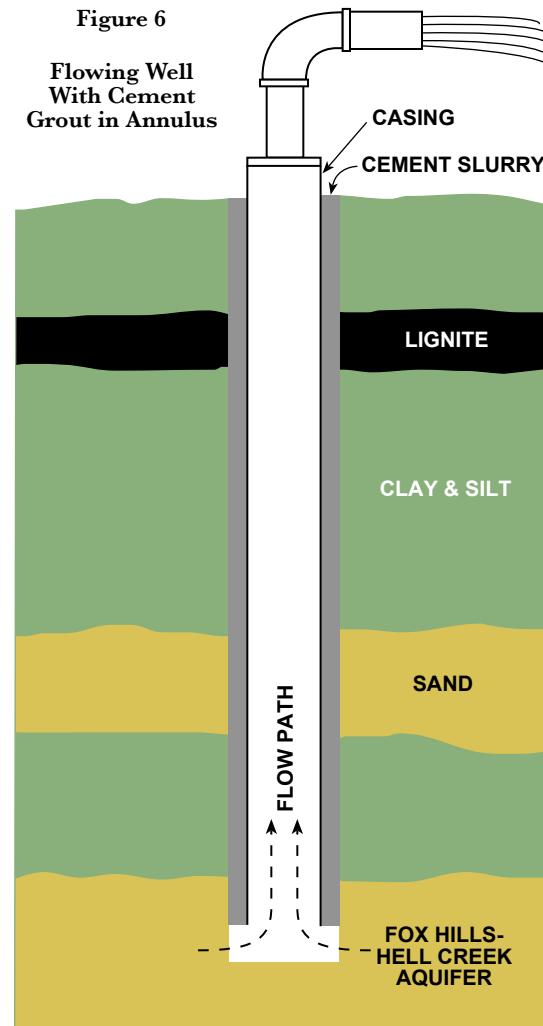
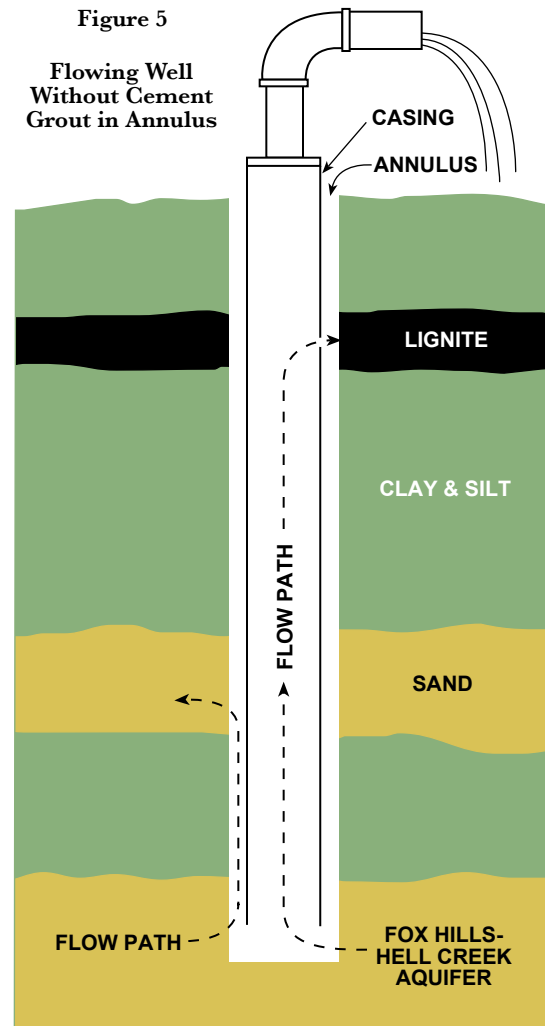


producing zone to land surface with a cement slurry (Fig. 6). This will prevent the migration of water from one permeable zone to another and will isolate the casing from the corrosive waters found in some permeable zones.

**Additional Information**

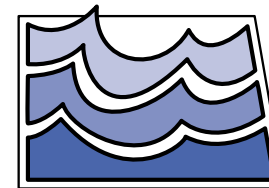
More specific information about well installation procedures can be found in the handbook, *Water Well Construction and*

*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 the Knife River Basin, 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 44* to download.



# FLOWING WELL PRESSURE CHANGES

in  
the Knife River Basin



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**North Dakota  
State Water Commission**

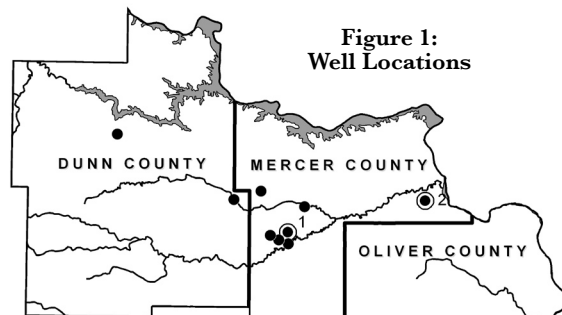
2007

## 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. Within the study area, the Fox Hills-Hell Creek aquifer ranges in depth from approximately 500 feet below land surface in eastern Oliver County to approximately 2,000 feet below land surface in western Dunn 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 September 2005 water levels were measured in 10 Fox Hills-Hell Creek flowing wells in the Knife River Basin (Fig. 1). Water levels in three 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 1984 and 1994. By comparing the 2005 measurements with earlier measurements the rate of water-level decline was determined. Water levels in the Fox Hills-Hell Creek aquifer will continue to be monitored in the future.



## Trends

Water-level measurements from two flowing wells were selected to show typical rates of decline. The two wells are located within the valley of the Knife River and are circled in Figure 1. Figures 2 and 3 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 1994 to 2005. Water levels are declining at an average rate of 0.8 feet per year. From 1984 to 1994 the average decline rate was 0.6 feet per year. Prior to 1984 the average decline was 0.8 feet per year. If the current trend continues within the study area, a majority of the wells installed in the Fox Hills-Hell Creek aquifer will stop flowing within the next 90 years.

## 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 2: Well No. 1

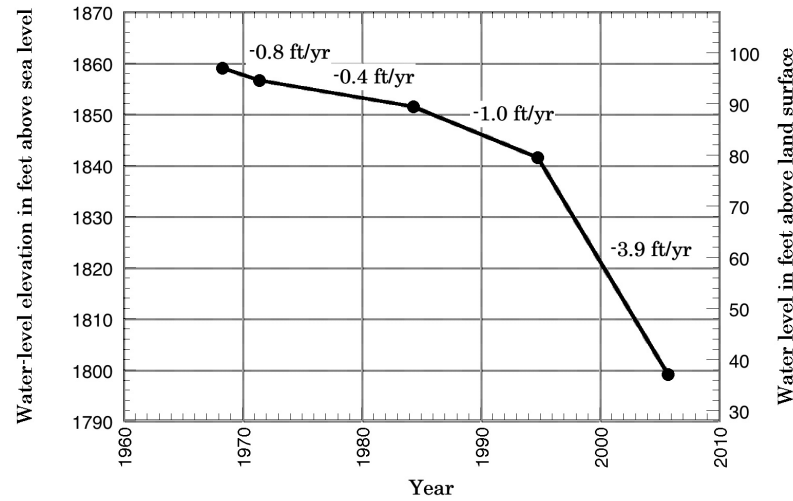
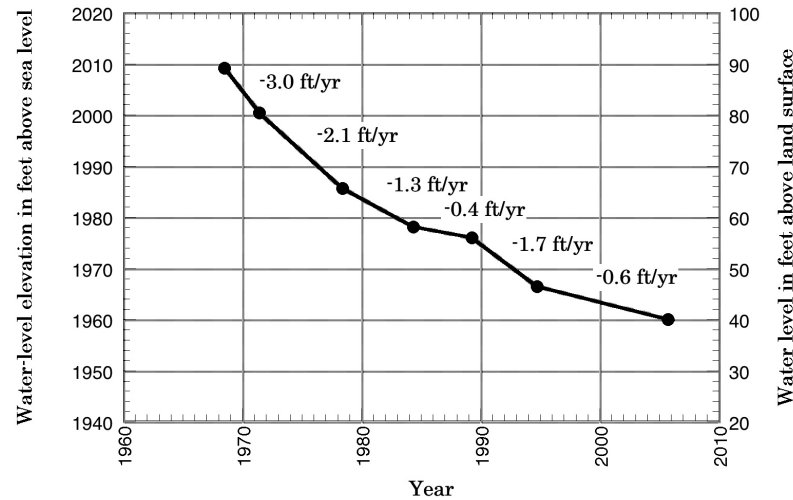


Figure 3: Well No. 2

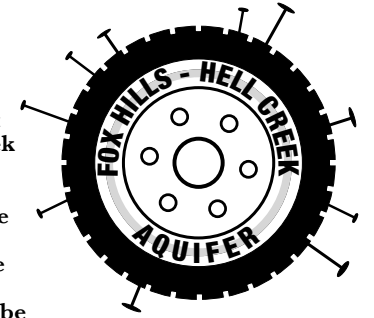


## Minimizing Decline

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. 4). 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.

Figure 4: 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 repressurized. Unfortunately, when the pressure head of the aquifer drops below land surface the flow in the well stops and is forever lost.



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. 5). 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