

STATE OF SOUTH DAKOTA
William J. Janklow, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES
John J. Smith, Secretary

GEOLOGICAL SURVEY
Merlin J. Tipton, State Geologist

Information Pamphlet No. 31

MAJOR AQUIFERS IN
LAKE AND MOODY COUNTIES, SOUTH DAKOTA

by

Donald S. Hansen
United States Geological Survey

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University of South Dakota
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ABSTRACT

Six glacial aquifers and four bedrock aquifers were delineated in Lake and Moody Counties. The Big Sioux, North Skunk Creek, Pipestone Creek, Battle Creek, and East Fork Vermillion aquifers are composed of glacial outwash, exposed at or near land surface and are as much as 73 feet thick. The Howard aquifer is composed of glacial outwash 100 to 470 feet below land surface, and is as much as 117 feet thick. The four bedrock aquifers are the Niobrara, Codell, Dakota, and quartzite wash aquifers.

The average thickness of the glacial aquifers ranges from 14 to 40 feet. Reported discharge from wells screened in the Big Sioux, North Skunk Creek, and East Fork Vermillion aquifers ranged from 30 to 1,000 gallons per minute; the Pipestone and Battle Creek aquifers ranged from 1 to 15 gallons per minute and the Howard aquifer ranged from 5 to 300 gallons per minute. Dissolved-solids concentrations in water from the glacial aquifers ranged from 300 to 5,520 milligrams per liter.

The average thickness of the bedrock aquifers ranges from 60 to 400 feet. Reported discharge from wells in the bedrock aquifers ranged from 2 to 75 gallons per minute. Dissolved-solids concentrations in water from the bedrock aquifers ranged from 1,200 to 2,290 milligrams per liter.

INTRODUCTION

This Information Pamphlet is one of a series of reports on water-resources studies of South Dakota counties. It is designed to acquaint the reader with the general distribution, quantity, and quality of ground water available from the major aquifers in Lake and Moody Counties. A comprehensive report, to be published later, will contain additional information on the hydrology and geology of the area, and will include some of the geohydrology data collected during the study. Information in this pamphlet is based on data (fig. 1) collected by the U.S. Geological Survey and the South Dakota Geological Survey during 1978 through 1980.

Copies of this publication and other county reports may be obtained from the South Dakota Geological Survey as they become available. Additional information about the hydrology and geology may be obtained from the U.S. Geological Survey in Huron or the South Dakota Geological Survey in Vermillion.

The inch-pound units used in this report may be converted to metric (SI) units by the following conversion factors:

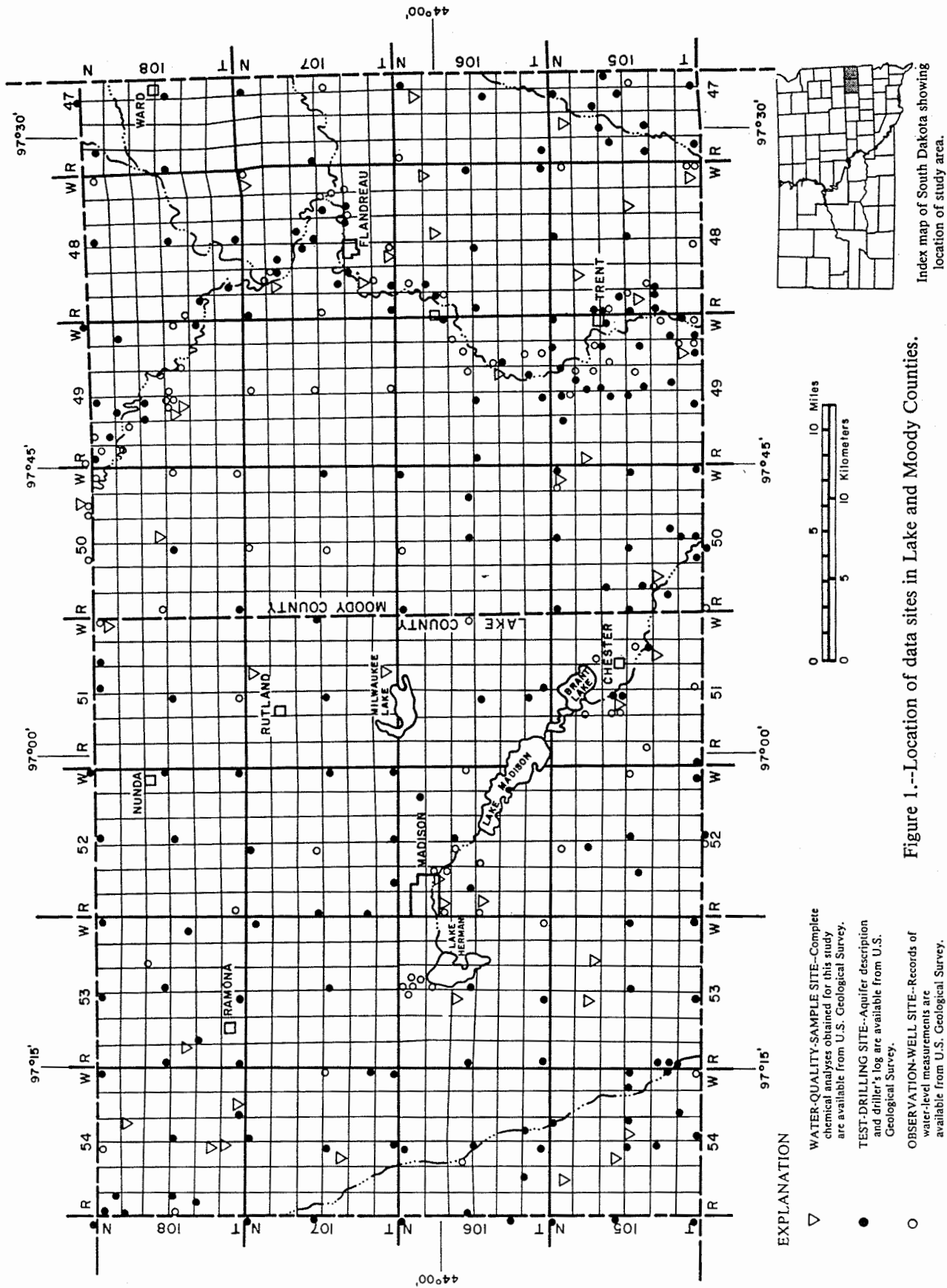


Figure 1.--Location of data sites in Lake and Moody Counties.

Multiply inch-pound unit	By	To obtain metric unit
foot (ft)	0.3048	meter (m)
gallon per minute (gal/min)	0.063	liter per second
mile (mi)	1.609	kilometer
square mile	2.590	square kilometer
acre-foot	1,233	cubic meter

DEFINITIONS OF TERMS

Aquifer: A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Artesian aquifer: A confined aquifer in which the water in a tightly cased well completed in the aquifer rises above the top of the aquifer.

Bedrock: A general term for the rock, usually consolidated, that underlies soil, sand, clay or other unconsolidated material. In Lake and Moody Counties, the uppermost bedrock deposit is shale in most of the area.

Dissolved solids: Term that expresses the quantity of dissolved constituents in a sample of water.

Glacial aquifer: An aquifer composed of materials derived from a glacier. In Lake and Moody Counties, glacial aquifers mainly consist of unconsolidated sand and gravel deposited as glacial outwash.

Hardness: Dissolved calcium and magnesium salts that decrease the lathering ability of soap and form scale in boilers and pipes. Hardness is reported as calcium carbonate and is classified by the U.S. Geological Survey as follows:

Classification	Milligrams per liter	Grains per gallon
Soft	0- 60	0 - 3.4
Moderately hard	61-120	3.5- 7.0
Hard	121-180	7.1-10.5
Very hard	More than 180	More than 10.5

Outwash: Sand, gravel, silt, and clay that was deposited by water from melting ice. In this report, the term is restricted to sand and gravel.

Till: A general term applied to all unsorted rock material (clay, sand, gravel, boulders) transported by glaciers and deposited directly on land or in the sea.

Water table: That water surface in an unconfined aquifer at which the pressure is atmospheric. Generally this is the upper surface of the zone of saturation, except where the surface is within a relatively impermeable rock type.

GLACIAL AQUIFERS

Big Sioux Aquifer

The Big Sioux aquifer (fig. 2) is composed of glacial outwash; primarily coarse sand and fine gravel. The aquifer is at or near land surface and is limited to the flood plain of the Big Sioux River. The average thickness of the aquifer is 22 ft. The thickness of the aquifer, shown in figure 2, is the total thickness of sand and gravel penetrated during test drilling. Reported discharge from wells screened in the aquifer ranged from 100 to 800 gal/min. A summary of the hydrologic characteristics of the aquifer is given in table 1.

Predominant chemical constituents in water from the aquifer are calcium and bicarbonate. Specific conductance, determined by onsite analyses, ranged from 600 to 1,200 mg/L (milligrams per liter) and averaged 850 mg/L. Hardness concentrations, determined by onsite analyses, ranged from 300 to 940 mg/L and averaged 520 mg/L. Water from the aquifer is used for domestic, municipal, stock, and irrigation purposes.

Pipestone Creek Aquifer

The Pipestone Creek aquifer (fig. 2) is composed of glacial outwash; primarily medium sand and coarse gravel. The average thickness of the aquifer is 30 ft. The depth to the top of the aquifer ranges from 2 to 60 ft below land surface. Reported discharge from wells screened in the aquifer ranged from 5 to 15 gal/min. A summary of the hydrologic characteristics is given in table 1.

Predominant chemical constituents in water from the aquifer are calcium and bicarbonate. Specific conductance, determined by onsite analyses, ranged from 550 to 2,360 umhos/cm (micromhos per centimeter at 25 degrees Celsius) and averaged 1,180 umhos/cm. Hardness concentration, determined by onsite analyses, ranged from 300 to 1,250 mg/L and averaged 600 mg/L. Water from the aquifer is used for domestic and stock purposes.

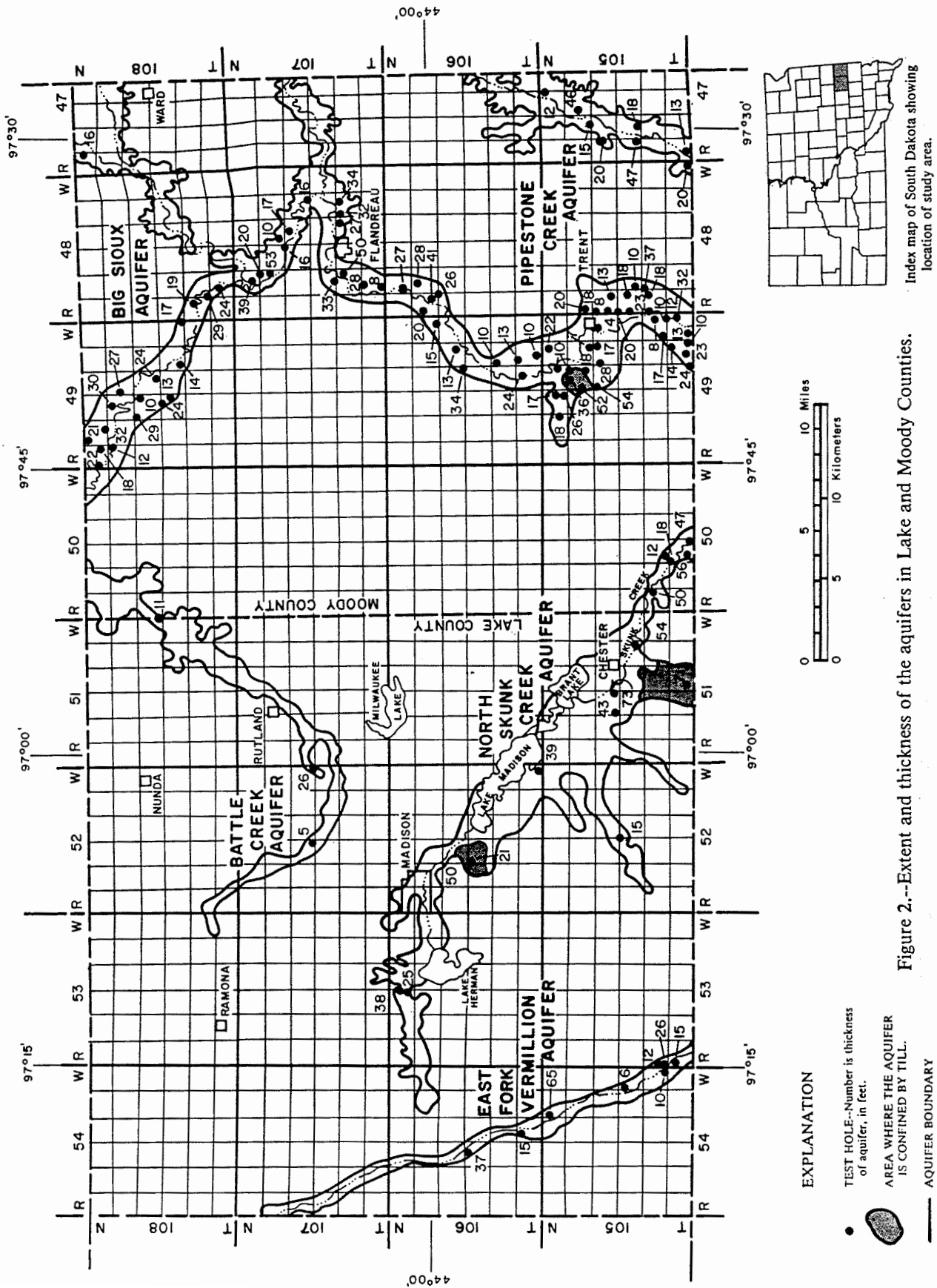


Figure 2.--Extent and thickness of the aquifers in Lake and Moody Counties.

- EXPLANATION**
- TEST HOLE--Number is thickness of aquifer, in feet.
 - ◐ AREA WHERE THE AQUIFER IS CONFINED BY TILL.
 - AQUIFER BOUNDARY

TABLE 1. Summary of the hydrologic characteristics of the major aquifers

Aquifer name	Areal extent (square miles)	Maximum thickness (feet)	Average thickness (feet)	Range in depth below land surface (feet)	Range of water level below land surface (feet)	Artesian (A) and (or) water table (WT) aquifer	Estimated quantity ^b of water in storage ^b (acre-feet)	Range of well yields ^c (gallons per minute)	Water suitable for irrigation ^d
GLACIAL AQUIFERS									
Big Sioux	58	54	22	0- 10	-0.5- 18	WT, A	163,000	100- 800	Yes
Pipestone Creek	12	47	30	0- 60	0- 15	WT	46,000	5- 15	Yes
North Skunk Creek	48	73	32	0- 60	4- 26	WT, A	196,000	100-1000	Yes
Battle Creek	19	26	14	0- 3	±0- 10	±WT	34,000	1- 3	No
East Fork Vermillion	9	±65	15	0- 3	12- 30	WT	15,000	30- 950	Yes
Howard	675	117	40	100- 470	6-190	A	3.5 million	5- 300	Yes
BEDROCK AQUIFERS									
Niobrara	693	180	85	200- 610	160-195	A	7.5 million	2- 5	No
Codell	630	70	60	600- 800	200-300	A	5.0 million	5- 75	No
Dakota	700	----	±400	±700-1000	±50-250	A	3.6 million	5- 20	No
Quartzite wash	291	210	73	100- 760	0-136	A	2.7 million	10- 20	Yes

a/ Reported data.

b/ Storage was estimated by multiplying average thickness by area extent and multiplying by specific yield of 0.2.

c/ Based on the South Dakota irrigation-water classification diagram (Koch, 1983).

d/ Based on data from Schoon, 1971.

North Skunk Creek Aquifer

The North Skunk Creek aquifer (fig. 2) is composed of glacial outwash; primarily medium to coarse sand and gravel, and is at or near land surface. The average thickness of the aquifer is 32 ft. Reported discharge from wells screened in the aquifer ranged from 100 to 1,000 gal/min. A summary of the hydrologic characteristics is given in table 1.

Predominant chemical constituents in water from the aquifer are calcium and bicarbonate. Specific conductance, determined by onsite analyses, ranged from 560 to 2,060 umhos/cm and averaged 1,250 umhos/cm. Hardness concentrations, determined by onsite analyses, ranged from 320 to 1,370 mg/L and averaged 710 mg/L. Water from the aquifer is used for domestic, municipal, stock, and irrigation purposes.

Battle Creek Aquifer

The Battle Creek aquifer (fig. 2) is composed of glacial outwash; primarily fine to medium sand, and mostly is at land surface. The average thickness of the aquifer is 14 ft. Reported discharge from wells screened in the aquifer ranged from 1 to 3 gal/min. A summary of the hydrologic characteristics is given in table 1.

Predominant chemical constituents in water from the aquifer are calcium, bicarbonate, and sulfate. Specific conductance, determined by onsite analyses, ranged from 610 to 2,300 umhos/cm and averaged 1,160 umhos/cm. Water from the aquifer is used primarily for livestock watering.

East Fork Vermillion Aquifer

The East Fork Vermillion aquifer (fig. 2) is composed of glacial outwash; primarily medium to coarse sand and medium gravel. The average thickness of the aquifer is 15 ft. Reported yields from wells screened in the aquifer ranged from 30 to 950 gal/min. A summary of the hydrologic characteristics of the aquifer is given in table 1.

Predominant chemical constituents in water from the aquifer are calcium, bicarbonate, and sulfate. Dissolved-solids concentrations in water from two wells sampled were 1,040 and 1,250 mg/L, and hardness concentrations were 680 and 840 mg/L. Water from the aquifer is used for domestic, stock, and irrigation purposes.

Howard Aquifer

The Howard aquifer (fig. 3) is composed of glacial outwash that ranges from a fine to medium sand in southeastern Moody County to a coarse sand and fine gravel in Lake and northern Moody Counties. The aquifer is 100 to 470 ft below land surface and is under artesian conditions. The average thickness of the aquifer is 40 ft. Reported discharge from wells screened in the aquifer ranged from 5 to 300 gal/min. A summary of the hydrologic characteristics is given in table 1.

Predominant chemical constituents in water from the aquifer are calcium and sulfate. Dissolved-solids concentrations in the water ranged from 960 to 5,520 mg/L and averaged 1,750 mg/L. The average specific conductance (determined by onsite field analyses) of water from the aquifer was 2,050 umhos/cm and the average hardness was 1,100 mg/L. Water from the aquifer is used for domestic, municipal, and stock supplies.

BEDROCK AQUIFERS

Bedrock aquifers in Lake and Moody Counties include the Niobrara, Codell, Dakota, and quartzite wash aquifers (fig. 4). The Niobrara, Codell, and Dakota are absent in southeastern Lake County and in the southern and eastern portion of Moody County. The quartzite wash aquifer (fig. 4) is present in southern Lake County and in eastern Moody County.

Niobrara Aquifer

The Niobrara aquifer in the Upper Cretaceous Niobrara Formation is a fractured, dark gray to white, calcareous chalk that contains numerous solution cavities. Fractures in the Niobrara have developed enough in the southwest quarter of Lake County to yield sufficient quantities of water for stock and domestic wells. The depth to the top of the aquifer ranges from 200 to 610 ft below land surface. The average thickness of the aquifer is 85 ft. Reported yields from wells screened in the aquifer ranged from 2 to 5 gal/min. A summary of the hydrologic characteristics of the aquifer is given in table 1.

Predominant chemical constituents in water from an observation well located in sec. 1, Township 105 North, Range 55 West were calcium, sodium, and sulfate. Dissolved-solids sulfate concentrations in water from the observation well was 1,840 mg/L, and hardness concentration was 850 mg/L. Water from the aquifer is used for domestic and stock supplies.

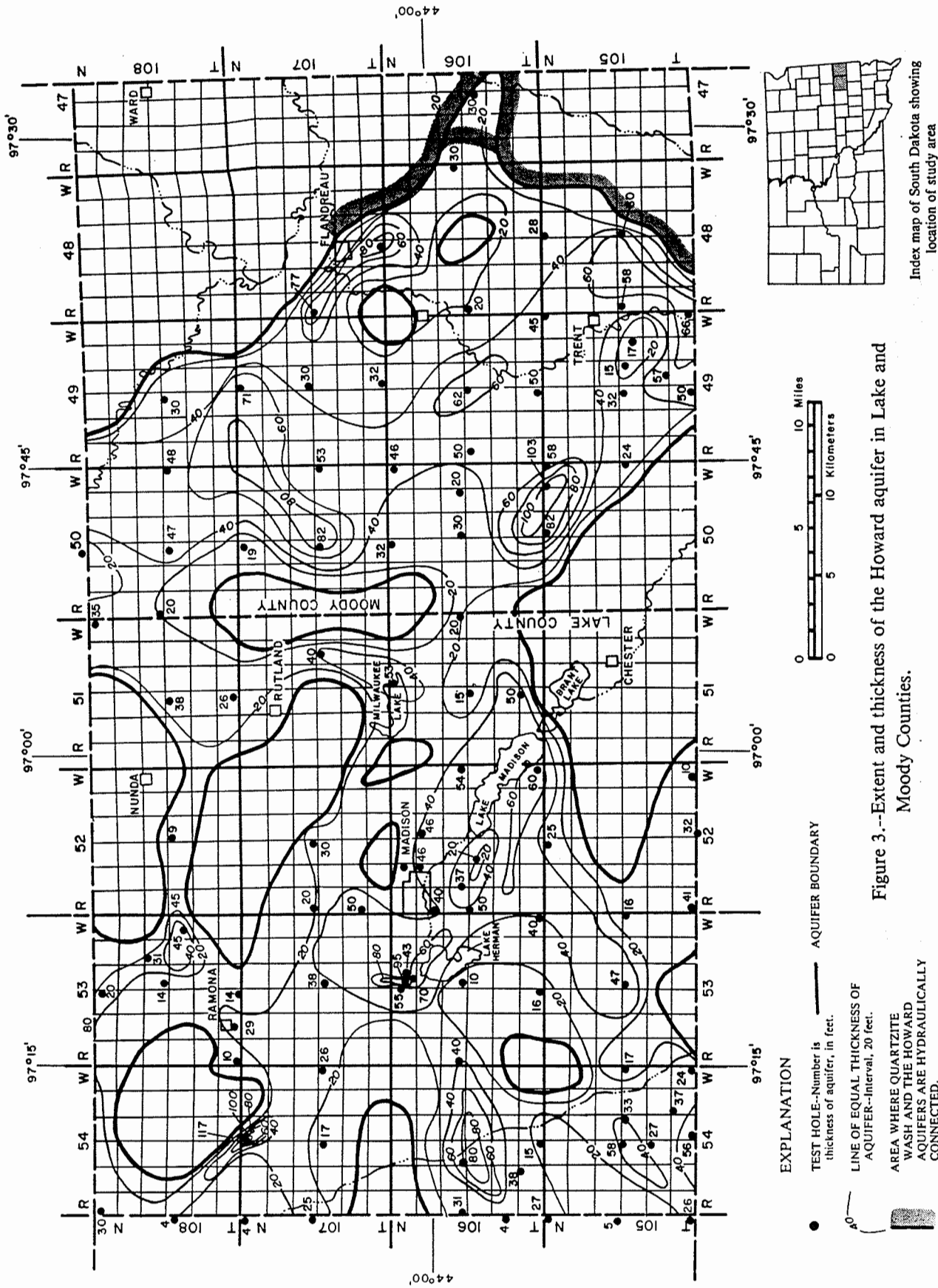
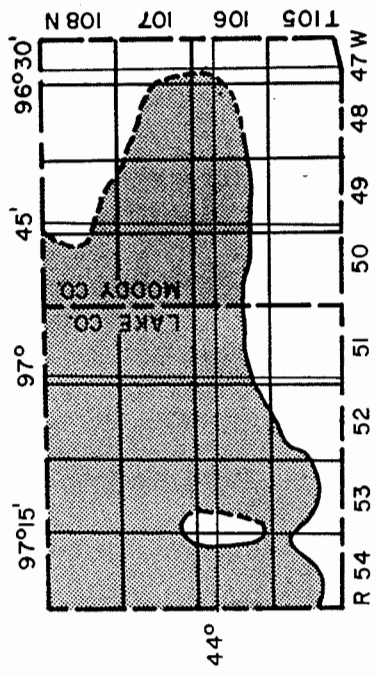


Figure 3.--Extent and thickness of the Howard aquifer in Lake and Moody Counties.

- EXPLANATION**
- TEST HOLE--Number is thickness of aquifer, in feet.
 - AQUIFER BOUNDARY
 - LINE OF EQUAL THICKNESS OF AQUIFER--Interval, 20 feet.
 - ▨ AREA WHERE QUARTZITE WASH AND THE HOWARD AQUIFERS ARE HYDRAULICALLY CONNECTED.





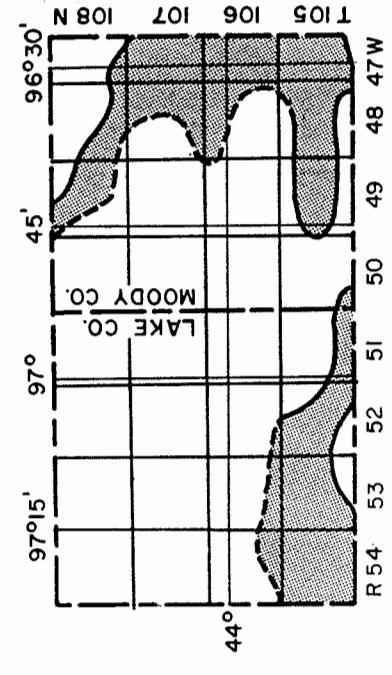
AQUIFER

NIORARA AQUIFER

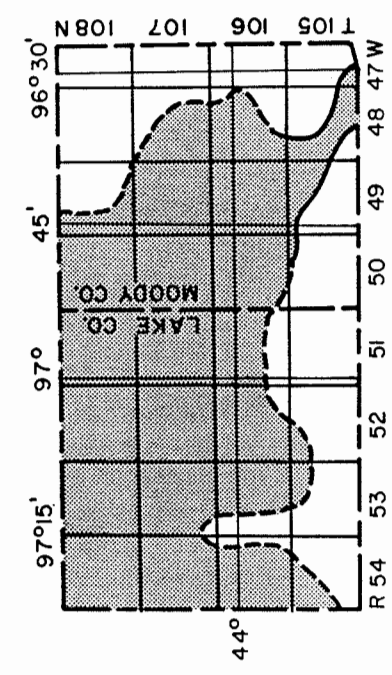
CODELL AQUIFER



 --- AQUIFER BOUNDARY --Dashed where approximately located.



DAKOTA AQUIFER



QUARTZITE WASH AQUIFER

Figure 4.--Extent of the bedrock aquifers in Lake and Moody Counties.

Codell Aquifer

The Codell aquifer in the Upper Cretaceous Codell Sandstone Member of the Carlile Shale is composed of white to yellow-brown medium sandstone. The top of the aquifer is about 800 ft below land surface in northern Lake County and is about 600 ft below land surface in southern Lake County. Reported yields from wells in the aquifer ranged from 5 to 75 gal/min. A summary of the hydrologic characteristics is given in table 1.

Predominant chemical constituents in water from the Codell aquifer are sodium and sulfate. Dissolved-solids concentrations ranged from 1,820 to 2,290 mg/L and averaged 1,970 mg/L. Hardness concentrations ranged from 120 to 1,400 mg/L and averaged 500 mg/L. The aquifer is the primary source of water for municipal, domestic, and stock use in northwestern Lake County.

Dakota Aquifer

The Dakota aquifer in the Cretaceous Dakota Formation is composed of a fine-grained, gray to brown sandstone that contains interbedded shale layers. The top of the aquifer is 700 to 1,000 ft below land surface. The depth to water below land surface in a domestic well in sec. 2, Township 106 North, Range 51 West was reported to be about 150 ft.

Predominant chemical constituents in water from this domestic well were sodium and sulfate. Dissolved-solids concentration was 2,210 mg/L, and hardness was 307 mg/L. Water from the aquifer is used for domestic and stock supplies.

Quartzite Wash Aquifer

The quartzite wash aquifer is composed of fine to coarse, angular to subrounded, pink, quartzose sand. The aquifer overlies the Precambrian Sioux Quartzite in southern Lake and eastern Moody Counties. The aquifer is interbedded with the Niobrara, Codell, and possibly, the Dakota aquifers in southern Lake County and eastern Moody County. The aquifer is 100 to 760 ft below land surface and has an average thickness of 73 ft. Reported yields from wells in the aquifer ranged from 10 to 20 gal/min. A summary of the hydrologic characteristics of the aquifer is given in table 1.

Predominant chemical constituents in water from the quartzite wash aquifer are calcium, sulfate, and bicarbonate. Dissolved-solids concentration ranged from 1,200 to 1,690 mg/L and averaged 1,420 mg/L. Hardness concentrations ranged from 560 to 920 mg/L and averaged 740 mg/L. Water from the aquifer is used for domestic and stock supplies.

REFERENCES

- Koch, N. C., 1983, Irrigation-water classification diagram for South Dakota: South Dakota Academy of Science Proceedings, v. 62, p. 107-114.
- Schoon, R. A., 1971, Geology and hydrology of the Dakota Formation in South Dakota: South Dakota Geological Survey Report of Investigations no. 104, 55 p.