KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 2003-54

RESEARCH ON THE HIGH PLAINS AQUIFER:

A REPORT FOR THE HIGH PLAINS AQUIFER COALITION

by the

Ogallala Aquifer Institute
January 2003

Disclaimer

The Kansas Geological Survey does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations based on data used in the production of this document or decisions based thereon. This report is intended to make results of research available at the earliest possible date, but is not intended to constitute final or formal publications.

Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence, KS 66047-3726

RESEARCH ON THE HIGH PLAINS AQUIFER: A REPORT FOR THE HIGH PLAINS AQUIFER COALITION

Ogallala Aquifer Institute
January 2003

Executive Summary

The High Plains aquifer underlies all or parts of eight Great Plains states. The High Plains aquifer, which includes the well-known Ogallala aquifer, is the most important regional water source on the Great Plains, yielding about 30 percent of the nation's ground water used for irrigation. However, recent years have seen dramatic declines in water levels in parts of the aquifer—including depletion or near-depletion in some locations

In response to concerns about this resource, individuals, organizations, and agencies across the eight states have taken various voluntary and regulatory actions. Long-term management of the aquifer, however, requires scientific understanding and access to high-quality scientific information. To enhance the scientific understanding and information about the aquifer, the state geological surveys of the eight states and their federal counterpart, the U.S. Geological Survey, formed the High Plains Aquifer Coalition. The Coalition's objective is to improve the geological characterization and understanding of the High Plains aquifer, with an eye toward extending the life of this vital resource.

The High Plains aquifer varies considerably from place to place across the Great Plains—several hundred feet thick in some places, very thin in others. Similarly, each state has taken a different approach to managing water use. Additionally, each state has various levels of information about the aquifer and thus differing research programs aimed at understanding the aquifer. However, the states are increasingly recognizing the need to cooperate in managing and understanding the aquifer.

The High Plains Coalition was formed in response to this need. As part of its mission, the Coalition (working with the Ogallala Aquifer Institute) collected information about the research efforts and needs of each state. Based on extensive interviews with individuals and agency staff, the Coalition produced a comprehensive inventory of the data that are available for each state. It also collected information about the types of data that are not available and are needed. In addition, the Coalition identified research needs common to all the High Plains states. Those needs are summarized below, and, as such, help provide a general plan of research aimed at better understanding and management of the aquifer.

Aquifer subunits: The High Plains aquifer underlies more than 174,000 square miles and is highly variable from place to place. Managing a resource of this size is more effective when the aquifer is divided into smaller areas of similar characteristics, such as similar geological make-up or ability to produce water. Managing the resource by these smaller areas (referred to as aquifer subunits or well fields) requires

- detailed knowledge of the aquifer's make-up, geology, porosity (or pore space), permeability (ability of water to move through the formation), depth to bedrock, and other characteristics
- detailed knowledge of the vertical and horizontal distribution of these aquifer characteristics.

Obtaining this detailed knowledge involves surface mapping, drilling, subsurface geophysical logging, correlation, and interpretation, and re-examination of existing surface and subsurface information.

Recharge: Recharge is the movement of water from the land's surface back into the aquifer, usually originating in the form of precipitation. Knowledge of recharge is crucial to managing the resource, to calculating how much water will be replenished compared to how much is pumped. Knowledge of recharge is also important for understanding the movement of contaminants, such as nitrates, back into the groundwater. Recharge is generally believed to be very low across much of the High Plains (less than an inch per year in many places), but exact amounts are difficult to determine for any single location and difficult to estimate for large areas. Recharge research would focus on

- quantifying recharge rates, understanding recharge processes, and predicting the variability of recharge,
- measuring deep recharge and rates of recharge,
- comparing recharge under irrigated land to that under dryland farms, and
- analyzing the efficacy of artificial recharge projects and the impact of natural features, such as playas, on recharge.

Ground-water/Surface-water Interaction: Until the past few decades, it was generally assumed that there was little connection between groundwater (underground water in aquifers) and surface (streams and lakes) water. Recent research has made that connection clear: the amount and quality of water in streams affects water in neighboring (or alluvial) aquifers. Pumping from alluvial aquifers likewise has an impact on streams, with an attendant impact on wildlife, water quality, and other factors. However, this connection is not well understood. Very little is known about how these water sources influence each other, both in terms of quality and quantity. This requires detailed measurements of ground-water and surface-water interaction.

Water Quality: Much of the water in the High Plains aquifer is of extremely high quality, one reason it is such a valuable resource. However, relatively little is known about the variability of water quality across the aquifer, how quickly contaminants can move into the aquifer, the role of natural contaminants such as uranium and radon, from bedrock geologic units, as well as man-made contaminants, such as nitrates. Research is also needed on

- the way contaminant movement is affected by the geology of the aquifer, both regionally and over time,
- the way water quality is affected by the movement of water from one geologic unit to another,
- the impact of production agriculture or confined-livestock feeding operations on ground-water quality.

Climate change: Much of the High Plains aquifer is in a semi-arid area. Small changes in temperature and precipitation patterns may have a dramatic impact on land-use, irrigation, water in storage, and other factors. Understanding the role of climate and its impact is crucial to ground-water management here.

Information/Data: The quality of information and data varies widely in the states underlain by the aquifer. Access to consistent, high-quality data is central to making the best possible management decisions. This includes the need for establishing

- instrumentation to provide real-time monitoring of water-level changes
- water-quality data bases and the linking of data bases in different areas,
- electronic access to drillers' logs and electric logs (the records of wells drilled),
- better data on actual pumping rates and amount of irrigated land, and
- taking advantage of the possibilities of electronic dissemination of information.

New techniques: A variety of new scientific techniques can be developed or applied to ground-water issues on the High Plains. Geophysical measurements, such as the use of micro-gravity to measure the amount of water in storage in the aquifer, can be applied to better understand the aquifer and the amount of water it contains, to create more detailed and uniform analyses, and to do it more efficiently.

High Plains Aquifer Coalition
High Plains Aquifer Strategic Plan
Jan. 2003

Introduction

Extending the life of the High Plains aquifer is essential to the economic viability of the High Plains region because there are no realistic alternative water sources. State and local water users, managers and regulators are increasingly demanding the types and quality of data needed to develop useful and reasonable water management programs. Accurate data about aquifer variability and subunit characteristics will allow for accurate determination of current water levels, where and at what rates aquifer water moves, and the variables that impact water recharge rates in aquifer subunits. Knowledge of these factors will allow for more accurate predictions of future water levels and ultimately will lead to development of improved approaches for enhancing and extending the life of the aquifer and other factors useful for management purposes.

The eight High Plains aquifer states each manage their water resources in a different manner. The number of state and local water agencies and their duties vary dramatically among the eight High Plains states. Because the structure for conducting hydrogeologic research on the aquifer differs dramatically among states, both the existing knowledge base and ongoing aquifer research efforts vary substantially from state to state. Much of past research was limited by state expertise, budget allocations and cooperation among state agencies. To prevent future inconsistencies among state research efforts and to efficiently utilize existing research data, in June 2000, the geological surveys of the eight High Plains aquifer states formed the High Plains Aquifer Coalition (HPAC).

This HPAC strategic plan is intended to guide the HPAC in the most effective use of resources, research, and technical capabilities targeted at the High Plains aquifer. In addition, the plan will be a roadmap for prioritizing issues and actions. A plan that supports an integrated science approach for planning and execution will more effectively facilitate the alignment of relevant science with local and regional needs and the delivery of information to decision makers in a useful format. This plan, and the activities defined, is a means for providing greater coordination of HPAC activities. A cooperative regional strategic plan for scientific research and collaboration will lead to a more detailed understanding of what research is required and a priority for the region.

High Plains Aquifer Coalition Overview

The High Plains Aquifer Coalition is a joint effort between the geological surveys of the eight High Plains Aquifer states and the USGS. Coalition members include Kansas Geological Survey, New Mexico Bureau of Geology and Mineral Resources, Nebraska Conservation and Survey Division, Texas Bureau of Economic Geology, Colorado Geological Survey, Oklahoma Geological Survey, South Dakota Geological Survey, Wyoming State Geological Survey and U.S. Geological Survey.

The Coalition objective is to improve the geological characterization and understanding of the High Plains aquifer. The purpose of the Coalition is to cooperate in joint investigations and scientific exchanges concerning the earth sciences (including hydrology, geology, geochemistry, geochronology, geophysics, geotechnical and geological engineering and related investigations) on topics of mutual interest. This agreement was specifically undertaken to advance the understanding of the three-dimensional distribution, character, and nature of the sedimentary deposits that comprise the High Plains aquifer in the eight-state Mid-continent region. It recognizes that the distribution, withdrawal,

and recharge of groundwater, and the interaction with surface waters is profoundly affected by the geology and the natural environment of the High Plains aquifer in all eight States – New Mexico, Texas, Oklahoma, Colorado, Kansas, Nebraska, South Dakota, and Wyoming – thereby establishing a commonality of interests among the Surveys and citizens of these states.

The Geological Surveys agreed that reaching a fuller understanding of the three-dimensional framework and hydrogeology of the High Plains Aquifer is necessary to provide local and state policymakers with the earth-science information required to make wise decisions regarding urban and agricultural land use, the protection of aquifers and surface waters, and the environmental well being of the citizens of this geologically unique region.

Regional Issues HPAC Can Address

- Research on the regional geologic framework, particularly the completion of detailed, quadrangle-size (1:24,000 scale) surface and subsurface geologic maps and models in digital format, and the public dissemination of these maps and models, as well as interpretive information derived from them.
- Research on geologic processes relating to deposition of sedimentary sequences – their definition, nature, extent, origin, and bounding surfaces -- forming the High Plains aquifer and adjacent aquifers.
- Research on the region's hydrogeology and its fluid systems.
- Research on processes controlling the quantity and quality of water recharging the High Plains aquifer, including the effect of past and future changes in climate and land-use activities on recharge.
- Research on enhancing the recharge of the High Plains aquifer.
- Research on the porosity, permeability, storage capacity, and specific yield of the aquifer.
- Research on the geological and hydrological processes controlling regional differences and temporal changes in water quality.
- Research on the vertical and lateral exchange of groundwater between different formations that make up the High Plains and adjacent aquifers and the effect of such exchange on water quality in the High Plains aquifer.
- Research on the age of groundwater recharging and moving through the aquifer.
- Research on improved techniques for modeling the occurrence, movement, and quality of water in the High Plains aquifer.
- Research on using geophysical techniques, procedures, and models for regional application in mapping subsurface deposits in the Mid-continent region.
- Transfer of technology and information among the Surveys and to both the private and public sectors.
- Determination of the approach to define aquifer subunits, such as hydrologic boundaries, ground-water divides, hydrological characteristics, aquifer extent, major differences in recharge, or saturated thickness, in conjunction with administrative boundaries.
- Determination of recharge, stream outflow, and ground-water inflow and outflow to give estimates of net sustainable quantities of water to be pumped from areas of different saturated thickness in the High Plains aquifer. Estimates of total saturated thickness and how it varies across the aquifer that will be needed for continued pumping.
- Estimates of depth ranges from ground surface to the base of the aquifer.

- Assessment of uncertainties for estimating sustainable yield volumetrics of the aquifer, including practical saturation thickness, water level measures, and depth to bedrock in different areas.
- Determination of methods to reduce the largest uncertainties in calculating the aquifer volume.
- Delineation of critical recharge areas.

Past and Current HPA Hydrogeologic Research Activities

Both the existing knowledge base and ongoing aquifer research efforts vary substantially from state to state. In addition, the structure for conducting hydrogeologic research on the High Plains aquifer differs dramatically among the states. Following is an overview of the major hydrogeologic HPA related research that has been conducted in the eight states during the past decade. (see attached grid)

HPA Strategic Plan

Vision:

The HPAC is a leader in the advancement and understanding of the three-dimensional distribution, character, and nature of the sedimentary deposits that comprise the High Plains aquifer in the eight-state region. Future decisions affecting the use, management and protection of the High Plains aquifer will benefit directly from the timely and appropriate HPAC research and data collection and collaboration.

Mission:

The mission of the HPAC is to improve the geological characterization and understanding of the High Plains aquifer through cooperation in joint investigations and scientific exchanges concerning the earth sciences (including hydrology, geology, geochemistry, geochronology, geophysics, geotechnical and geological engineering and related investigations) on topics of mutual interest.

Goals and Action Areas:

- Identify priority areas of research that is mutually beneficial for the eight High Plains aquifer states. *Action: Develop priority area list and gain approval from all members.*
- Develop science plans that address specific High Plains aquifer research areas. *Action: Develop a plan for each issue. Establish a team for each issue.*
- Identify and secure funding and other resources to implement the HPAC scientific strategic plan. *Action: Identify potential sources of external and/or internal funding for proposed High Plains aquifer activities. Develop proposals or action plans to request funding.*
- Implement a communications strategy that promotes dissemination of information in a simple, timely, and efficient manner. *Action: Define strategy for communicating HPAC results to High Plains stakeholders.*

Partners:

Kansas Geological Survey
Nebraska Conservation & Survey Division
Colorado Geological Survey
South Dakota Geological Survey
U.S. Geological Survey
New Mexico Bureau of Geology & Mineral Resources
Texas Bureau of Economic Geology
Oklahoma Geological Survey
Wyoming State Geological Survey
State and Local agencies

Summary and Conclusions:

This strategic plan defines the long-term goals for the HPAC to develop a unified approach to addressing High Plains aquifer issues in the eight state region. The priority areas will continually be

refined as the HPAC determines areas of need. Each year the HPAC will meet to review progress on building the HPAC strategies and to define a new set of activities for the following year.