Minimizing Decline

Water withdrawn from an aquifer that is not used results in the unnecessary decline of the water level in the aquifer. To minimize the decline of water levels, water withdrawal from wells should be limited to only that which is needed. Flowing wells are required to be constructed with valves or reducers to restrict the flow. These should be adjusted to limit the flow to only that which is necessary (Fig. 5). When conditions permit, flowing wells should be shut in. Wells that are abandoned or are no longer in use should be properly plugged by a certified water well contractor.

Another source of unnecessary water-level decline is water leaking through or around the well casing. If not sealed, water will leak along the outside of the casing from zones of higher pressure, such as the Fox Hills-Hell Creek aquifer, to zones of lower pressure, such as overlying beds of sandstone and lignite (Fig. 6). Also, the casing itself can corrode adjacent to permeable zones, allowing water to escape.

New wells completed in the aquifer must be grouted to prevent leakage. This is accomplished by filling the entire annulus around the casing from the top of the producing zone to land surface with a cement slurry (Fig. 7). This will prevent the migration of water from one permeable zone to another and will isolate the casing from the corrosive waters found in some permeable zones.

Figure 6

Flowing Well Without Cement Grout in Annulus

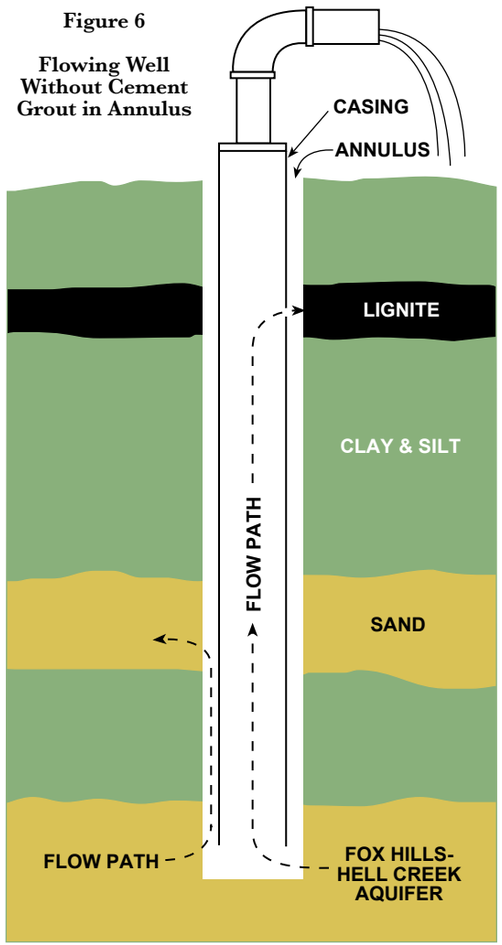
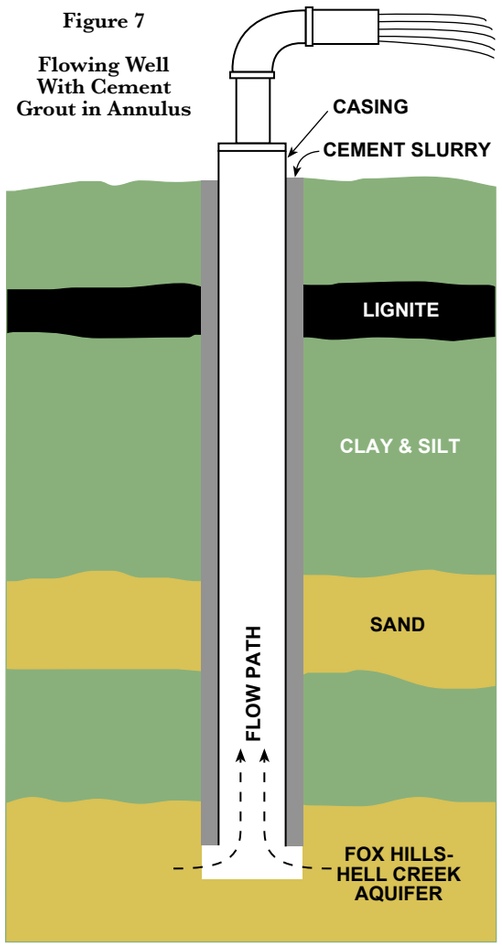


Figure 7

Flowing Well With Cement Grout in Annulus



Additional Information

More specific information about well installation procedures can be found in the handbook, *Water Well Construction and Water Well Pump Installation*, available from the North Dakota Board of Water Well Contractors or the State Water Commission. A report titled *Pressure Head Fluctuations of the Fox Hills-Hell Creek Aquifer in McKenzie County, North Dakota* from which this brochure is based, may be downloaded as a PDF file from the State Water Commission website at: http://swc.nd.gov. Click on *Reports and Publications*, then click on *Water Resource Investigations*, and choose *WRI No 43* to download.

North Dakota
State Water Commission
900 East Boulevard Ave.
Bismarck, ND 58505
701-328-2754
http://swc.nd.gov

FLOWING WELL PRESSURE CHANGES

in

McKenzie County

PHOTO BY MERLYN SKALEY

North Dakota
State Water Commission

2007

Introduction

Under North Dakota law, the State Engineer is responsible for gathering information about flowing wells in order to advise the public on the use and maintenance of the wells. The purpose of this brochure is to provide information, which will help in the conservation of water in the Fox Hills-Hell Creek aquifer and thereby extend the life of the flowing wells completed in the aquifer. The Fox Hills-Hell Creek aquifer within McKenzie County ranges in depth from approximately 1,000 feet below land surface in the Yellowstone and the Missouri River Valley to approximately 2,000 feet below land surface in southeastern portion of the county. The aquifer is under pressure, which forces the water level in wells far above the top of the aquifer and in low-lying areas the water level extends above the land surface allowing wells to flow.

Data Collection

In May 2006 water levels were measured in 13 Fox Hills-Hell Creek flowing wells in McKenzie County (Fig. 1). Water levels in 10 observation wells are measured annually and were also included in this study. Water levels in most of the wells had been measured during previous studies in 1985 and 1995. By comparing the 2006 measurements with earlier measurements the rate of water-level decline was determined. Water levels in Fox Hills-Hell Creek aquifer will continue to be monitored in the future.

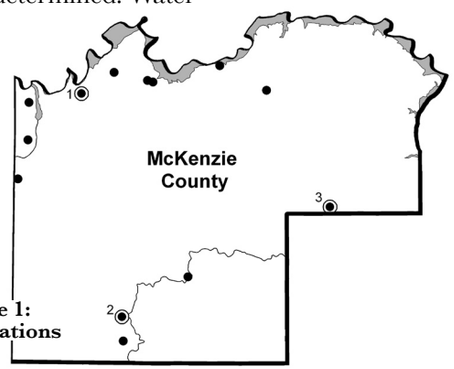


Figure 1: Well Locations

Trends

Water-level measurements from three flowing wells, circled in Figure 1, were selected to show typical rates of decline. Figures 2, 3, and 4 illustrate the water level changes over time in the wells.

General Projections

The rate of decline of the water level was determined for the flowing and observation wells from 1995 to 2006. Water levels are declining at an average rate of 1.6 feet per year. However, not all of the decline is associated with pumping. A majority of the wells monitored in McKenzie County are located in the northern portion of the county adjacent to Lake Sakakawea. Fluctuations in the lake levels of Lake Sakakawea have an affect on the water levels of the Fox Hills-Hell Creek aquifer in this area. The large volume of water in Lake Sakakawea adds more weight on the land surface, which propagates down through the underlying formations and compresses the aquifer matrix in the Fox Hills-Hell Creek aquifer. Water levels in the aquifer rise in response to aquifer matrix compression. When the water-level measurements were made in June of 1995, Lake Sakakawea was at an estimated elevation of 1846 feet above mean sea level. In May of 2006 when the most recent water-level measurements were made, Lake Sakakawea was at an estimated elevation of 1814 feet above mean sea level. The 32-foot decline in lake level over this period increased the rate of water-level decline in the wells adjacent to the lake. It is difficult to quantify the impact the declining lake levels had on the average pressure head decline rate from 1995 to 2006. However, the average decline rate of 1.6 feet per year would have likely been much lower if Lake Sakakawea maintained its elevation from 1995. From 1985 to 1995 the average decline rate was 1.0 feet per year. During the 1985 to 1995 monitoring period, the loading effect of Lake Sakakawea had minimal effect on the pressure head declines of the aquifer, because the lake elevation in 1985 was similar to the elevation in 1995. If the current trend continues within McKenzie County, a majority of the wells installed in the Fox Hills-Hell Creek aquifer will stop flowing within the next 60 years.

Figure 2: Well No. 1

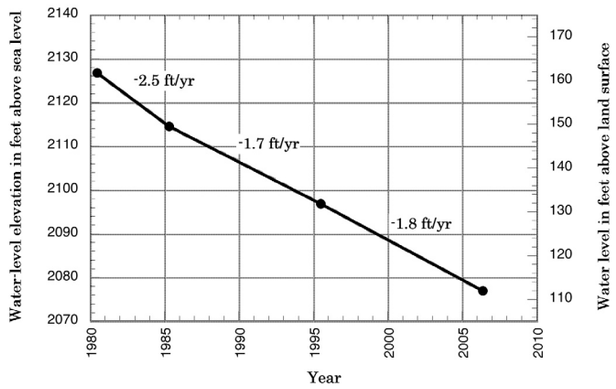


Figure 3: Well No. 2

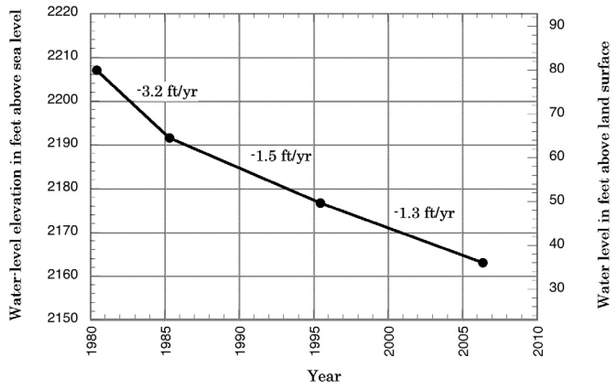
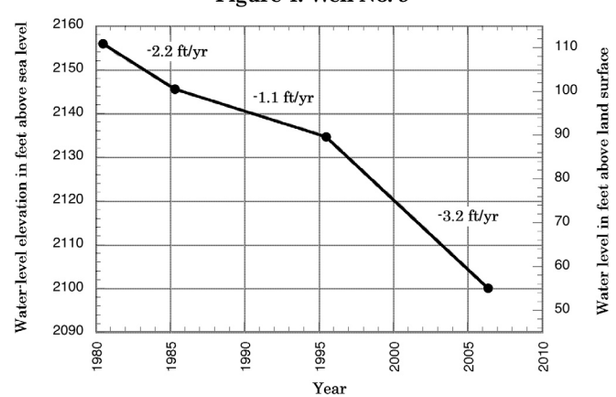


Figure 4: Well No. 3



Cause of Decline

Water levels in an aquifer decline when the amount of water leaving the aquifer (discharge) is greater than that entering the aquifer (recharge). This imbalance between discharge and recharge results in a decline in pressure in the aquifer and a corresponding decline in water levels. Recharge to the Fox Hills-Hell Creek aquifer is very small and is easily exceeded by the discharge from the aquifer, which occurs mainly in the form of withdrawal of water from wells. The rate of water-level decline can be kept to a minimum by restricting the withdrawal of water from wells.

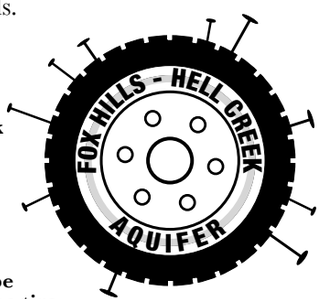


Figure 5: The pressure head in the Fox Hills-Hell Creek aquifer can be compared to the air pressure in a car tire. Each nail in the illustration is allowing air to be released from the tire, thereby lowering its pressure. The same is true with flowing wells in the aquifer. When water is released by flowing wells, the pressure head in the aquifer is lowered, thus lowering the water level. Fortunately, unlike the nails in the tire, flow from the wells can be restricted by valves. Restricting the flow in wells to only what is needed, slows the decline in pressure head in the aquifer, thereby extending the life of the well. When the tire goes flat it can be re-pressurized. Unfortunately, when the pressure head of the aquifer drops below land surface the flow in the well stops and is forever lost.