GROUNDWATER IN THE NEBRASKA PANHANDLE

Steven S. Sibray, Research Hydrogeologist
Conservation and Survey Division

Groundwater is an important natural resource in the Nebraska Panhandle. In much of the relatively arid Panhandle, farmers are highly dependent on groundwater for a source of irrigation water. The importance of the 4,100+ irrigation wells and 141 municipal wells to the future economic viability of this arid region cannot be overly stressed. In addition, nearly everyone in the Panhandle is dependent on groundwater for their drinking water. Good management practices are essential to maintain both good quality groundwater and sufficient quantities of groundwater for future use.

Although groundwater is fairly abundant in the Nebraska Panhandle, the distribution of both quantity and quality of groundwater is highly variable. In some areas of the Panhandle, there are no important aquifers, while in other ares, the thickness of the principal aquifer exceeds 500'. In most of the Panhandle, groundwater quality is not a problem. However, in some areas of the Panhandle, groundwater can be alkaline or contain trace elements which can be harmful to certain crops. In other areas of the Panhandle, farming has contaminated shallow aquifers with agricultural chemicals such as nitrate and possibly pesticides. In order to better understand some of the problems with groundwater in the Nebraska Panhandle, it is important to know some of the basic principals of groundwater flow and occurrence.

Contrary to what many people think, groundwater does not occur in underground lakes, rivers, or veins. Groundwater fills the spaces between rock particles and, occasionally, within fractures. Formations that yield economically significant amounts of groundwater are called aquifers. Formations where groundwater moves very slowly and yield only small amounts of water are called aquitards. There are two different types of aquifers - confined and unconfined. Aquifers close to the land surface with aquifer material extending from the land surface to the base of the aquifer are termed water table aquifers or unconfined aquifers. Confined aquifers are overlain by a confining layer or aquitard. Unconfined aquifers are much more vulnerable to contamination than confined aquifers. Most of the aquifers in the Nebraska Panhandle are unconfined.

Groundwater movement is fairly slow, usually on the order of feet per year. The permeability of an aquifer is the measure of how easily a fluid can move through the aquifer material. The permeability of coarser grained rocks such as gravels is much greater than fine sand and silts and water moves much faster through these rock types. Fractures also have very high permeabilities.

The measure of how much water can move through a formation is transmissivity. This is important to an irrigator because transmissivity determines how much water can be pumped from an aquifer. Transmissivity is the saturated thickness of the aquifer times the

permeability of the aquifer. If the saturated thickness of an aquifer decreases through excessive pumping, the transmissivity declines resulting in smaller pumping rates. This has happened in the High Plains Aquifer in Texas, Oklahoma, New Mexico and is occurring in some areas of the Panhandle (see Figure #1).

The most significant water table decline in the Nebraska Panhandle is in Box Butte County. Box Butte County has 970 registered irrigation wells or approximately 25% of the wells in the Panhandle. The water table has declined approximately 40' in the Alliance area in the 40 years since the beginning of groundwater development.

A detailed hydrogeologic study of Box Butte County by Vern Souders in 1980 has shown that the water level declines in Box Butte County are due to natural low recharge rates and can be expected to continue. One question we are often asked is, when will the aquifer dry up? The answer to this question is never. The irrigators will reach economic limits long before the aquifer is completely drained. As the water table declines, the transmissivity decreases and well yields decline to the point where wells have to be deepened or additional wells have to be drilled in order to supply the same amount of water. This adds to the cost of pumping until it is no longer profitable to irrigate and dryland farming becomes more economically attractive.

The economic limit depends on the site specific aquifer characteristics of depth to water, saturated thickness, and permeability. At the present time, the economic limit probably is reached in northern Box Butte County where the aquifer is relatively thin. Other very important factors that will influence the future economics of irrigation in Box Butte County are commodity prices, energy prices, and government policies including possible regulations. Fortunately, the greatest decline in the water table in Box Butte County has been in the area of greatest saturated thickness (300' to 500'). In 1975, Vern Souders estimated only 2 to 3% of the total groundwater in storage had been depleted in Box Butte County.

In order to extend the economic life of the aquifer in Box Butte County, it may be necessary to establish some sort of control area that would promote water conservation. At the present time, the Conservation and Survey Division of UN-L is working with the Upper Niobrara-White NRD in a groundwater level measuring program and a computer mapping project that will better define the extent of the groundwater declines in Box Butte County.

The well yields in the Brule aquifer in the Sidney area can be very sensitive to water table fluctuations. The Brule aquifer consists of thin (5' to 10') horizontal to subhorizontal zones or layers of fractured siltstone that transmit large volumes of water. Since the producing zone is relatively thin (5' to 10') and at shallow depth, a moderate drop in the water table can result in significant loss of transmissivity. In the late 1970's and early 1980's, there was significant water quantity problems in the Sidney area. Fortunately, the Brule aquifer has a large recharge area and increased precipitation in this area has caused net gains in the water table in the mid 1980's.

At the present, lower precipitation and greater groundwater withdrawals have led to small declines in the water table in this area.

It is anticipated that there can be significant rises and declines in the Brule aquifer in the Sidney area in the future depending on variations in precipitation (recharge) and variable groundwater consumption (discharge). The Conservation and Survey Division in cooperation with the South Platte NRD and the City of Sidney is currently conducting a computer modeling study of the Brule aquifer in order to better understand the flow of groundwater through this fractured siltstone aquifer.

Groundwater quality in the Nebraska Panhandle is of increasing interest to the public. There are some naturally occurring problems with groundwater quality in some areas of the Nebraska Panhandle. The Chadron aquifer, which is a confined aquifer has high concentrations of sodium and boron. Beans and other sensitive crops may be adversely affected by these naturally occurring chemicals in Chadron groundwater. Water quality problems with the Chadron aquifer are not a major concern to most irrigators because relatively few wells are screened in this relatively deep aquifer. Chadron development is restricted to a few isolated areas in the North Platte Valley where shallow aquifers with good quality water are absent.

An additional problem area is the alkali lakes region east of Alliance where shallow groundwater is high in total dissolved solids (TDS) and is of poor quality. Another area of possible concern would be the moderately high levels of radioactivity in groundwater from shallow aquifers noted by a recent Nebraska Public Health Department survey. The Conservation and Survey Division, in cooperation with the USGS and the North Platte NRD is conducting a study in the North Platte Valley in order to better understand the distribution of the major constituents, trace elements, and radionuclides in the groundwater of the different aquifers.

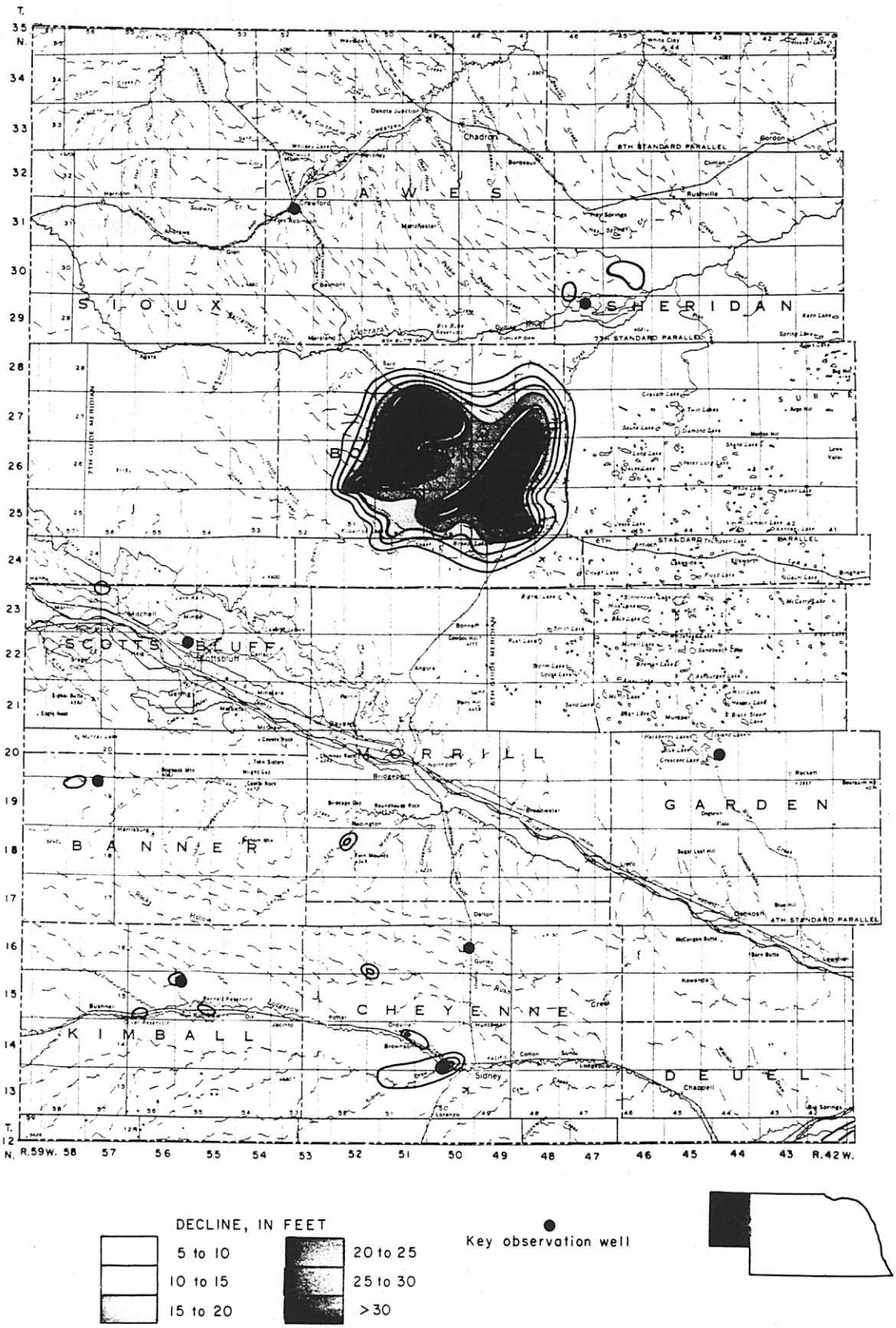
Contamination of the unconfined aquifers in the Panhandle is becoming an increasing problem. The main problem is the contamination by agricultural chemicals including nitrates and possibly pesticides. The areas most vulnerable to contamination are those with sandy soils and shallow depth to water. Nitrate contamination is a problem in the Brule aquifer in Sidney and the shallow alluvium near Oshkosh. The groundwater quality study being conducted by the Conservation and Survey Division, USGS, and NRD should also help us define some of the man-made groundwater quality problems.

SUMMARY

Although groundwater is an abundant and important natural resource in the Nebraska Panhandle, there are areas where quantity and quality problems exist. Box Butte County is experiencing a decline in the water table of approximately 1'/year due to low recharge rates. It is expected that groundwater declines will increase in Box Butte County until an economic limit is reached. Controls on the use of groundwater that would promote water conservation could extend the economic life of

the aquifer in Box Butte County. Groundwater declines have occurred in other areas of the Panhandle but are not as widespread as those in Box Butte and can be reversed when precipitation increases and/or consumption is decreased.

Groundwater contamination of the shallow water table aquifers with agricultural chemicals is of increasing concern in the Nebraska Panhandle. The Conservation and Survey Division's cooperative study with the USGS and NRD will help in defining potential problem areas.



Areas of significant water-level change in the Panhandle Division from 1946 to fall 1988

Figure 1