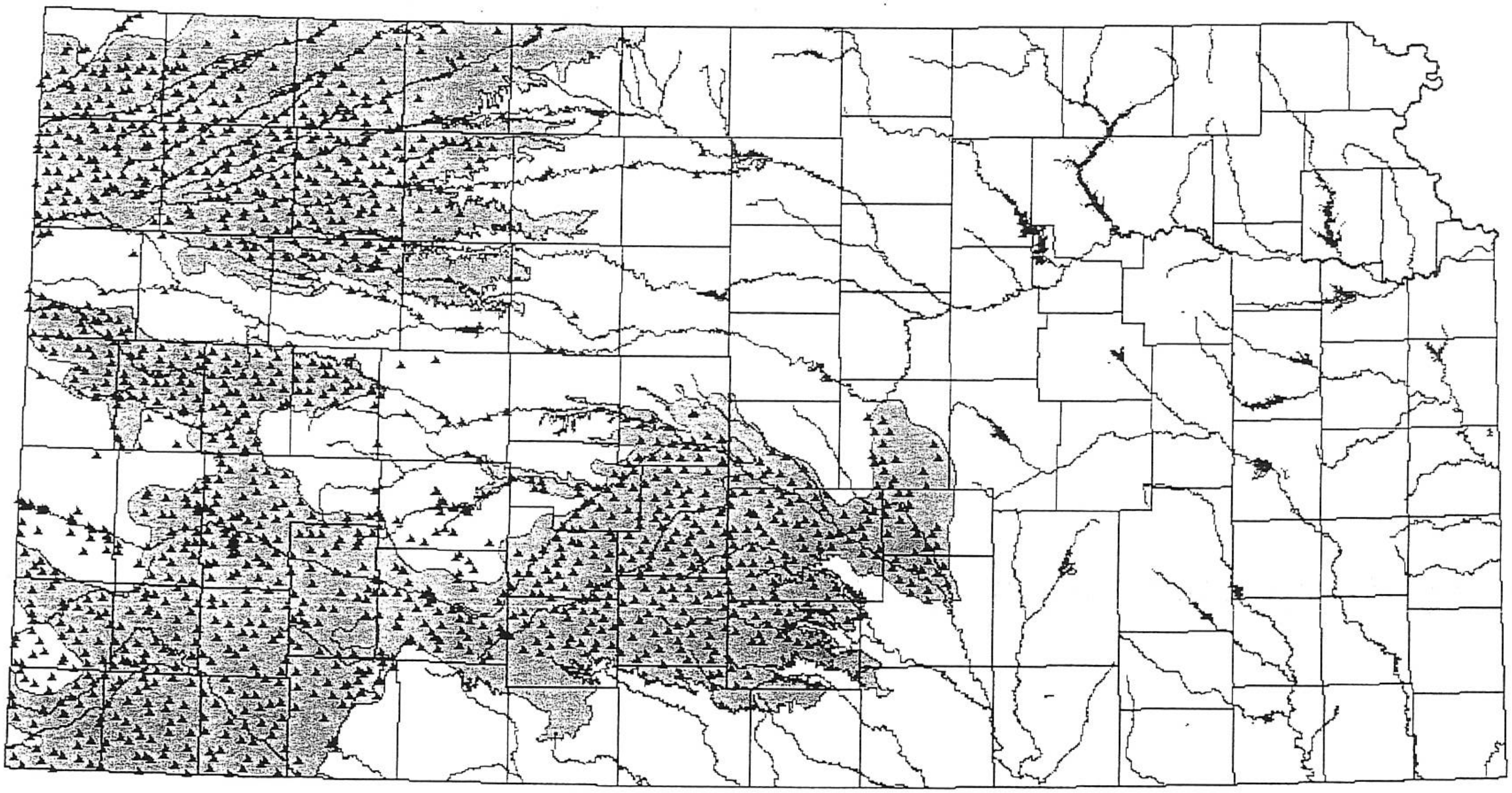
- About two-thirds of the annual water-level data is collected by the KDA-DWR and local GMDs with the other third by the KGS

- Over 1,300 wells are measured annually mostly in the High Plains Aquifer Region

- Year 2003 measurements are currently being reviewed. Public release in the coming weeks.

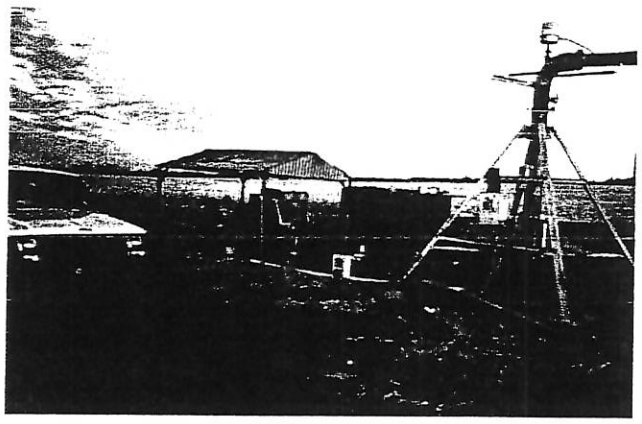
Location of Wells Used for Water Level Measurements

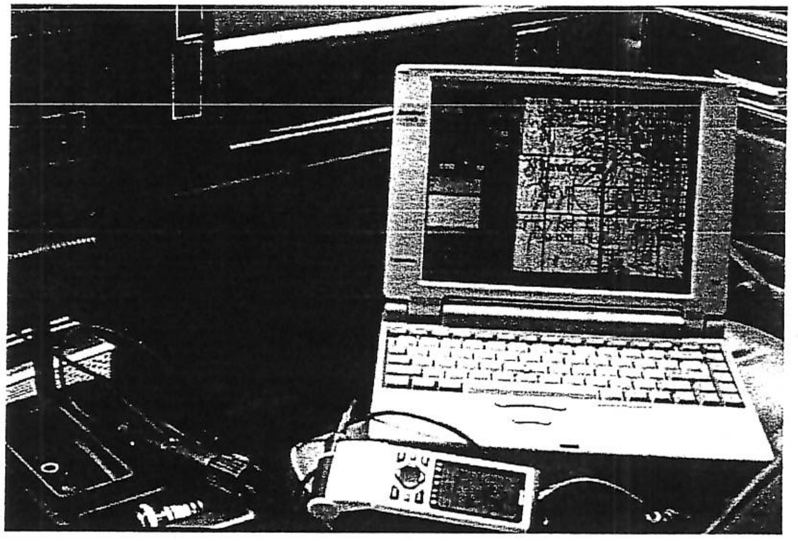
2-17

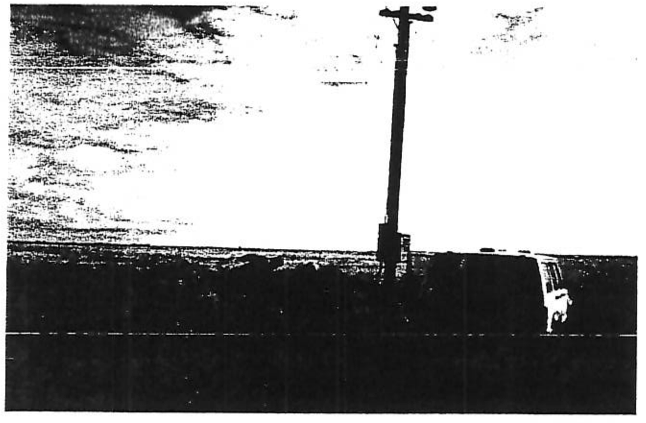


Water-Level Measurements Using Computer Systems with GPS

Digital map system acting as navigational aid to locate wells and as data recorder, with site comments and photographs

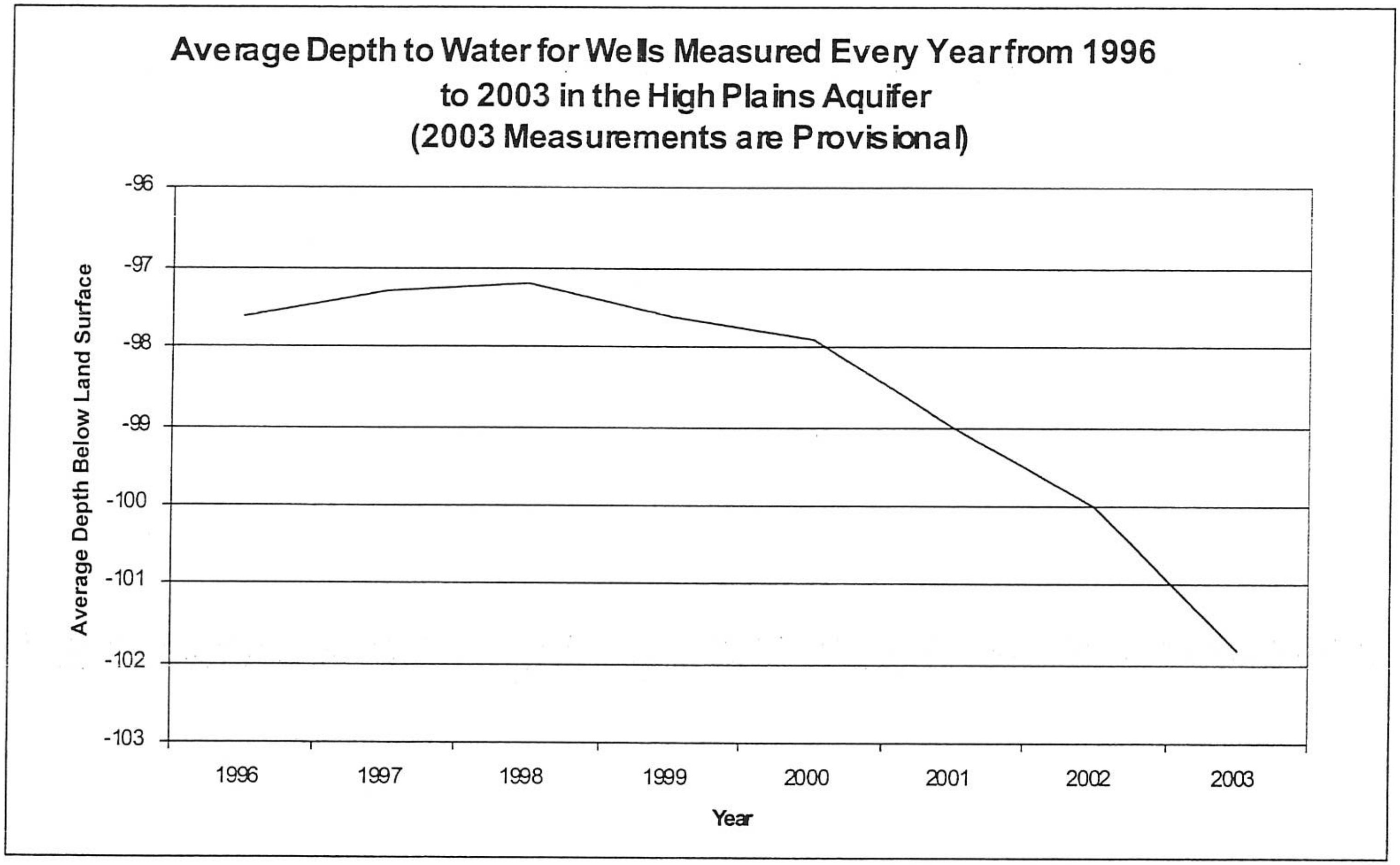






2003 Preliminary Results- High Plains Aquifer

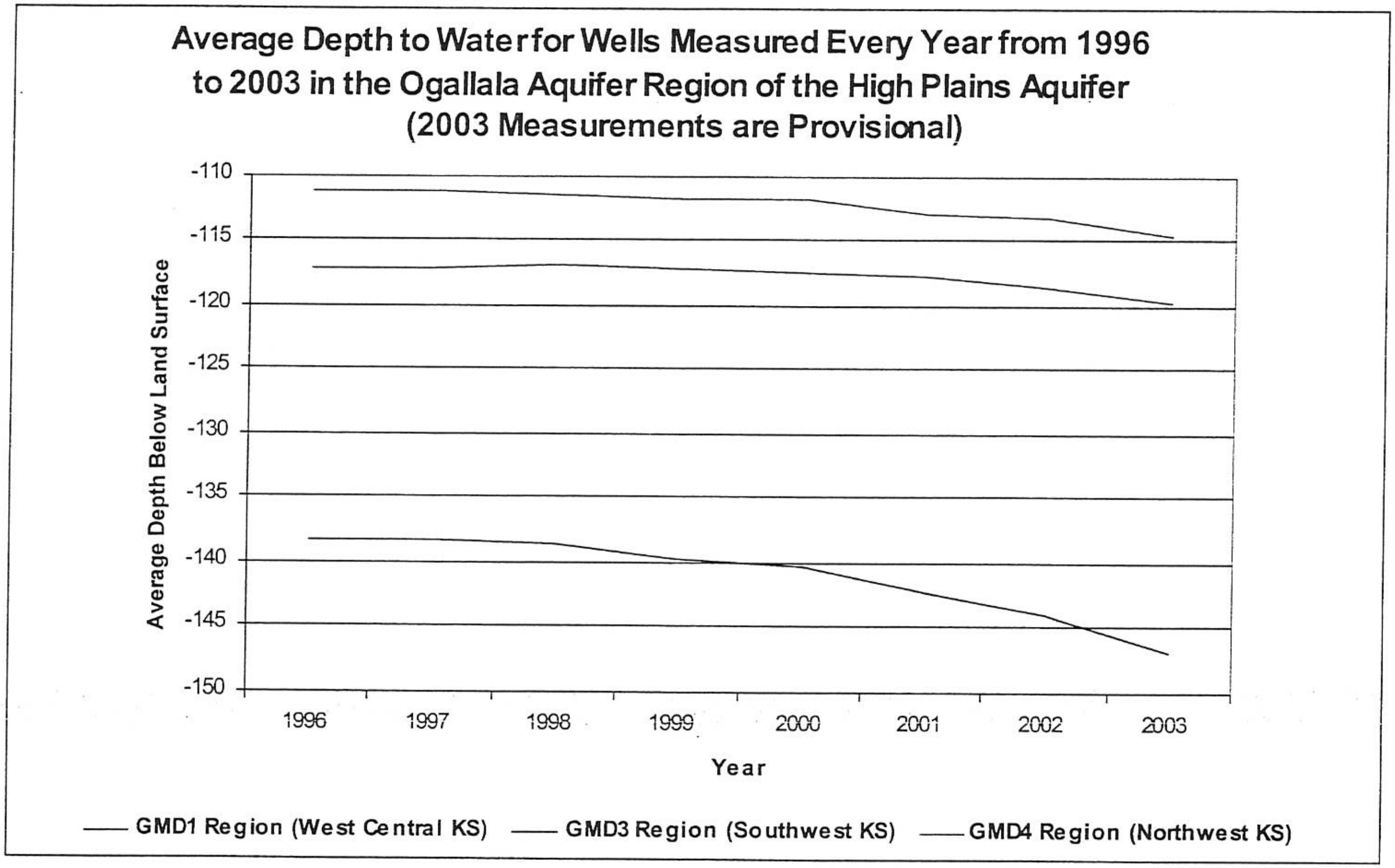
2-19

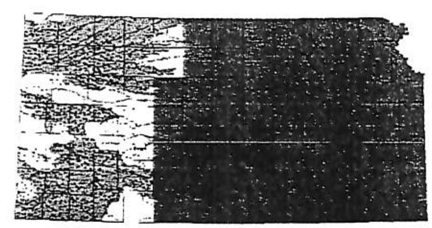


003 Measurements are considered provisional

2-20

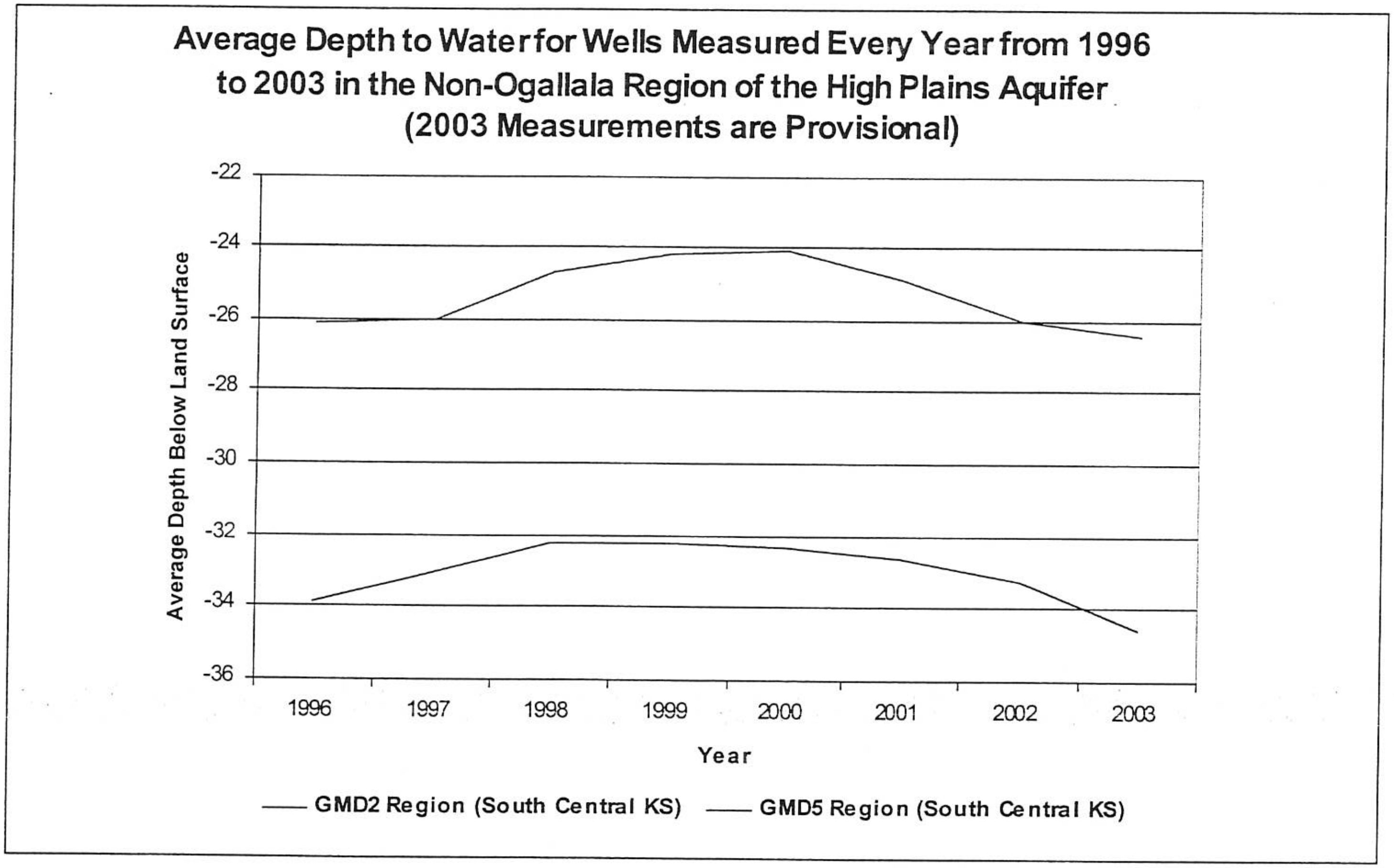
2003 Preliminary Results- Ogallala Aquifer Portion of the High Plains Aquifer

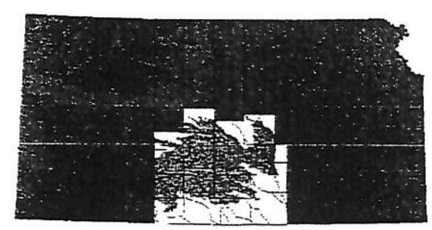




.003 Measurements are considered provisional

2003 Preliminary Results- Non-Ogallala Aquifer Portion of the High Plains Aquifer





003 Measurements are considered provisional

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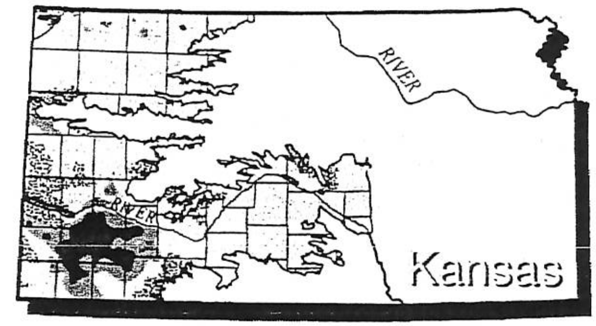
Comparison of Kansas Water Research and Data Activities with the Other Seven High Plains Aquifer States

Ogallala Aquifer Institute – Kansas Geological Survey

2-23

Kansas

Current HPA-related research



- Quantity and quality
- HPA subunit protocol development
- Ground water declines
- Safe and sustainable yield
- Ground water nitrate contamination
- Drawdown
- Stream and aquifer interactions
- Aquifer site characterization
- Saturated thickness
- Storage and availability
- Recharge
- Water use
- Usable lifetime
- Sustainability
- Salinity
- River flow and quality

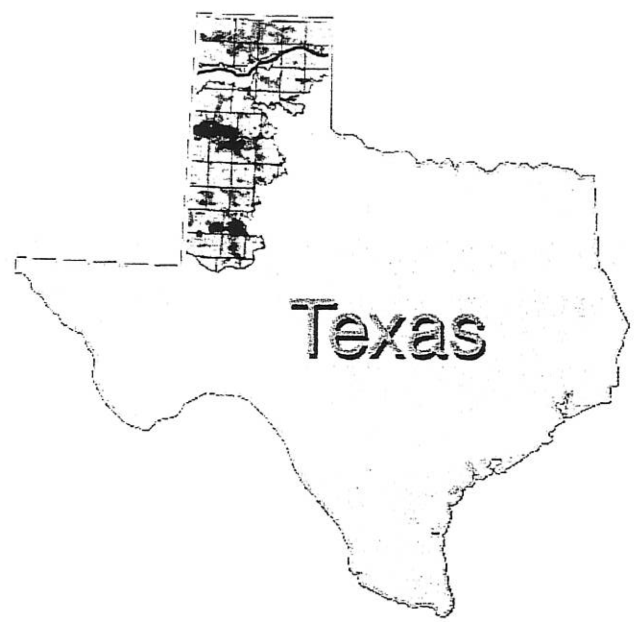
HPA- a priority research topic in KS

Research is a joint effort among agencies

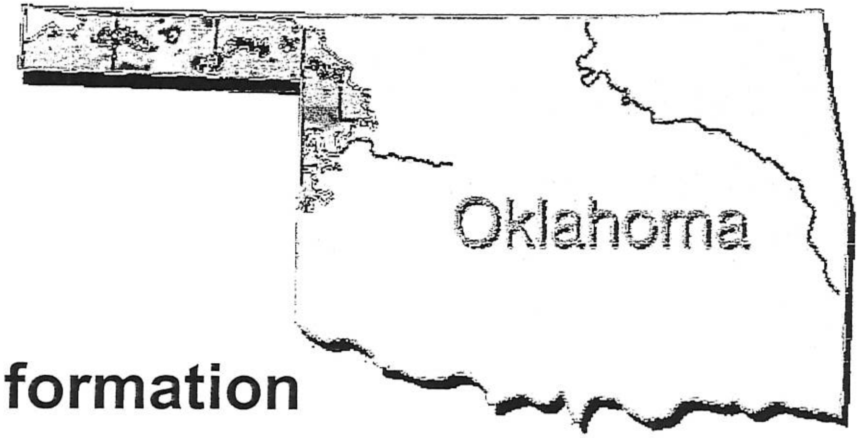
Texas

- Current HPA related research
  - Projections of ground water conditions
  - Ground water flow
  - Hydrogeologic and geologic HPA data (1987)

Limited comprehensive studies directly related to the HPA in the past 10 years, although HPA is priority focus area for TX. Research is a joint effort among state agencies.



Oklahoma



- Current HPA related research
  - Geologic maps of Ogallala formation
  - Hydrology
  - Water use
  - Simulation of flow
- HPA not a major research priority in OK.

Research is initiated by OK Water Resources Board (OWRB).

2-26

Nebraska

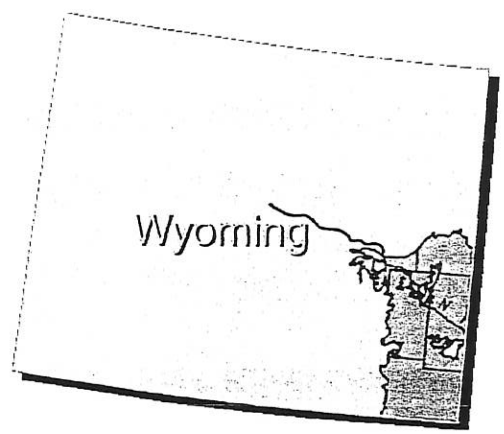
- Current HPA related research
  - Ground water and surface water interaction
  - Saturated thickness
  - Contamination
  - Quantity
  - Quality
  - Water usage
  - Recharge sources
  - Geological mapping

- HPA related research completed at state and local (NRD) levels. Research efforts are not coordinated among state agencies.

Wyoming

- Current HPA related research
  - Well water levels
  - Hydrogeologic and geochemical characteristics

- HPA related research is conducted by WY USGS in conjunction with state agencies.



2-28

New Mexico

- Current HPA related research
  - Well levels
  - Ground water flow models and simulations

- Recent water-related studies in N.M. focus on the Rio Grande valley and adjacent groundwater basins b/c state's population and agricultural activity is concentrated in those areas. HPA related research is a joint effort between N.M. USGS, NMBGMR and Office of the State Engineer (OSE).

South Dakota

- Current HPA related research
  - Ground water flow model
  - Geologic units
- HPA covers small portion of S.D. and therefore is not considered a state priority. HPA covers Rosebud and Pine Ridge Indian Reservations. Majority of HPA related research is conducted by S.D.USGS.

Colorado

- Current HPA related research
  - Water users
  - Aquifer properties
  - Water levels
  - Depletion rates
  - Aquifer mapping
  - Aquifer characteristics
  - Storage estimates
  - Predictions of aquifer life
  - Water quality
- Majority of HPA related research in CO is conducted by USGS.

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Current HPA related research in 8 states

- Water quality and quantity
- Water level changes
- Hydrology
- Water storage
- Water use
- Ground water simulation
- Surface and ground water interaction
- Recharge
- Hydrogeology
- Water resources
- Discharge
- Hydrologic and chemical interaction
- Ground water withdrawals
- Nonpoint-source contamination
- Water chemistry
- Physical characteristics
- Stream habitat
- Aquatic life
- Base characterization
- Physical and chemical characteristics
- Ground water flow
- Bank filtration in ground water quality
- Evapostranspiration
- Reservoir base
- Contamination

WIZARD Internet Access

Testing Murphy's Law

Live Demonstration of the New WIZARD Internet Data Access Web Page

High Plains Aquifer in the US