SHALLOW GROUND-WATER RESOURCES

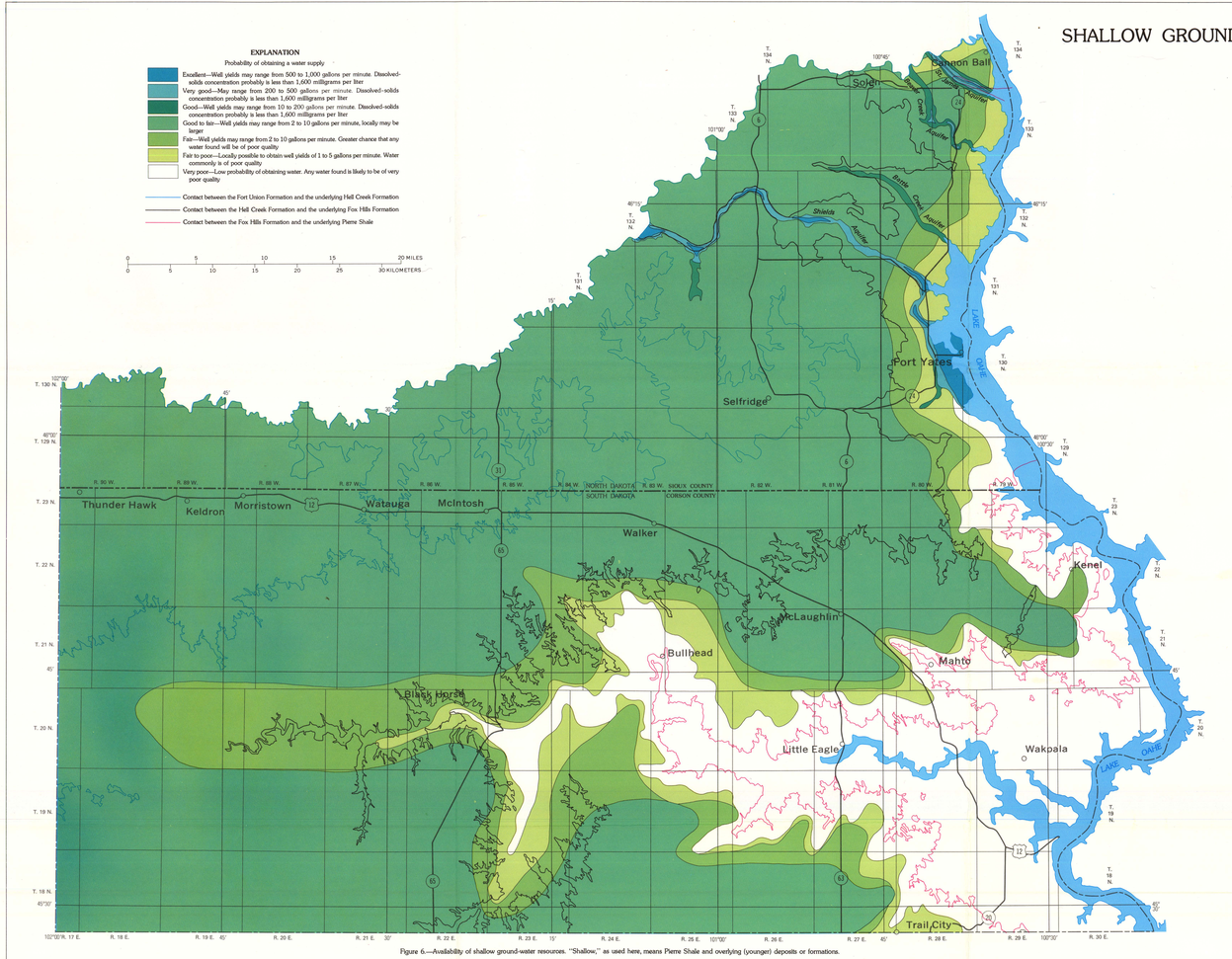

Figure 6.—Availability of shallow ground-water resources. "Shallow," as used here, means Pierre Shale and overlying (younger) deposits or formations.

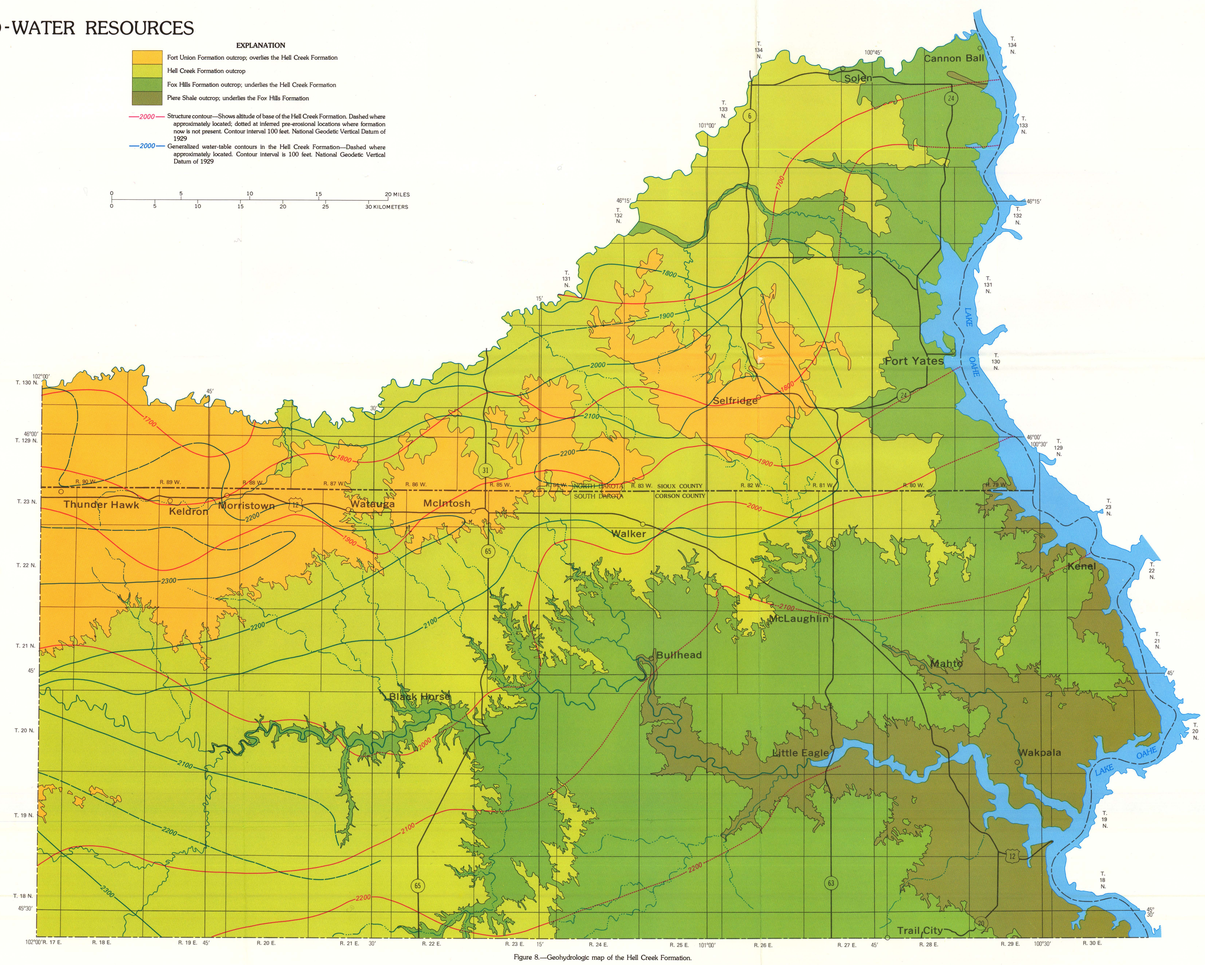

Figure 8.—Geohydrologic map of the Hell Creek Formation.

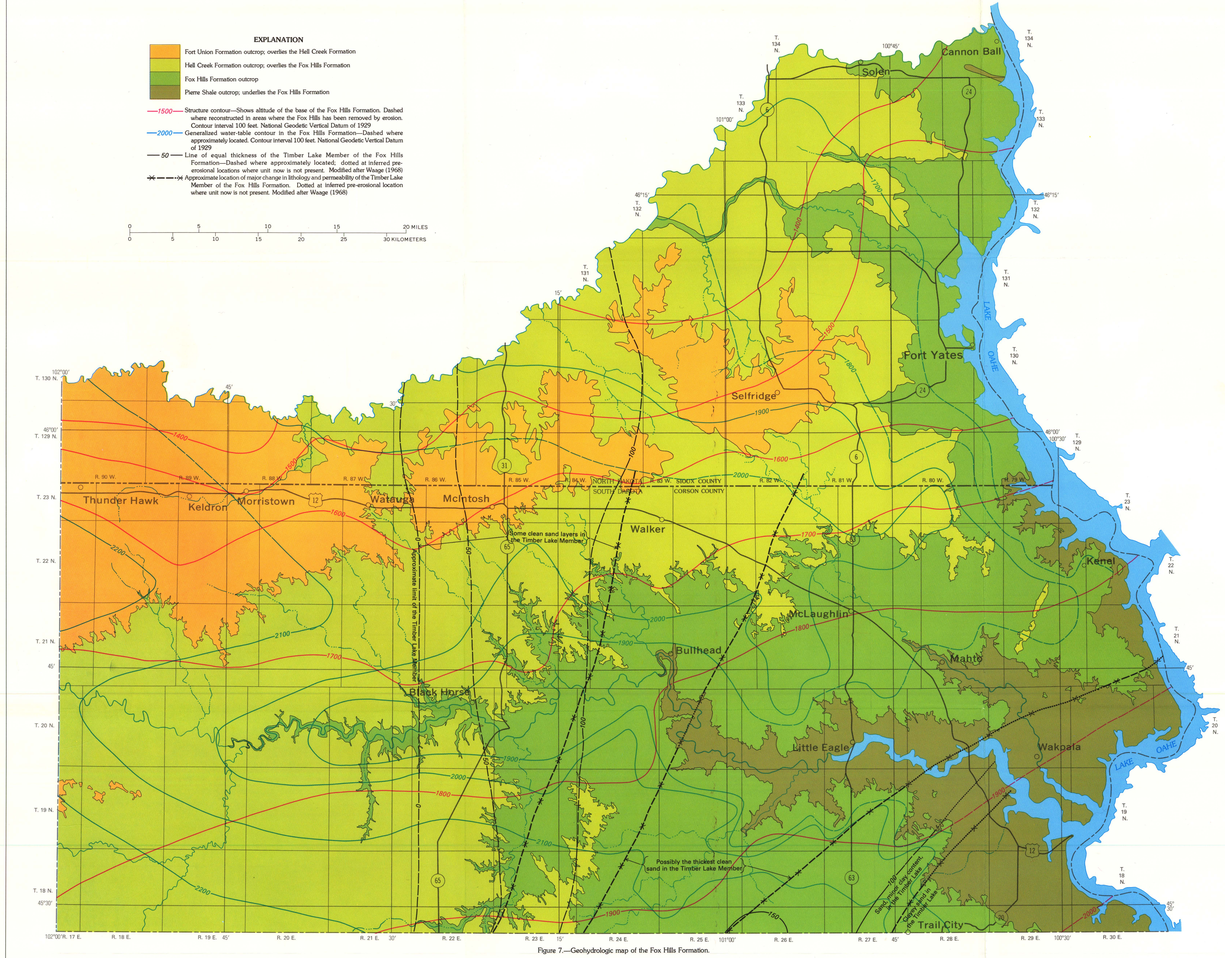

Figure 7.—Geohydrologic map of the Fox Hills Formation.

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The possibility of obtaining adequate supplies of good quality water from surficial deposits (fig. 6) generally is limited to bedrock formations overlying the Pierre Shale where their total thickness is at least 150 feet, to four buried glacial valleys in eastern Sioux County, and to alluvium along Cedar Creek and the Cannonball and Missouri Rivers. In a few places, adequate supplies of stock or domestic water may be found in alluvium along the Grand River and in a few terraces.

Pierre Shale has almost no potential as a source of potable water. The Pierre usually will not yield water to wells, but where water can be obtained, usually the quantity is meager and quality is very poor. Colluvium and alluvium along streams draining areas where shale is at the surface commonly are composed of clay or silty clay and are relatively impermeable; where water can be obtained the quality, again, usually is very poor.

The lower part of the Fox Hills Formation is relatively impermeable and is a poor source of water. The most permeable part of the Fox Hills (fig. 7) is the Timber Lake Member; this silty, fine to medium sand is the source of water tapped by the Trail City and Glencross Water Association to supply their rural water distribution system in northern Dewey and southern Corson Counties. Though a large amount of water is stored in this aquifer, the generally fine grain size of the aquifer material makes it difficult to construct high capacity (more than 100 gallons per minute) wells. The "Bullhead" (banded) and "Colgate lithofacies " of the Iron Lightning Member probably are the best potential sources of water in the Fox Hills west of the edge of the sand in the Timber Lake Member. Potential yields to wells tapping the Fox Hills are from 2 to 100 gallons per minute.

The Hell Creek Formation (fig. 8) can yield supplies of good quality water adequate for stock and domestic use throughout most of its extent in the two-county area, particularly where it is more than 100 feet thick. Potential yields to wells tapping the most permeable zones in the Hell Creek should range from 1 to 5 gallons per minute for each 10 feet of aquifer material.

Within a regional framework that includes northwestern South Dakota, southwestern North Dakota, and the adjacent area in Wyoming and Montana, the Fox Hills and Hell Creek Formations probably form a single hydrologic unit. On the Standing Rock Indian Reservation, the "true" or regional water table lies from 50 to more than 430 feet below the surface of the rolling uplands. This depth to the water table is the result of climate, topography, and geology. Relatively low precipitation (about 16 inches per year) and fairly high potential evaporation (about 36 inches per year) result in a low rate of recharge to the aquifer (most recharge occurs from March to early June). Fairly high relief at the edges of the rolling uplands permits rapid discharge of ground water. The thick sequences of silty or clayey material of relatively low permeability that separate the most permeable beds in the Fox Hills and Hell Creek have caused the formation of many perched or semiperched water-table zones. Perched water-table zones occur where downward moving water is intercepted by much less permeable layers, commonly lenses of clay. The water then moves laterally to the edge of the confining layer where it again moves downward toward the regional water table.

Within Sioux and Corson Counties, the hydrologic unity of the Fox Hills and Hell Creek Formations is not obvious. At any given site where both units are present, the water level in the Hell Creek may be 50 to more than 100 feet higher than the water level in the Fox Hills. The reason for this situation, in addition to the factors mentioned above, probably is the extensive development of semiperched water-table zones. The more extensive and most permeable beds in both formations are separated by fairly thick sequences of much less permeable material. These intervening beds are not impermeable, but their vertical permeability is less than 0.001 percent of the horizontal permeability of the most permeable beds. Thus, though water moves vertically downward to the regional water table, its rate of movement is slowed by the silty or clayey beds and one or more extensive "aquifers" has developed under conditions similar to those that give rise to the areally restricted perched water-table zones.

Wells tapping a perched water-table zone have a very limited "reservoir" of water from which to develop a supply. Consequently, such wells commonly yield water only at low rates of pumping, or may yield usable quantities of water for only part of the year, or, if pumpable at fairly high rates, may yield water for only a few days or weeks. Examples of all three types are common in the report area.

Wells tapping the extensive semiperched water-table zones commonly yield year-round supplies of water. Yields are limited only by the transmissivity of the aquifer and by available recharge. However, such wells are more sensitive to water-level declines caused by drought or by intensive development than are wells that tap the regional water table because the zone in which they are screened is continuously losing water downward to the regional water table.

The sandstone beds in the Cannonball and Ludlow Members of the Fort Union Formation appear to be aquifers throughout most of their extent in western Sioux and northwestern Corson Counties (fig. 9); the Tongue River Member is too thin and too shallow to contain an aquifer. The water-bearing beds in the Fort Union consist of very fine- to medium-grained sandstone interbedded with thin lenses of siltstone and shale. Potential yields to wells are estimated at from 2 to 60 gallons per minute. Perched water-table zones are common, in the western part of Sioux County, wells developed on the floor of the valley of Cedar Creek may have enough head to flow.

Glacial deposits that fill buried valleys in eastern and northeastern Sioux County contain four aquifers; these are the Shields, Saint James, Beaver Creek, and Battle Creek aquifers. The Sioux County part of the Shields aquifer underlies the valley of Porcupine Creek and extends from the Missouri River near Fort Yates northwest to the Cannonball River. The aquifer is made up of several sand and gravel beds along the axis of the buried valley. The thickest and most productive part of the aquifer in Sioux County is near Fort Yates. Water levels in the aquifer range from 5 to 95 feet below land surface. Recharge to the aquifer is by infiltration of precipitation. Most discharge from the aquifer is to the Missouri River, though some discharge to the Cannonball River and to the Fox Hills Formation does occur. Within 2 miles of the Missouri River, water levels in the aquifer fluctuate with stage changes of Oahe Reservoir. The Shields aquifer contains an estimated 155,000 acre-feet of water in Sioux County. Depending upon local conditions, properly constructed wells tapping the Shields aquifer could yield from 50 to 1,000 gallons per minute.

In the northeastern corner of Sioux County is a segment of the St. James aquifer. The thickest and coarsest sand and gravel beds in this glacial deposit are along the axis and near the base of the valley fill. Local perched water-table zones are common in the fill of this buried valley. The water level is from 75 to 80 feet below land surface in the main sand and gravel deposits, and from 30 to 77 feet below land surface in the perched zones. Recharge to the St. James aquifer is by infiltration of precipitation and by subsurface discharge from the adjacent and underlying Fox Hills Formation. Discharge from the aquifer is to the Missouri River. An estimated 8,000 acre-feet of water is stored in this aquifer. Depending upon local conditions, properly constructed wells tapping the main sand and gravel beds could yield from 50 to 1,000 gallons per minute.

The Beaver Creek aquifer is in the basal sand and gravel of a glacial valley fill that underlies part of Beaver Creek valley in northeastern Sioux County. Water levels in the aquifer range from near land surface, at discharge areas in the Cannonball and Missouri Rivers, to 72 feet below land surface in higher parts of the aquifer. The highest point in the water table is just south of where State Highway 24 crosses the aquifer; from here water in the aquifer moves toward both the Missouri and Cannonball Rivers. Recharge is by infiltration of precipitation and by discharge from the adjacent and underlying Fox Hills Formation. An estimated 14,000 acre-feet of water is stored in this aquifer. Depending upon local conditions, properly constructed wells tapping the Beaver Creek aquifer could yield from 50 to 500 gallons per minute.

The Battle Creek aquifer is in a narrow glacial diversion channel that underlies part of Battle Creek valley in northeastern Sioux County. The aquifer consists of discontinuous sand and gravel deposits in the glacial valley fill. Water levels in the aquifer range from 66 feet below land surface to slightly above land surface where State Highway 24 crosses the aquifer. Recharge to the aquifer is from infiltration of precipitation and by discharge from the Fox Hills Formation. Discharge from the aquifer is to the Missouri River. An estimated 6,000 acre-feet of water is stored in the Battle Creek aquifer. Properly constructed wells tapping this aquifer could yield from 2 to possibly as much as 50 gallons per minute.

Where alluvial deposits contain recoverable water, it could be derived from three sources: infiltration of rainfall on the alluvium and of runoff from adjacent higher areas; by infiltration of water from the stream with which the alluvial deposit is associated; and by discharge of water to the alluvium from adjacent and underlying aquifers in the bedrock. Thus, availability of water from alluvium is localized because infiltration of precipitation and runoff not only is small, but also is "channeled" to topographic lows on the bedrock surface underlying the alluvium; because permeable deposits in alluvium seldom extend below the level of the present-day streambeds except for Cedar Creek, the Cannonball River, and some streams in eastern Sioux County; and because recharge from the bedrock aquifers is generally restricted both in time and in areal extent. In the geologic setting found on the Standing Rock Indian Reservation, base flow of streams is a fairly accurate reflection of significant recharge to alluvium by aquifers in the bedrock. Because all streams except Cedar Creek and the Grand and Cannonball Rivers are dry by the end of June in most years, and Cedar Creek and the Grand River are dry in many years by the end of July, little or no significant recharge to alluvium from bedrock aquifers occurs after June. Ground-water discharge to Cedar Creek in the reach bordering Sioux County may average about 12,000 acre-feet per year, to the Cannonball River in the reach bordering Sioux County may average 6,000 acre-feet per year, and to the Grand River in Corson County may average about 25,000 acre-feet per year.

Alluvial deposits in the reach of the Cannonball River valley bordering Sioux County contain an estimated 16,000 acre-feet of water. Alluvial deposits in the reach of Cedar Creek valley bordering Sioux County contain an estimated 22,000 acre-feet of water.

The potential of terrace deposits as sources for water supplies is much less than that of alluvium. All of the terrace deposits are topographically higher than the associated streams. Also, the terraces commonly are underlain by steeply dipping bedrock surfaces; as a result, infiltrating water can easily and rapidly drain out of the terraces.

The quality of water from deposits overlying the Pierre Shale varies widely, often within short distances. Well owners have reported large and rapid changes in water quality in a given well. In general, the poorest quality water comes from thin alluvial deposits overlying the Pierre Shale and from small permeable lenses in the Fox Hills, Fort Union, and (to a lesser extent) the Hell Creek Formations. The best quality ground water generally comes from the Hell Creek Formation and from the Fox Hills Formation where it is more than 200 feet thick.

Base from U.S. Geological Survey
Bismarck, 1954–76, and McIntosh, 1953–76,
1:250,000

GEOHYDROLOGY OF THE STANDING ROCK INDIAN RESERVATION, NORTH AND SOUTH DAKOTA

By
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