TESTIMONY

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SUBCOMMITTEE ON WATER AND POWER

Hearing on Senate Bill 212 - The High Plains Aquifer Hydrogeologic Characterization, Mapping, Modeling and Monitoring Act

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STATE AND LOCAL SCIENCE NEEDS FOR THE HIGH PLAINS AQUIFER

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Mr. Chairman and Members of the Committee, thank you for the opportunity to speak to you today. I am submitting this testimony on behalf of the High Plains Aquifer Coalition in support of Senate Bill 212 – The High Plains Aquifer Hydrogeologic Characterization, Mapping, Modeling and Monitoring Act. The Coalition is a joint effort between the geological surveys of the eight High Plains Aquifer states and the U.S. Geological Survey. The Coalition objective is to improve the geological characterization and understanding of the High Plains aquifer at the state and local level. We appreciate the Committee holding a hearing on this important issue.

Introduction: A reliable source of water is essential to the well-being and livelihoods of people in the High Plains region where ground water is used for drinking water, ranching, farming, and other purposes. Many areas of the High Plains aquifer have experienced a dramatic depletion of this resource. Large-volume pumping from this aquifer has led to steadily declining water levels in the region, and the area faces critical water-related issues. No other major source of water is available for the region.

Let me begin with some facts about the aquifer. The High Plains aquifer is the most widespread blanket sand and gravel aquifer in the nation. It encompasses one of the major agricultural regions in the world and underlies 174,000 square miles, including parts of eight states – New Mexico, Texas, Oklahoma, Kansas, Colorado, Nebraska, Wyoming, and South Dakota (Figure 1).

Approximately 2.3 million people live within the High Plains, and the aquifer supplies drinking water for 82 percent of them. Agriculture, however, represents both the dominant land and water use in the region (94 percent of ground water withdrawals from the aquifer are for irrigation). The High Plains aquifer is the most intensely pumped aquifer in the United States, yielding about 30 percent of the nation's ground water used for irrigation. During 1995, total water use in the High Plains was estimated to be 19.9 billion gallons per day and, with the exception of the Platte River valley of Nebraska, 92 percent of that need was met by aquifer water. It is estimated that 5 trillion gallons of water are pumped from the aquifer each year, which, for comparison, is 10 times the average annual water use for New York City.

Although High Plains dry-land farming is possible, availability of “water on demand” from the aquifer has made abundant, reliable crop yields a reality. As a result, the region accounts for about 19 percent of total U.S. production of wheat and of cotton, 15 percent of our corn, and 3 percent of our sorghum. In addition, the region produces nearly 18 percent of U.S. beef and is rapidly becoming a center for hog and dairy industries. Those numbers alone should elevate concern about the sustainability of the aquifer from a regional to a national level.

Aquifer characterization: Aquifers are underground deposits containing porous rock or sediments (silts, sands, and gravels) from which water can be pumped in usable quantities. Although the High Plains aquifer often is discussed as a single entity, it is a regional system composed of eight smaller units that are geologically similar and hydrologically connected – that is, water can move from one aquifer to the other. The aquifer consists of a highly variable mixture of loose clays, silts, sands, and gravels that formed over millions of years by ancient river systems. These ancient rivers meandered across the landscape, so that over time, the stacks of sediments that were deposited differ greatly from one area to the next, often over the distance of a few miles or less. The Ogallala Formation is the principal geologic unit, but the aquifer as a whole also includes deposits that are older and younger than the Ogallala.

Aquifer characteristics are determined in large part by geology. 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.

Beneath the High Plains aquifer is much older, consolidated bedrock, usually limestone, sandstone, or shale. In some places this bedrock holds enough water to be called an aquifer, and it may be connected to the overlying aquifer. Some layers of the underlying bedrock contain saline water; where these are directly connected to the High Plains aquifer, they pose a threat to water quality.

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 laterally slowly from west to east, usually at the rate of tens of feet per year. One measure of ground water is saturated thickness. The saturated thickness of the High Plains aquifer is the vertical distance between the water table and the base of the aquifer. 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. The saturated thickness of the aquifer can exceed 1,000 feet, but averages about 200 feet. Much greater saturated thicknesses were common before the onset of large-scale irrigation.

Ground water also can 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 many areas in the region, 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.

Recharge is the natural movement of water into an aquifer, usually from precipitation. Areas of increased recharge to the aquifer can be the result of one or more of the following factors: greater than normal precipitation; decreased withdrawals; or downward leakage of surface-water irrigation and water from unlined canals and reservoirs. The relatively low rainfall of the region limits aquifer-recharge rates and thus provides a long-term limit on sustainable water use. The estimated average annual potential recharge from rainfall is as little as 1/4 of an inch per year in the southwestern portion of the aquifer area. 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 in the High Plains aquifer generally flows eastward and discharges naturally to streams and springs. Water also may be lost from the aquifer by evapotranspiration or through leakage into underlying rock units. However, pumping from the numerous irrigation wells is the primary cause of ground water withdrawal. Decreases in saturated thickness of 10 percent or more result in a decrease in well yields and an increase in pumping costs because the pumps must lift the water from greater depths (Figures 3 and 4).

Water-level Declines in the Aquifer: Large-scale irrigation began in the High Plains in the late 1800's, with the use of ditches to divert water from rivers. As technology improved, ground water became the major irrigation source because surface water (lakes, rivers, and streams) is relatively scarce in the region. 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. 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. These irrigation methods led to the cultivation of crops, such as corn, that could not previously be grown reliably in the area.

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.

Withdrawals greatly exceeded recharge in many areas since intensive irrigation began in the 1940’s. This has resulted in widespread water-level declines, especially in southern areas — more than 100 feet in parts of Kansas, New Mexico, Oklahoma, and Texas. In some places, irrigation has become impossible or cost prohibitive because of such declines. From 1980 to 1997, the average water level in the aquifer fell 2.7 feet (Figure 2). Depth to water table ranges from 0 to 500 feet, with an average of about 100 feet.

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 note 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. The geology of the aquifers is highly variable and poorly characterized. I mentioned that the aquifer sediments in some areas are gravels and coarse sands deposited within ancient river channels. However, outside of these channels the aquifer sediments can be composed of muddy and silty overbank deposits, with significantly less capacity to store and transport water.

Over the past few decades, petroleum companies have spent billions of dollars to characterize the geology of oil and gas fields. New technologies have been developed and new concepts of reservoir characterization have evolved. As a result, the life of our oil and gas fields is being dramatically increased. In ground-water geology we are applying similar approaches and analyses, but we have not had the resources to make full use of technology advances, especially at the state and local levels.

With those qualifications in mind, researchers 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 already exhausted. Other parts of the aquifer 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 or longer. It is important to remember that these projections are based on past trends, and future changes could alter the actual depletion rate.

A saturated thickness of 30 feet has been accepted as the minimum needed to sustain high-yield pumping. However, in recent years, we have recognized rapid drawdowns of 70 feet or more in some areas. These areas may run out of sufficient water for irrigation much sooner than expected. We need to geologically characterize these areas to determine what factors are causing these dramatic drawdowns, their extent, and possible solutions to the problem.

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.

Local water districts are making critical decisions about the future of the aquifer using limited data often gathered at considerable distances that may not be applicable to their situations. More detailed knowledge of the geological framework of the aquifer will allow local water agencies to make decisions using the data and analyses that are most relevant and applicable to their situations.

High Plains Aquifer Coalition: Each state manages its water resources differently. The number of state and local water agencies and their duties vary dramatically among the eight High Plains states. None of the eight state geological surveys deals directly with ground-water management. State geological surveys provide scientific advice to their respective state and local management agencies. Some state surveys focus strictly on the geologic framework in which ground water exists; others investigate both the geology and the hydrology of ground water.

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 share the results among state research efforts and to efficiently utilize existing research data, in June 2000, the geological surveys of the eight states that contain the High Plains aquifer formed the High Plains Aquifer Coalition, in alliance with the U.S. Geological Survey. Coalition members are 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 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 make up the High Plains aquifer in the eight-state mid-continent region. It recognizes that the distribution, withdrawal, and recharge of ground water, and the interaction with surface waters, are 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.

Research Needs:
When it comes to water, people on the High Plains have trouble agreeing on almost anything. Each state manages its water in different ways, and each state collects information about the High Plains aquifer in different ways. The Ogallala Aquifer Institute (OAI) surveyed dozens of state and local water agencies in all eight High Plains states about their research and data needs. The agency offices contacted represented more than 130 local water districts and an uncounted number of water systems. A copy of the OAI findings is attached with our written statement to the Committee. Yet the detailed survey of the needs of water agencies of the eight High Plains states showed remarkable agreement in terms of the need for

- detailed knowledge of the aquifer's make-up,
- research on recharge, or the movement of water back into the aquifer,
- improved knowledge of interaction of ground water and surface water,
- better understanding of the impact of climate change,
- more information about the aquifer's water quality,
- the ability to efficiently exchange information, and
- the development of new techniques for understanding the aquifer.

Through past research, we have learned that the aquifer consists of many sub-regions or smaller units. Past research also helped identify the need to focus future efforts on geological and hydrological characterization, mapping, modeling, and monitoring of aquifer subunits. The eight state geological surveys and the U.S. Geological Survey, in consultation with state and local water agencies and groups, have agreed on the need for comprehensive understanding of the subsurface configuration and hydrogeology of the High Plains aquifer. Improved knowledge in these areas will refine our understanding of the aquifer and provide better tools and strategies for long-term aquifer management.

In addition to a possible increase in the density of data, the Coalition has identified a preliminary list of other data that would be needed to enhance local decision-making abilities about the aquifer. These include:

- 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 of the aquifer, including practical saturated 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.

Why the Bill is Important to the Region and the Nation: Extending the life of the High Plains aquifer is essential to the economic viability of the region. No realistic alternative water sources exist to supply this region of the country. Accurate data about aquifer variability and subunit characteristics will allow us to properly determine 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 us to better predict 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 economic and management purposes.

The High Plains Aquifer Hydrogeologic Characterization, Mapping, Modeling and Monitoring Act is a grass-roots effort by scientists at the state level to provide the data and research needed by state and local agencies and by water users to make informed decisions about the future of this threatened resource. This bill grew out of two years of discussion, collaboration, and consensus building among all segments of the water community.

Federal funds under this bill will expand existing capabilities and enhance the effects of ongoing state and local funding. Complementary activities will allow us to build critical data bases and understanding of the aquifer. The bill enlists expertise from the U.S. Geological Survey not available at the state level and fosters better coordination with other groups within states and across state boundaries. 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. For example, in Kansas, local Groundwater Management Districts are requesting subunit characterization of the aquifer that requires a more sophisticated and regional understanding of the nature of the aquifer. Current resources for state and federal water agencies are insufficient to meet these increasing needs.

This bill empowers the states in their efforts to protect a declining resource and extend the life of the High Plains aquifer. Scientific analyses and data collection would be improved. This bill provides a mechanism for states to develop or enhance their own capabilities in hydrogeology. Without this assistance, states are less able to control their destinies; they are less able to evaluate data, analyses, and interpretations produced by others. This bill puts the states on a more equal footing with the federal government.

New studies would either build on important, but often small and intermittent efforts underway in the states, or would fill gaps and needs that are not being addressed at all. Nothing in this bill changes the ways the aquifer is managed. Nothing in this bill duplicates current efforts. This bill provides resources requested by state and local water agencies and establishes the High Plains aquifer as a priority area of study. The U.S. Geological Survey has undertaken aquifer studies for most of its 115-year history. Early water studies on the High Plains by the U.S.G.S. go back to 1905. The role of the U.S.G.S. is being better defined through the High Plains Aquifer Coalition as one of support in response to state requests and as a source of highly specialized technical expertise that individual state and local jurisdictions cannot afford. In their testimony to the Senate regarding this bill last March, the U.S.G.S. stated that the, “goals of this bill can be achieved without legislation through better coordination of existing Federal and State programs.” While that may be possible, we have not seen that improved coordination. This bill sets those goals as higher priorities for the U.S.G.S. and authorizes resources to help achieve them.

We in the states who are struggling to extend and preserve the life of the High Plains aquifer know that ignorance is dangerous. Good information is needed by farmers, bankers, cities and towns, businesses, water districts, and state legislators, among others, to make rational and realistic decisions.

In conclusion, The High Plains Aquifer Hydrogeologic Characterization, Mapping, Modeling and Monitoring Act is an important step in a comprehensive program to extend the life of the aquifer. We are adamant about the primacy of the states in managing and controlling of our water. The Review Panel required in the bill is set up to assure state control of state activities under this bill. Each state is given the ability to assure that local stakeholders guide the investigations needed to address state and local issues. In times of reduced state funding, this bill will help states and local stakeholders develop their own data and interpretations without having to rely on federal agencies.

The bill will help ensure that the relevant science needed by state and locals agencies to address aquifer depletion is available so that we will have a better understanding of the resources of the High Plains aquifer and can ultimately lead to extending the life of the aquifer. We urge this committee to support Senate Bill 212 – The High Plains Aquifer Hydrogeologic Characterization, Mapping, Modeling and Monitoring Act.

This concludes my testimony. I would be pleased to answer any questions that the members of the Committee may have.

Acknowledgments:
Substantive parts of the above text were taken with permission from Buchanan and Buddemeier, 2001, and modified slightly for use here. Some material in this testimony was prepared with assistance from Dana Woodbury of the Ogallala Aquifer Institute, Garden City, Kansas.

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Rex Buchanan and Robert Buddemeier, 2001. *The High Plains Aquifer*. Kansas Geological Survey, Public Information Circular 18, 6p.

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V. L. McGuire, March 2001. *Water-Level Changes in the High Plains Aquifer, 1980 to 1999*. United States Geological Survey. Fact Sheet -029091.

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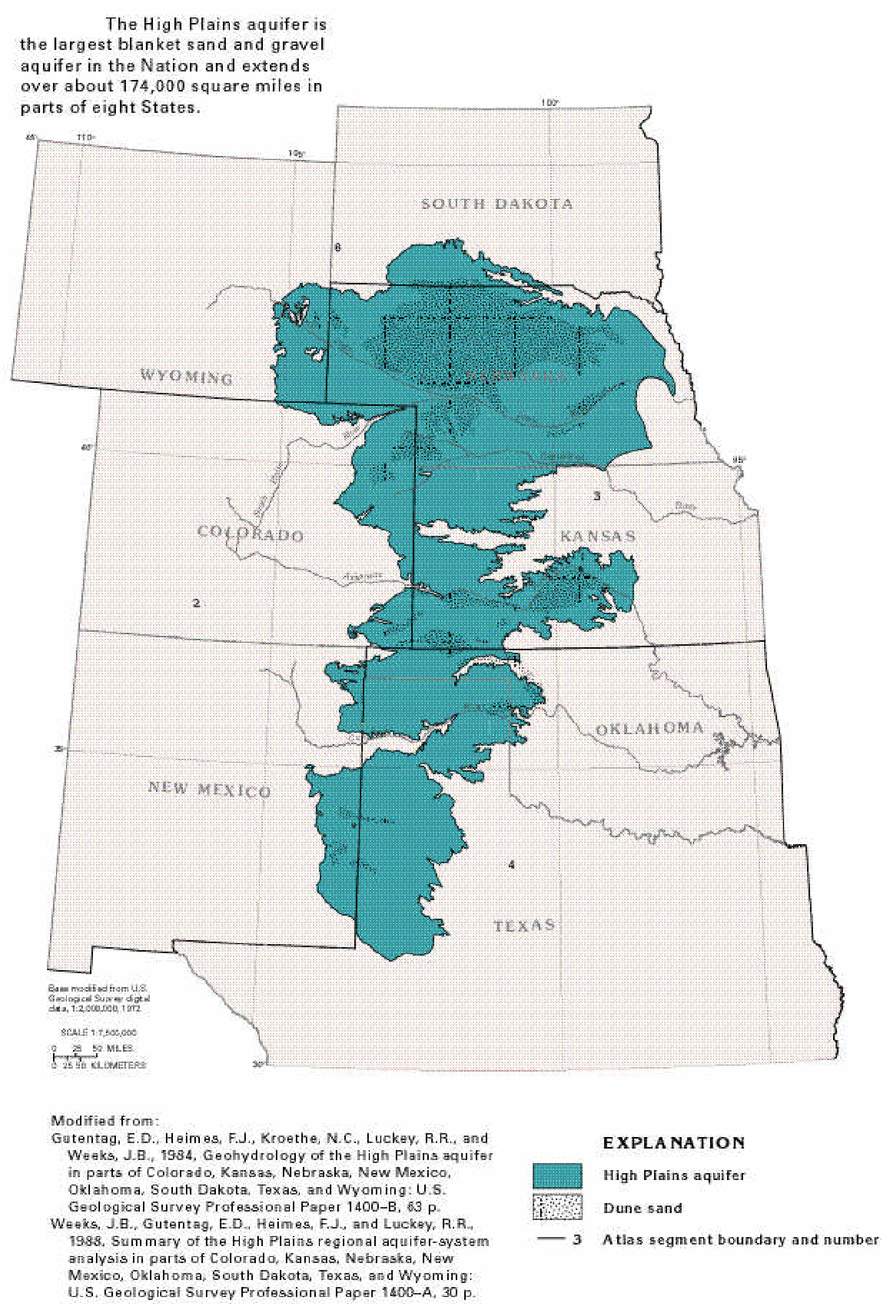


Figure 1

James Miller, 1999. USGS *Ground Water Atlas for the United States*. United States Geological Survey, Introduction and National Summary. http://capp.water.usgs.gov/gwa/index.html

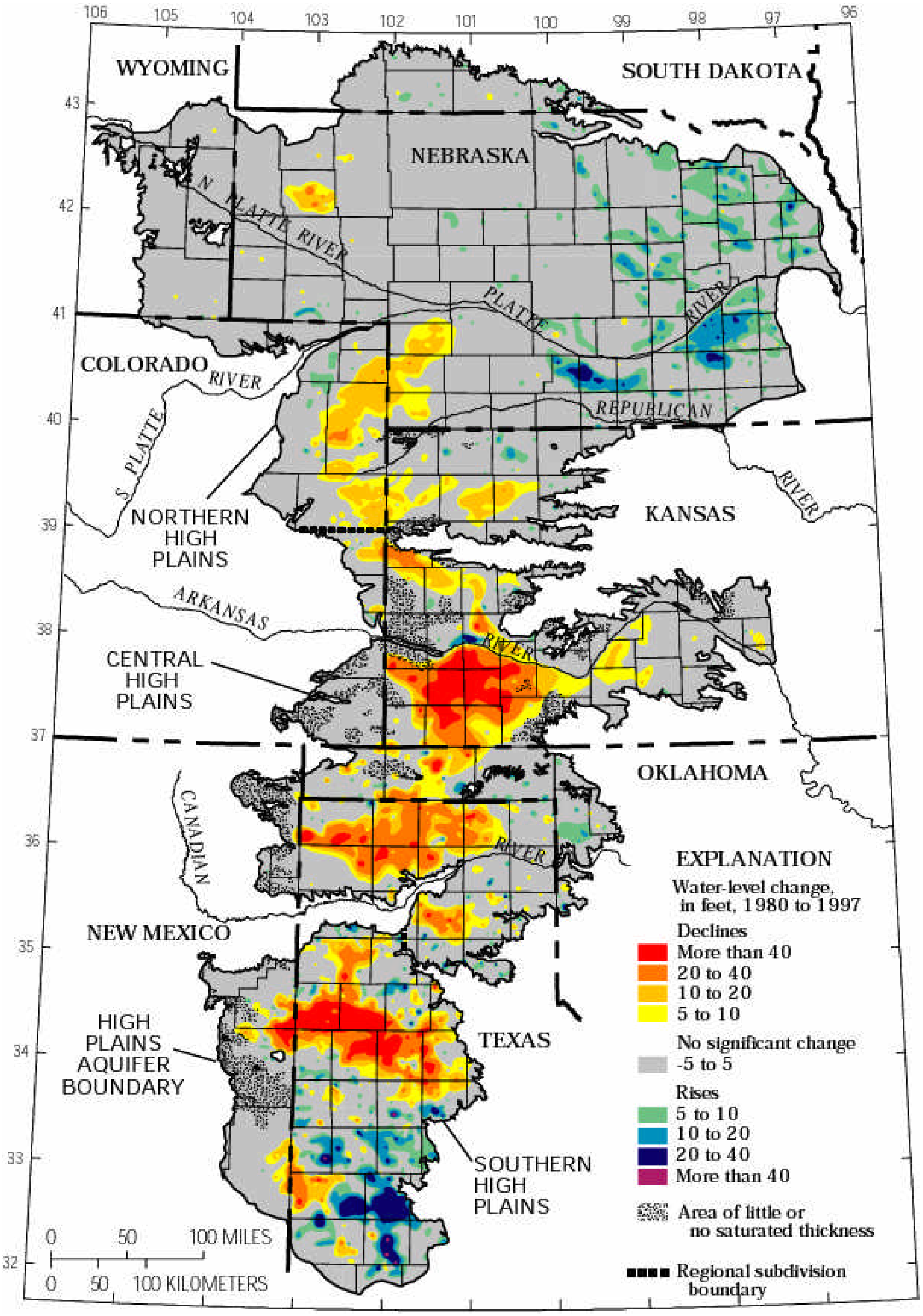


Figure 2

USGS – Water Level Changes in the High Plains Aquifer, 1980 to 1999.

V. L. McGuire, March 2001. *Water-Level Changes in the High Plains Aquifer, 1980 to 1999.* United States Geological Survey. Fact Sheet -029091.

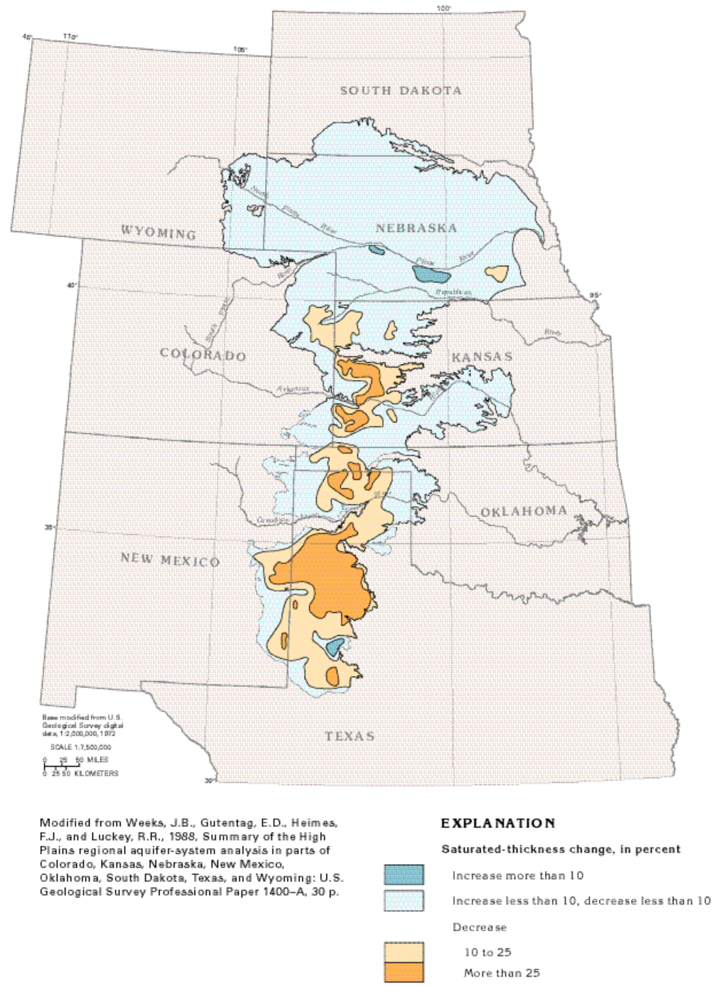
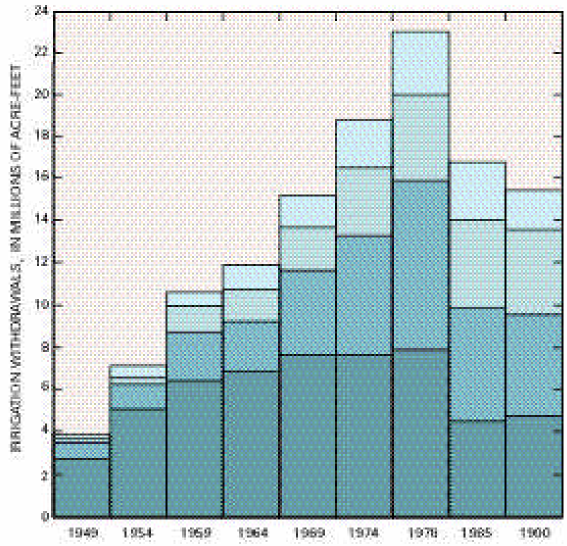


Figure 3

James Miller, 1999. *Ground Water Atlas for the United States*. United States Geological Survey, Introduction and National Summary. http://capp.water.usgs.gov/gwa/index.html



Ground-water withdrawals from the High Plains aquifer for irrigation account for most of the discharge from the aquifer. Irrigation withdrawals have been largest in Texas and Nebraska.

Modified from:

Weeks, J.B., Gutentag, E.D., Heimes, F.J., and Luckey, R.R., 1988, Summary of the High Plains regional aquifer-system analysis in parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming: U.S. Geological Survey Professional Paper 1400–A, 30 p.

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Figure 4

James Miller, 1999. *Ground Water Atlas for the United States.* United States Geological Survey, Introduction and National Summary. http://capp.water.usgs.gov/gwa/index.html