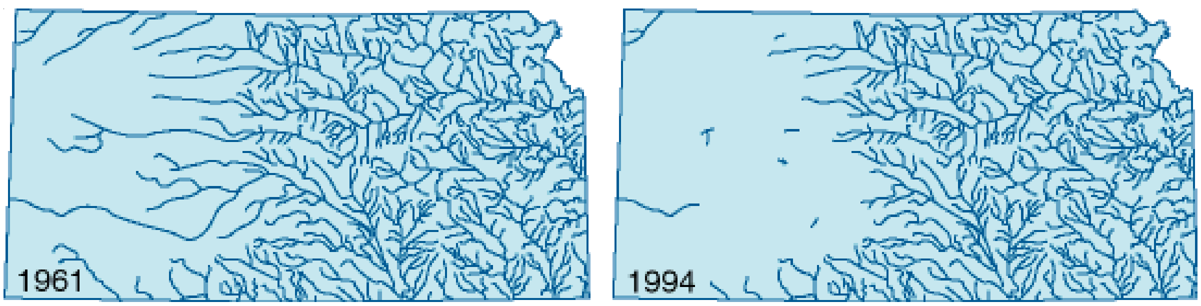
Ground Water and Surface Water—the Vital Connection

Minnesota's aquifers, streams, lakes, and wetlands are sustained by a balancing act between precipitation and these parts of the hydrologic system. In the absence of human intervention, ground water and surface waters exist in a state of approximate equilibrium. A change in one part of the system, whether due to natural climatic variation or withdrawal of surface water or ground water, results in a balancing response in another part of the system. The rate of system response to change is variable, specific to local conditions, and much slower for ground water than for surface water (except in karst). In some cases, the system may rebalance itself in response to change (such as additional ground-water withdrawal) in months to years. In other cases, the system may adjust very slowly in generations.

Use of water resources that minimizes impacts on both ground water and surface water requires a comprehensive, long-term approach to water resources management that takes system interactions into account.



Where Did Kansas Rivers and Streams Go?

Kansas rivers and streams changed between 1961 and 1994. High ground-water pumping rates caused the loss of perennial streams by 1994 in western Kansas. That area is underlain by the High Plains aquifer, which has been heavily pumped to support irrigation. The pumping, over time, has "captured" surface-water flows. Minnesota's streams, lakes, and wetlands are vulnerable to this kind of change, too. Indications of this happening now in Minnesota are local impacts on the Rock River near Luverne; Pipestone Creek; Oxbow Creek in Brooklyn Park; and Boiling Springs, Eagle Creek, and Savage fen near Savage.

In response to drastically declining water levels in the High Plains aquifer in western Kansas, as much as 200 feet or more than 50 percent of the aquifer thickness in some places, local ground-water management districts were authorized by the Kansas Legislature in 1972 to manage the resource. Five local ground-water management districts have since been created. In 1982, the Kansas Legislature passed a law that requires minimum desirable stream flows. Management policies vary in the districts, including planned depletion, zero depletion, and modified sustainable yield. In some locations, new wells are not allowed. Local, state, and regional planning efforts continue to manage *collectively* the ground-water and surface-water resources in the High Plains aquifer area. For more information, see Kansas Ground-Water Management Districts in the fact sheet on "Options for Sustainable Management".

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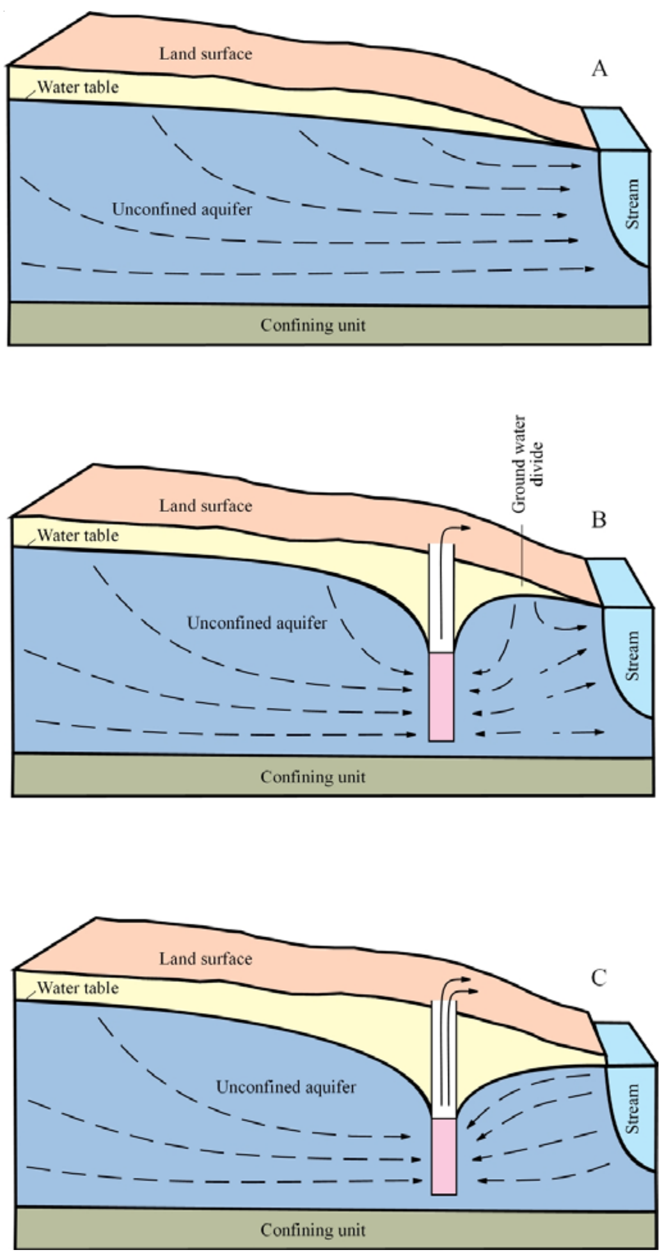
Ground-Water Use *Can* Deplete Surface Water

The figures below (adapted from USGS Circular 1139) illustrate how pumping can initially affect ground water and later surface water as well.

Figure A shows how precipitation moves into a water-table aquifer and later discharges to a stream, supporting stream flows (base flow) when there is no direct precipitation runoff to the stream. Under natural conditions, recharge to the aquifer over time and on average equals discharge from the aquifer. Although the contribution is variable, it is estimated that the average contribution of ground water to flow in small- and medium-sized streams is between 40 percent and 50 percent.



Adapted from USGS Circular 1139

In Figure B, the well pumps water from the aquifer. Initially, the source of water to the well is removal of ground water in storage, as evidenced by the lowering of water levels around the well. As a result, the well intercepts ("captures") some of the ground water that would normally discharge to the stream to support base flow. In the diagram, only the ground water to the right of the ground-water divide can discharge to the stream. The stream no longer receives the full amount of base flow that it would under natural conditions and would be expected to have reduced base flow.

In Figure C, if pumping increases, the well removes more water in storage and intercepts all ground water moving toward the stream. The well also draws water from the stream, inducing flow from the stream. In effect, the well acts as if there were a pipe to it from the stream. The closer a well is to a stream and the greater the pumping, the greater the effect will be on the stream.

With the passage of time, the source of water to a well shifts from 100 percent ground water from storage withdrawal to 100 percent surface water, resulting in a new system equilibrium. How fast this change occurs can be calculated and can vary from days to hundreds of years or longer.

We Must Manage Ground-Water Use to Protect Surface Waters

System response to ground-water withdrawals is most obvious in lowered ground-water levels. However, long-term effects may include depletion of wetlands, streams, springs, and lakes, as well as ecological or other changes. Use of ground-water resources has long-term impacts beyond the point of withdrawal that future management must consider to minimize impacts on surface-water resources.