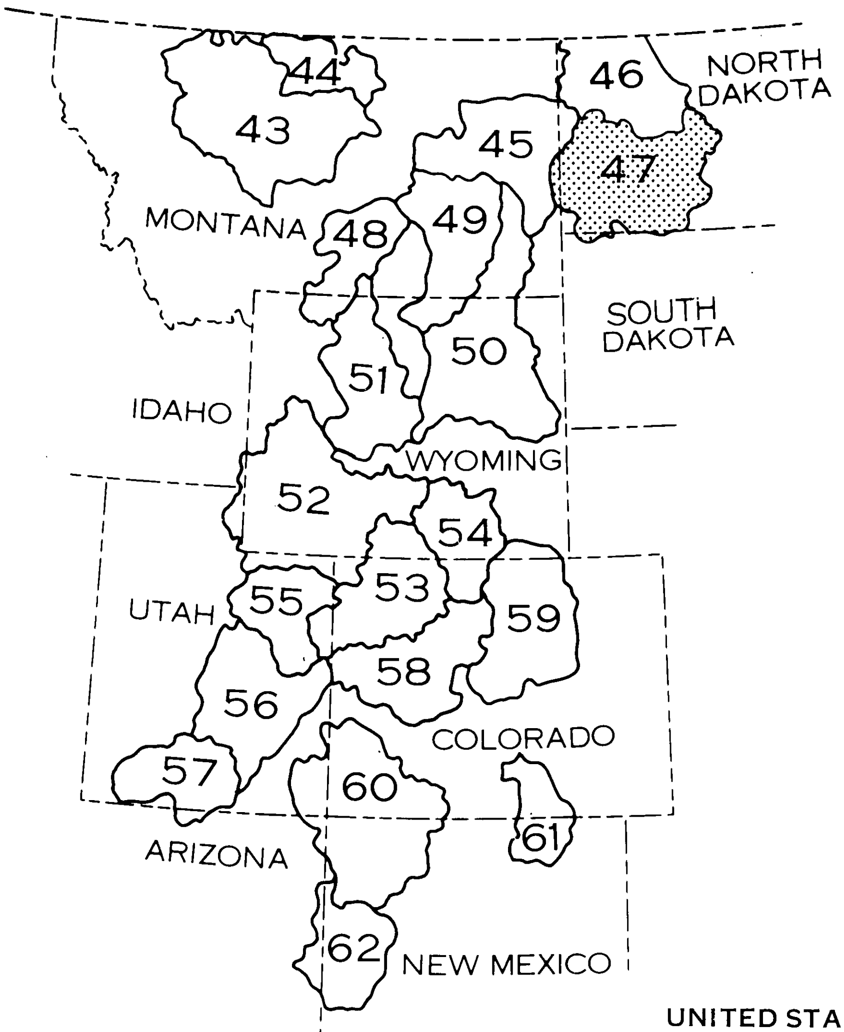
HYDROLOGY OF AREA 47, NORTHERN GREAT PLAINS AND ROCKY MOUNTAIN COAL PROVINCES, NORTH DAKOTA, SOUTH DAKOTA, AND MONTANA



- MISSOURI RIVER
- KNIFE RIVER
- HEART RIVER
- CANNONBALL RIVER
- NORTH FORK GRAND RIVER
- LITTLE MISSOURI RIVER
- CEDAR CREEK

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS
OPEN-FILE REPORT 83-221

HYDROLOGY OF AREA 47, NORTHERN GREAT PLAINS AND ROCKY MOUNTAIN COAL PROVINCES, NORTH DAKOTA, SOUTH DAKOTA, AND MONTANA

BY
ORLO A. CROSBY AND ROBERT L. KLAUSING

U.S. GEOLOGICAL SURVEY

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OPEN-FILE REPORT 83-221

BISMARCK, NORTH DAKOTA
MAY 1984

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, *SECRETARY*

GEOLOGICAL SURVEY

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CONTENTS

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For the convenience of readers who may want to use the International System of Units (SI), the data may be converted by using the following factors:

Multiply	By	To obtain
Acre	4,047	square meter
Acre-foot	1,233	cubic meter
Acre-foot per square mile	476.2	cubic meter per square kilometer
Cubic foot	0.02832	cubic meter
Cubic foot per second	0.02832	cubic meter per second
Cubic foot per second per square mile	0.01093	cubic meter per second per square kilometer
Foot	0.3048	meter
Foot per mile	0.1894	meter per kilometer
Gallon	3.785	liter
Gallon per minute	0.06309	liter per second
Gallon per second	3.785	liter per second
Inch	25.40	millimeter
Inch per hour	25.40 2.54	millimeter per hour centimeter per hour
Mile	1.609	kilometer
Million gallons per day	0.04381 3,785	cubic meters per second cubic meters per day
Square mile	2.590	square kilometer
Ton (short, 2,000 pounds)	0.9072	metric ton

$$°C = (°F - 32) \times 5/9$$

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

1.0 INTRODUCTION
1.1 Objective

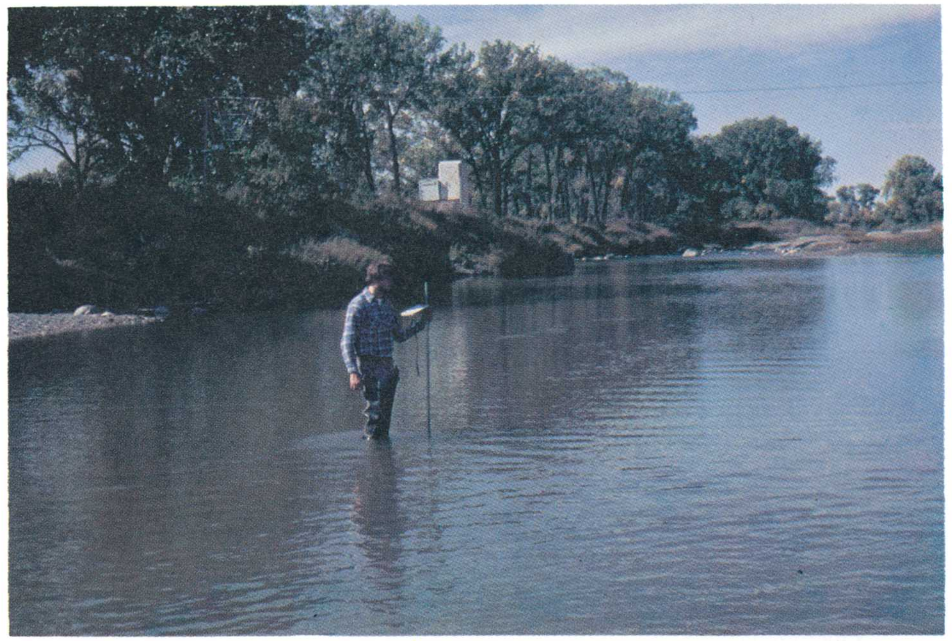
Report Summarizes Available Hydrologic Information

Existing hydrologic conditions and sources of information are identified to aid leasing decisions and preparation and appraisal of environmental impact studies and mine-permit applications.

Hydrologic information (fig. 1.1-1) and analyses are necessary to aid in decisions to lease federally owned coal and for the preparation of the required environmental assessments and the impact study reports. The need for information and analysis has become even more critical with the enactment of Public Law 95-87, the "Surface Mining Control and Reclamation Act of 1977." This act requires an appropriate regulatory agency to issue mining permits based on the review of permit-application data supplied to assess hydrologic impacts. The need for data is partly fulfilled by this report, which generally characterizes the hydrology of a part of the Northern Great Plains Coal Province (Area 47). This report is one of a series that describes coal provinces nationwide.

General hydrologic information for Area 47 is provided by means of a brief text with accompanying map, chart, graph, or other illustrations for each of a series of water-resources-related topics. The topical discussions of the report provide a description of the hydrology of the area. The information contained herein will be useful to Federal agencies in the leasing and management of Federal coal lands; surface-mine owners, operators, and others preparing permit applications; and regulatory authorities evaluating the adequacy of the applications.

The hydrologic information presented herein or available through sources identified in this report will be useful in describing the hydrology of the "general area" of any proposed mine. This hydrologic information may be supplemented by specific-site data as well as data from other sources to provide a detailed appraisal of the hydrology of the area in the vicinity of the mine and the anticipated hydrologic consequences of the mining operation.



A. Will development change stream discharge?

B. What will happen to water quality?

C. Where are the aquifers?

D. Is there adequate ground water?

E. Will acid precipitation be a problem?

FIGURE 1.1-1—Hydrologic information is needed for decision making.

Area 47 Includes Parts of North Dakota, South Dakota, and Montana

Area 47 is in the Williston structural basin predominantly in southwestern North Dakota.

Area 47 is one of the subareas of the Northern Great Plains Coal Province (see front cover for area of the Northern Great Plains and Rocky Mountain Coal Provinces). It is in the Williston structural basin. The center of the basin is in the northwestern part of the area. The area is mostly in southwestern North Dakota but includes small parts of eastern Montana and northern South Dakota (figure 1.2-1). The area includes 19,400 square miles in all or part of Adams, Billings, Bowman, Burleigh, Dunn, Golden Valley, Grant, Hettinger, McKenzie, McLean, Mercer, Morton, Oliver, Sheridan, Sioux, Slope, and Stark Counties, North Dakota; Fallon and Wibaux Counties, Montana; and Corson, Harding, and Perkins Counties, South Dakota.

The area is drained by the Missouri River and its tributaries. The north-central border is defined by Lake Sakakawea and the southeastern border is defined by the Missouri River and Lake Oahe. The study area is composed of drainage basins or parts of basins based on the surface-water hydrology.

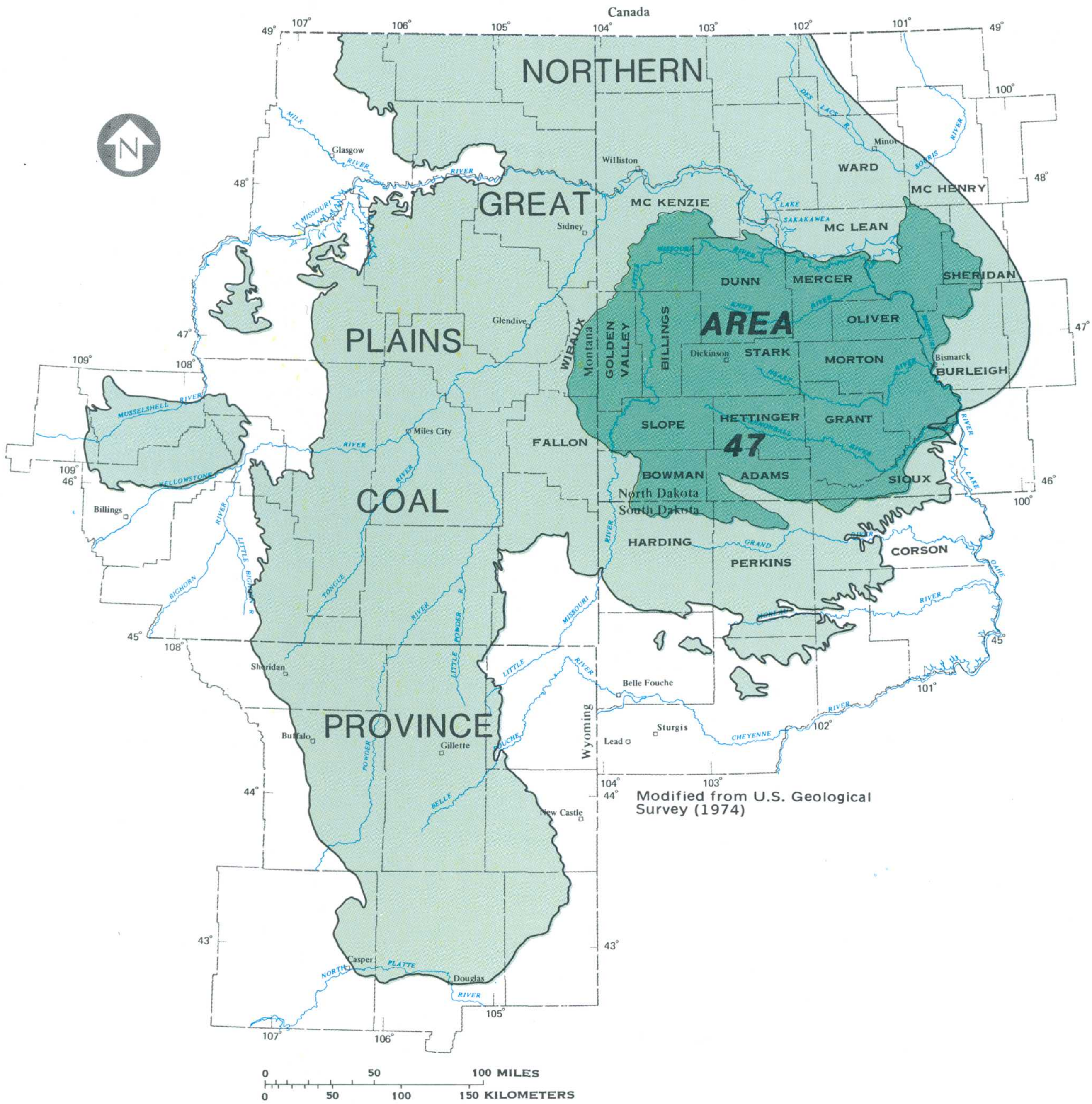


FIGURE 1.2-1—Location of study area.

Hydrologic Problems Described for Area 47

Some of the more obvious problems related to coal development include destruction of aquifers and potential contamination of aquifers, streams, and the atmosphere.

Many hydrologic problems (fig. 1.3-1) are related to coal development; some are common to all sites and some are unique, some are temporary and localized, and some are permanent and widespread. Probably the most obvious problem will be the destruction of aquifers in the coal beds and the overlying materials. Most farmsteads in Area 47 rely on shallow ground-water sources for domestic and, in some instances, livestock supplies. After these aquifers have been destroyed by mining, alternative sources of water need to be found, usually by developing deeper aquifers.

Degradation of water quality in the immediate vicinity of mining operations has been typified by large concentrations of sulfate and dissolved solids. Adequate safeguards need to be taken to minimize or prevent contamination of the underlying bedrock aquifers and adjacent alluvial and buried glacial aquifers (fig. 1.3-1). These latter aquifers generally are recharged by seepage from the bedrock or by streams draining the bedrock areas.

Coal development can decrease streamflow, increase dissolved chemical constituents in the streams, or increase sediment loads, all of which adversely affect the utility of the water (fig. 1.3-1).

One of the major deficiencies in the understanding of hydrologic problems is in the field of precipitation chemistry. However, in recent years there has been significant documentation of deterioration in the quality of atmospheric precipitation, most notably acidic rain and snow.

Because the hydrology of a given mine site or coal-conversion unit is unique, a general statement of the problems is impossible and conditions need to be evaluated for each location of concern.

A. Uneven subsidence decreases runoff, increases infiltration, and limits iand use.

B. Important glacial-drift aquifers generally underlie the alluvial valleys.

C. Atmospheric emissions from coal development can change the chemistry of precipitation and surface water.

D. Unreclaimed spoils change runoff patterns, increase infiltration, increase sediment loads, and alter water chemistry.

FIGURE 1.3-1—Hydrologic problems can result from coal development.

2.0 DEFINITION OF TERMS

Terms Used in Hydrologic Reports Defined

Technical terms that occur in this hydrologic report are defined.

Acre-foot - the quantity of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or about 326,000 gallons.

Aquifer - an aquifer is a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield a significant quantity of water to wells and springs.

Cubic foot per second - the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to approximately 7.48 gallons per second or 449 gallons per minute.

Cubic foot per second per square mile - the average number of cubic feet of water flowing per second from each square mile of area drained, assuming that the runoff is distributed uniformly in time and area.

Discharge - the volume of water (or more broadly, volume of fluid plus suspended material), that passes a given point within a given period of time.

Dissolved - refers to the quantity of substance present in true chemical solution. In practice, however, the term includes all forms of substance that will pass through a 0.45-micrometer membrane filter and thus may include some very small (colloidal) suspended particles.

Drainage area - drainage area of a stream at a specific location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river or stream upgradient from the specified point. Figures of drainage area given herein include all closed basins, or noncontributing areas within the area, unless otherwise noted.

Drainage basin - a part of the surface of the Earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Gaging station - a particular site on a stream, canal, lake, or reservoir where systematic observations of hydraulic data are obtained.

Hydrologic unit - a geographic area representing part or all of a surface drainage basin as delineated by the U.S. Geological Survey, Office of Water Data Coordination, on the State Hydrologic Unit Maps; each hydrologic unit is identified by an eight-digit number.

Instantaneous discharge - the discharge at a particular instant of time.

Mean discharge - the arithmetic mean of individual daily mean discharges during a specific period.

Micrograms per liter - a unit expressing the concentration of chemical constituents in solution as mass (micrograms) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter.

Milligrams per liter - a unit for expressing the concentration of chemical constituents in solution. Milligrams per liter represent the mass of solute per unit volume (liter) of water. In dilute solutions 1 milligram per liter is equivalent to 1 part per million.

National Geodetic Vertical Datum of 1929 (NGVD of 1929) - a geodetic datum derived from a general adjustment of the first order level nets of both the United States and Canada, formerly called mean sea level.

pH - indicates the degree of acidity or alkalinity of water and is expressed in terms of pH units. The pH value of a solution is the negative logarithm of the concentration of hydrogen ions, in moles per liter. A pH of 7.0 indicates that the water is neither acid nor alkaline. Values of pH progressively less than 7.0 denote increasing acidity and those progressively greater than 7.0 denote increasing alkalinity. A pH change from 7.0 to 6.0 corresponds to a tenfold increase in acidity and a pH change from 6.0 to 5.0 corresponds to a hundredfold increase in acidity.

The pH of most natural surface waters ranges between 6 and 8.

Sediment - solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water; it includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are affected by environmental factors. Some major factors are degree of slope, length of slope, soil characteristics, land use, and quantity and intensity of precipitation.

Streamflow - the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Stream order - a method of numbering streams as part of a drainage-basin network. The smallest unbranched mapped tributary is called first order, the stream receiving the tributary is called second order, and so on.

Area 47 Includes Two Physiographic Sections

Land surface is characterized by wide flat alluvial valleys, rolling uplands, and highly dissected badlands.

The study area is in the Great Plains physiographic province and is divided into two physiographic sections (fig. 3.1-1). The two sections are the glaciated and unglaciated parts of the Missouri Plateau (Fenneman, 1946).

The glaciated Missouri Plateau is an area of glacially modified bedrock topography. Glacial drift still overlies much of the area north of the Knife River and northeast of Square Butte Creek. South of these areas glacial drift occurs only as erosional remnants on the uplands and as valley fill in the major drainages and associated diversion channels. The topography is characterized by relatively wide flat alluvial valleys, rolling prairie, and low to moderately high hills. The local relief ranges from about 20 feet to as much as 560 feet.

The unglaciated Missouri Plateau, which lies south and west of the limit of glaciation, is comprised of an eroded bedrock surface. The topography varies from gently rolling uplands with scattered high buttes to highly dissected badlands. Local relief ranges from a few tens of feet to as much as 500 feet.

The maximum relief in the study area is about 2,000 feet. The altitude of the highest point is 3,602 feet at Table Mountain in northwestern Harding County, South Dakota, and the lowest point is approximately 1,610 feet on the Missouri River flood plain in the vicinity of the mouth of the Cannonball River in Sioux County, North Dakota.

The population of the area is about 110,000 (U.S. Bureau of the Census, 1981). Cities in the study area with populations of more than 5,000 are Bismarck, Dickinson, and Mandan.

FIGURE 3.1-1—Physiographic divisions.

Missouri River Drains Area 47

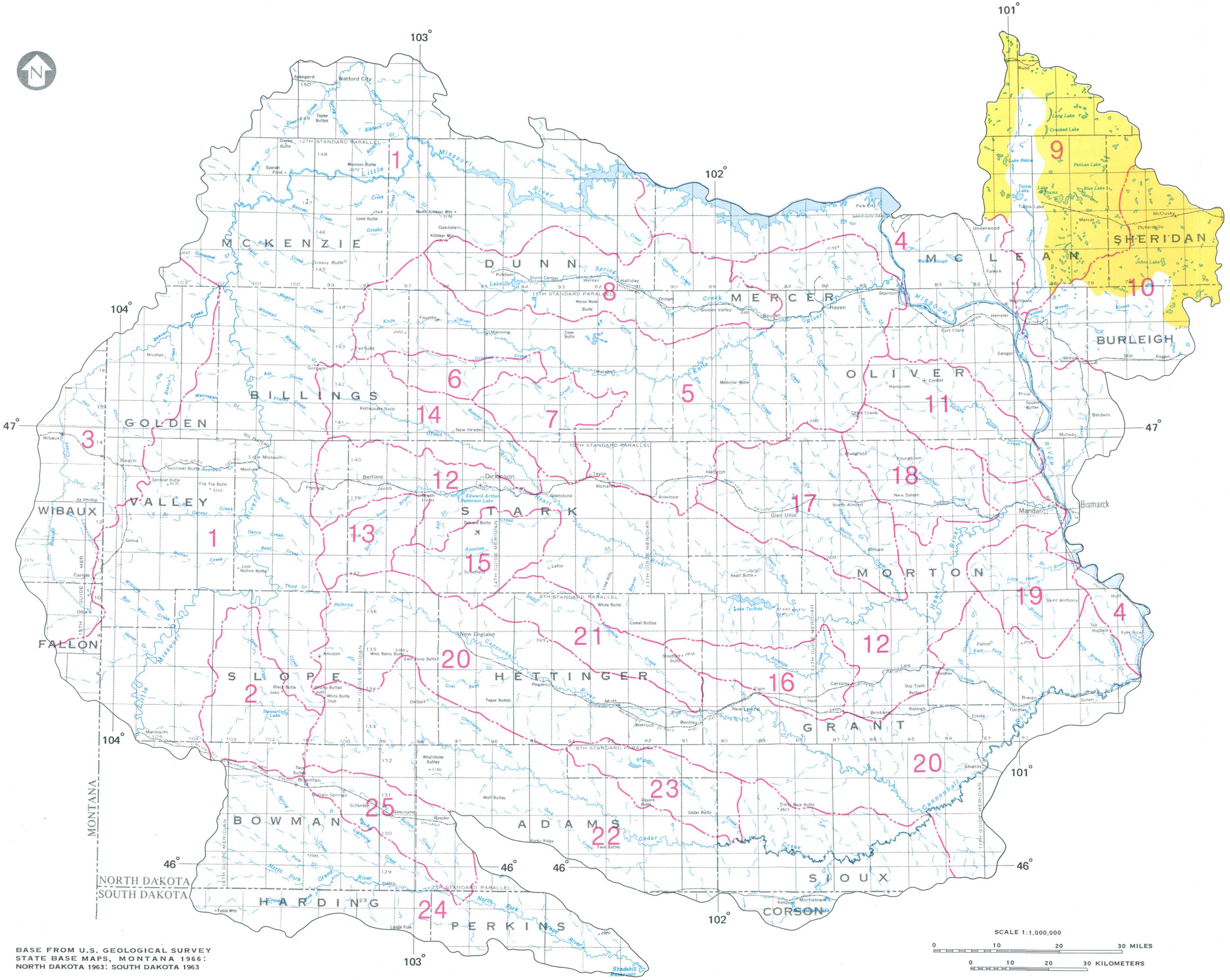
Most of the tributaries of the Missouri River in Area 47 drain areas with known coal reserves.

Area 47 is drained by the Missouri River and several of its major tributaries. The major tributaries draining the area are the Little Missouri, Knife, Heart, Little Heart, Cannonball, and North Fork Grand Rivers, and Turtle, Square Butte, and Painted Woods Creeks. The drainage boundaries of the streams and some lower-order tributaries important to coal development are shown in figure 3.2-1. Drainage areas for specific sites on streams are given in Supplementary Information (section 11.1).

The Little Missouri River is the only stream other than the Missouri River with its headwaters outside Area 47. The Little Missouri River originates in Wyoming and drains about one-half its total drainage before crossing into Area 47.

The drainage basins of Turtle Creek and Painted Woods Creek include large areas considered noncontributing to the streamflow. The noncontributing areas contain numerous undrained lakes and prairie potholes and have no developed stream system.

All tributaries of the Missouri River shown in figure 3.2-1, except Turtle Creek, drain areas with known coal reserves. Most of the current development of the coal reserves has taken place at the upper ends of the basins or along interbasin divides.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, MONTANA 1966; NORTH DAKOTA 1963; SOUTH DAKOTA 1963

EXPLANATION

NONCONTRIBUTING AREA

BASIN BOUNDARY

DRAINAGE BASINS

1. Little Missouri River (main stem)
2. Deep Creek
3. Beaver Creek
4. Missouri River (main stem)
5. Knife River (main stem)
6. Crooked Creek
7. Deep River
8. Spring Creek
9. Turtle Creek
10. Painted Woods Creek
11. Square Butte Creek
12. Heart River (main stem)
13. South Branch Heart River
14. Green River
15. Antelope Creek (upper Heart River)
16. Antelope Creek (lower Heart River)
17. Big Muddy Creek
18. Sweetbriar Creek
19. Little Heart River
20. Cannonball River (main stem)
21. Thirty Mile Creek
22. Cedar Creek
23. Timber Creek
24. North Fork Grand River (main stem)
25. Buffalo Creek

FIGURE 3.2-1—Drainage basins.

Rocks of Paleocene Age the Dominant Bedrock

Lignite-bearing rocks of the Paleocene Fort Union Formation underlie about 95 percent of Area 47.

All of Area 47 lies within the approximately oval Williston basin. The axis of the basin is oriented north-northwest to south-southeast with the deepest part in eastern McKenzie County, North Dakota. The total thickness of the sedimentary rocks at this location is about 15,000 feet. The regional dip is about 10 to 20 feet per mile, but may vary depending on local structure. Dip along the western flank of the Cedar Creek anticline in southwestern Bowman County is as much as 100 feet per mile (Croft, 1978).

The basin was subjected to periodic advances of the sea from Cambrian through early Paleocene. During periods of submergence, sediments of marine origin were deposited; between and following the advances of the sea, continental deposits were laid down. After the final recession of the sea, western North Dakota became a humid lowland with shallow lakes and densely vegetated and forested swamps. The organic debris that accumulated in the swamps during long periods of time were converted by partial decomposition to peat, which was subsequently buried by alluvial deposits. The cycle of vegetative growth, accumulation of organic debris, and burial was repeated many times. As burial continued, the peat was eventually converted to lignite.

The oldest formations exposed in Area 47 are the Pierre Shale and the overlying marine Fox Hills Sandstone. The outcrops occur along the downstream reach of the Cannonball River. The Pierre Shale is a very narrow surface exposure along the river and does not show on the generalized bedrock map (fig. 3.3.1-1). The Fox Hills Sandstone generally is considered the deepest formation that will yield fresh water. It consists of sandstone and interbedded siltstone, shale, and sandy shale. Overlying the Fox Hills Sandstone is the continental Hell Creek Formation. The Hell Creek crops out along the Missouri and Cannonball Rivers in the southeastern part of the area and along the North Fork Grand and Little Missouri Rivers in the southwestern part of the area. The Hell Creek Formation is composed of interbedded sandstone, claystone, and lignitic shale.

Rocks of the Paleocene Fort Union Formation underlie about 95 percent of the study area (fig. 3.3.1-1), and consist of four members: Ludlow, Cannonball, Tongue River, and Sentinel Butte. The Ludlow and Cannonball Members crop out along the eastern, southern, and southwestern parts of the area. The continental Ludlow Member consists of poorly consolidated sandstone and lignitic shale. The Cannonball Member consists of marine sandstone and mudstone. The Cannonball is underlain by the Ludlow Member throughout the east and central parts of the area and the two members interfinger to the west.

The minable lignite deposits occur in the Tongue River and Sentinel Butte Members, which underlie about 70 percent of the study area. Approximately 70 percent of the Tongue River-Sentinel Butte section is siltstone and claystone, 24 percent is sandstone, and 6 percent is lignite (Clayton, 1972, fig. R2).

Rocks of Eocene, Oligocene, and Miocene age crop out in steep-sided buttes and on the crests of high ridges in the west-central part of the area. Erosion of the post-Paleocene deposits followed the uplift of the mountain ranges in Montana and Wyoming.

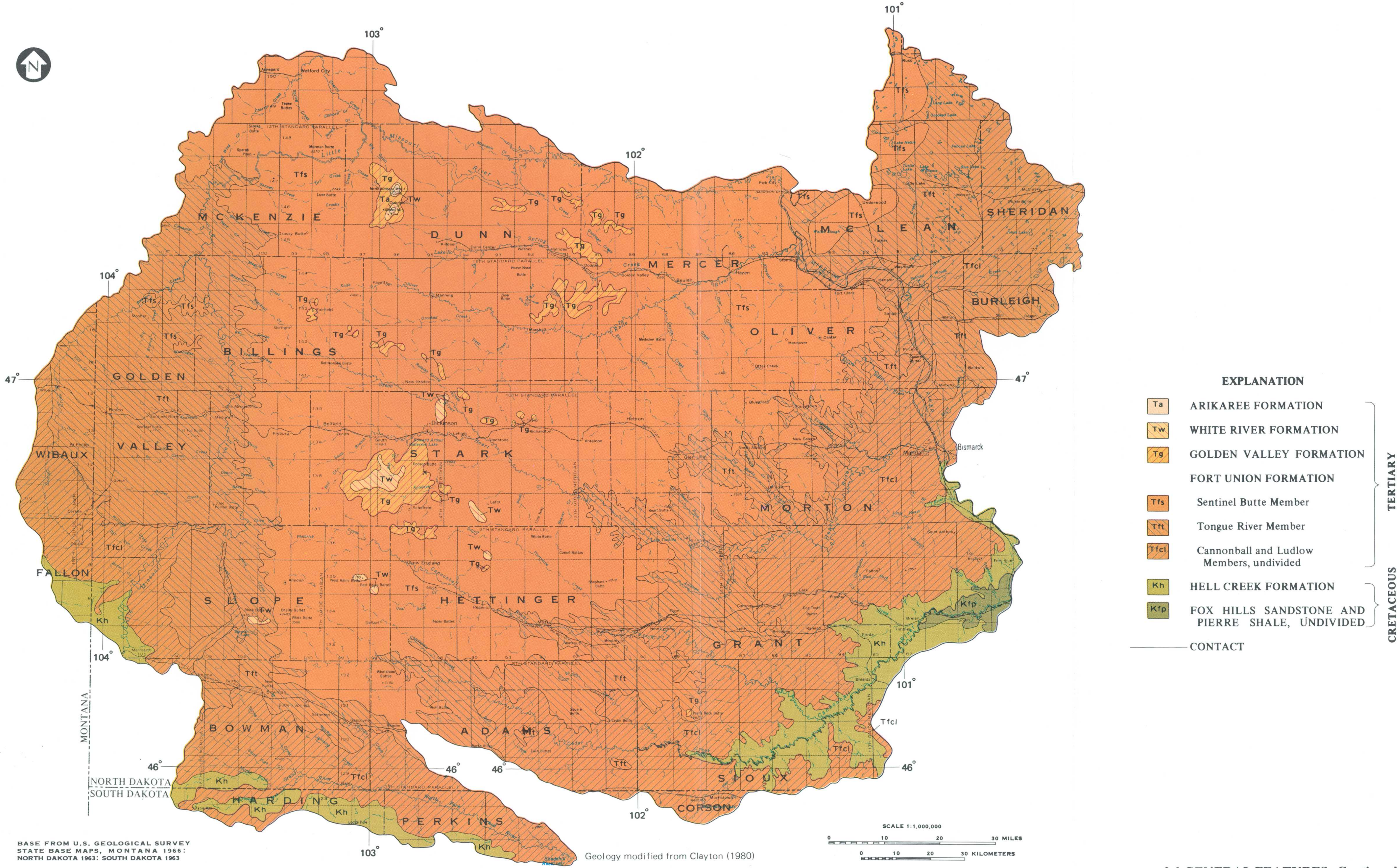


FIGURE 3.3.1-1—Generalized bedrock geology.

Unconsolidated Deposits of the Quaternary System Overlie Part of the Paleocene Bedrock

Glacial drift of late Pleistocene age overlies the Paleocene bedrock in the northern part of the study area, and alluvium and other deposits of Holocene age locally overlie the bedrock elsewhere.

The Quaternary system includes glacial deposits and all postglacial deposits. The glacial deposits cover the northern and northeastern parts of Area 47 (fig. 3.3.2-1). The southwestern extent of glaciation occurs in the study area and the southwestern two-thirds of the area probably was unglaciated.

The northeastern part of the study area was subjected to at least four glacial advances during late Pleistocene time. The first glacial advance extended into the area south and west of the present Missouri River. The glacial drift in this area is thin and patchy owing to proglacial and postglacial erosion. The orientation of the drift border and the ice-marginal melt-water channel indicates that this first glacier advanced from the northeast. Subsequent glacial advances from the northeast extended only into the areas north and east of the Missouri River.

As the first glacier advanced toward the study area, it blocked the north- and east-flowing streams, reversed the gradient, and diverted them to the east and southeast. Sediment, chiefly sand and gravel, was deposited in the existing and newly eroded stream valleys by large volumes of water flowing from the intermittently melting glacial ice. These stream valleys were eventually buried as the glacier continued to advance to its southwestern limit, where it became stagnant. The cycle of diversion, erosion, deposition, and burial was repeated during each glacial advance.

The primary sediments deposited by the glaciers are glacial till and glaciofluvial deposits. Glacial till is an unsorted mixture of clay, silt, sand, gravel, and boulders. Glacial till in the area ranges in thickness from 0 to as much as 600 feet. Glaciofluvial deposits include surficial outwash deposits and melt-water channel deposits, consisting of water-washed clastic material ranging in size from silt to very coarse gravel, and lenses of sand and gravel in the till. The glaciofluvial deposits are variable in thickness, but are known to have aggregate thicknesses of as much as 300 feet.

Postglacial deposits consist of alluvium and windblown sand. Alluvium, consisting of clay, silt, sand, and gravel, occurs in channels and as flood plains of present-day streams. The alluvial sediments, which are as much as 40 feet thick, frequently are composed of reworked outwash. Windblown silt and sand derived from alluvial, glacial, and weathered bedrock deposits is more extensive than shown in figure 3.3.2-1, but has not been adequately mapped.

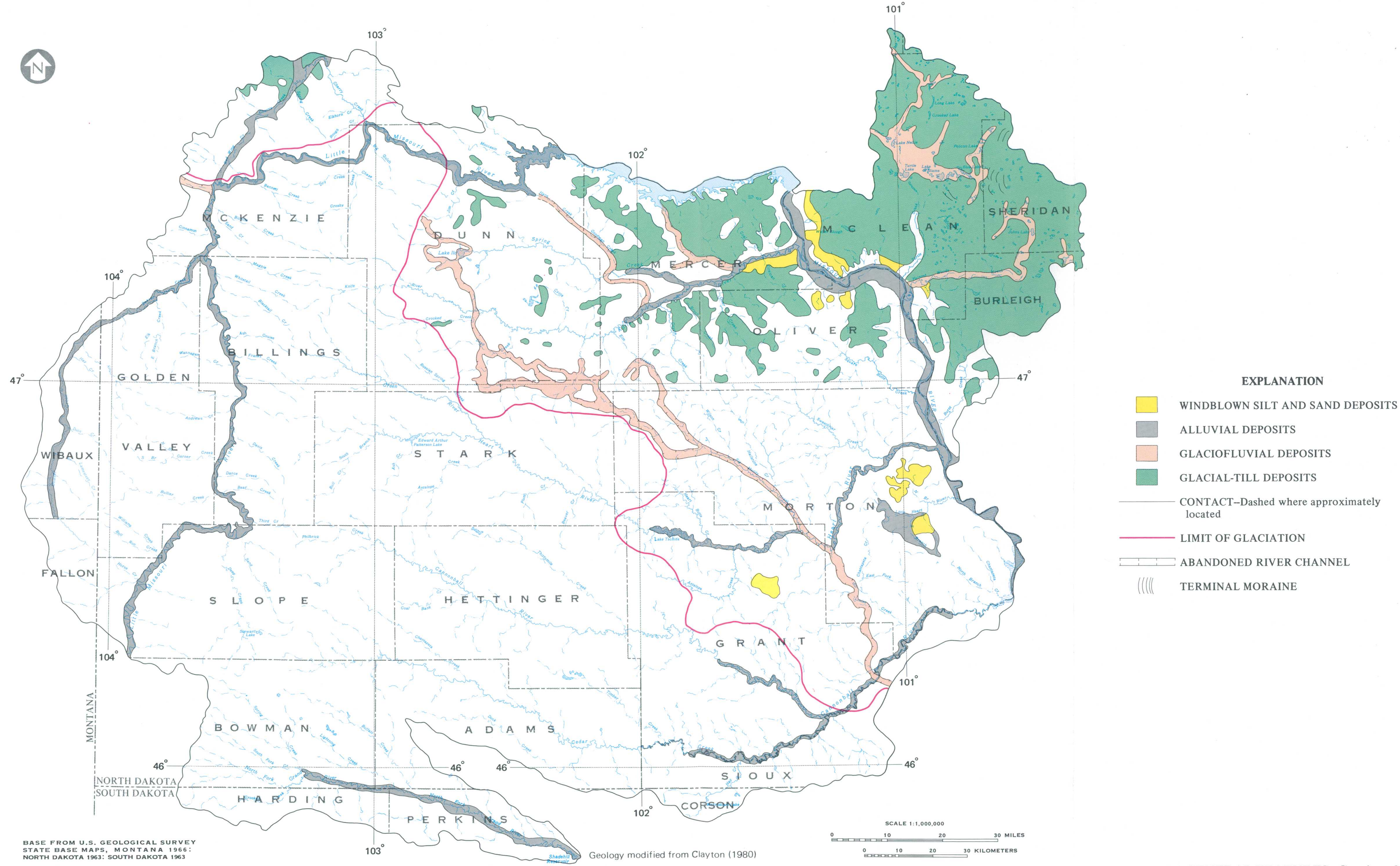


FIGURE 3.3.2-1—Glacial and alluvial geology.

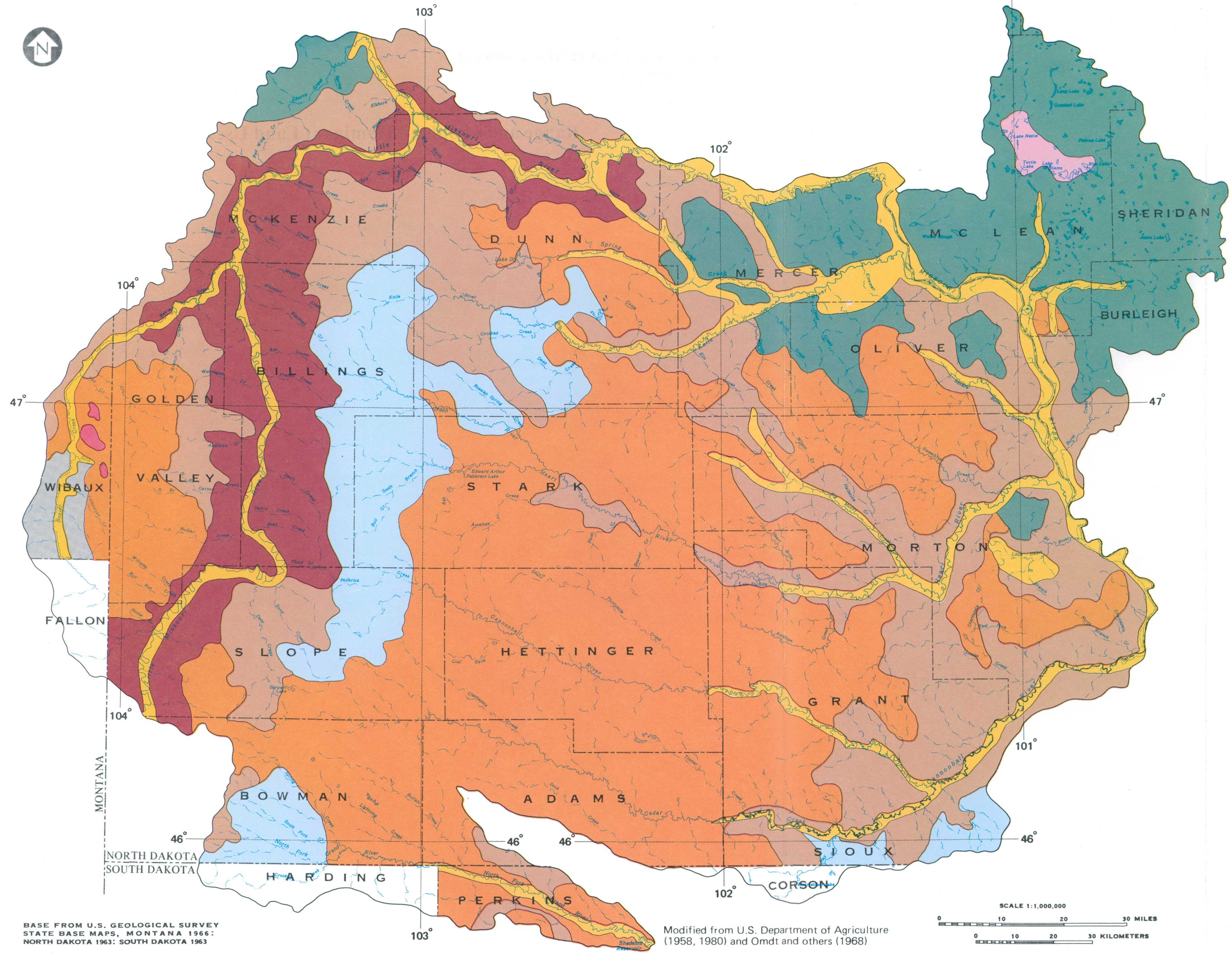
Soil Data Have Been Collected for Most of Area 47

Soils are slowly to rapidly permeable, alkaline, and subject to wind and water erosion.

Soil permeabilities range from 0.05 to greater than 5 inches per hour. Soils are slightly acidic to significantly alkaline, but most have slight to moderate alkalinity. The productivity of the soils varies from poor to very good, but most soils are moderately productive. Water erosion is a problem on steep slopes, and wind erosion is severe on cultivated land that is left bare of vegetation.

Most of the soils in the southern and eastern part of the area were developed from the shale, siltstone, and sandstone that comprise the underlying Cretaceous and Tertiary bedrock. Soils developed from glacial outwash and glacial till are present in the northeastern part of the area. Soils developed from Pleistocene and Holocene alluvium and terrace deposits are predominant in stream valleys.

A general description of the soil associations is shown in figure 3.4-1. The description was obtained from the general soils maps of North Dakota and parts of South Dakota and Montana. Information on the soils of Corson and Harding Counties, South Dakota, and Fallon County, Montana, was not available. Information pertaining to the physical properties of the soils and detailed soils maps of most of the counties in the area are published by the U.S. Department of Agriculture, Soil Conservation Service.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, MONTANA 1966; NORTH DAKOTA 1963; SOUTH DAKOTA 1963

Modified from U.S. Department of Agriculture (1958, 1980) and Omdt and others (1968)

EXPLANATION

SOILS DEVELOPED FROM HOLOCENE AND PLEISTOCENE ALLUVIUM

Havre-Banks, Savage-Wade-Farland, Farland-Savage-Harlem, Parshall-Liher: grayish brown to very dark brown silty clay and silt loams to sandy loams; nearly level to rolling

SOILS DEVELOPED FROM GLACIAL OUTWASH

Oahe-Sioux: dark gray loam to black gravelly loam; gravel substrata; rolling to strongly sloping

SOILS DEVELOPED FROM GLACIAL TILL

Williams, Agar-Williams-Zahl, Zahl-Williams, Barnes-Svea, Barnes-Buce: very dark brown loam and silty loam to black loam; nearly level to hilly

SOILS DEVELOPED PRIMARILY FROM TERTIARY AND CRETACEOUS SANDSTONE, SILTSTONE, AND SHALE

Chama-Morton-Bainville, Morton, Morton-Regent, Morton-Rhoades, Morton-Arnegard, Morton-Williams: very dark grayish brown silt loams; nearly level to hilly

Bainville-Flasher-Agar, Bainville-Morton, Bainville-Rhoades, Flasher-Vebar: dark grayish brown silt loam to dark grayish brown fine sandy loam; hilly to steep

Rhoades-Morton: very dark grayish brown silt loam; saline with segregated salts; gently rolling to strongly rolling

Badlands-Bainville: dark grayish brown silt loam on crests and upper slopes of drainage divides, slopes of drainage divides, steep barren slopes; steep to rough

Wibaux-Morton-Chama-Bainville-Searing: dark reddish brown stony loam; baked clay substrata; strongly rolling to rough

Moreau-Midway-Regent: grayish brown silty clay loam; gently rolling to steep

NO DATA

CONTACT

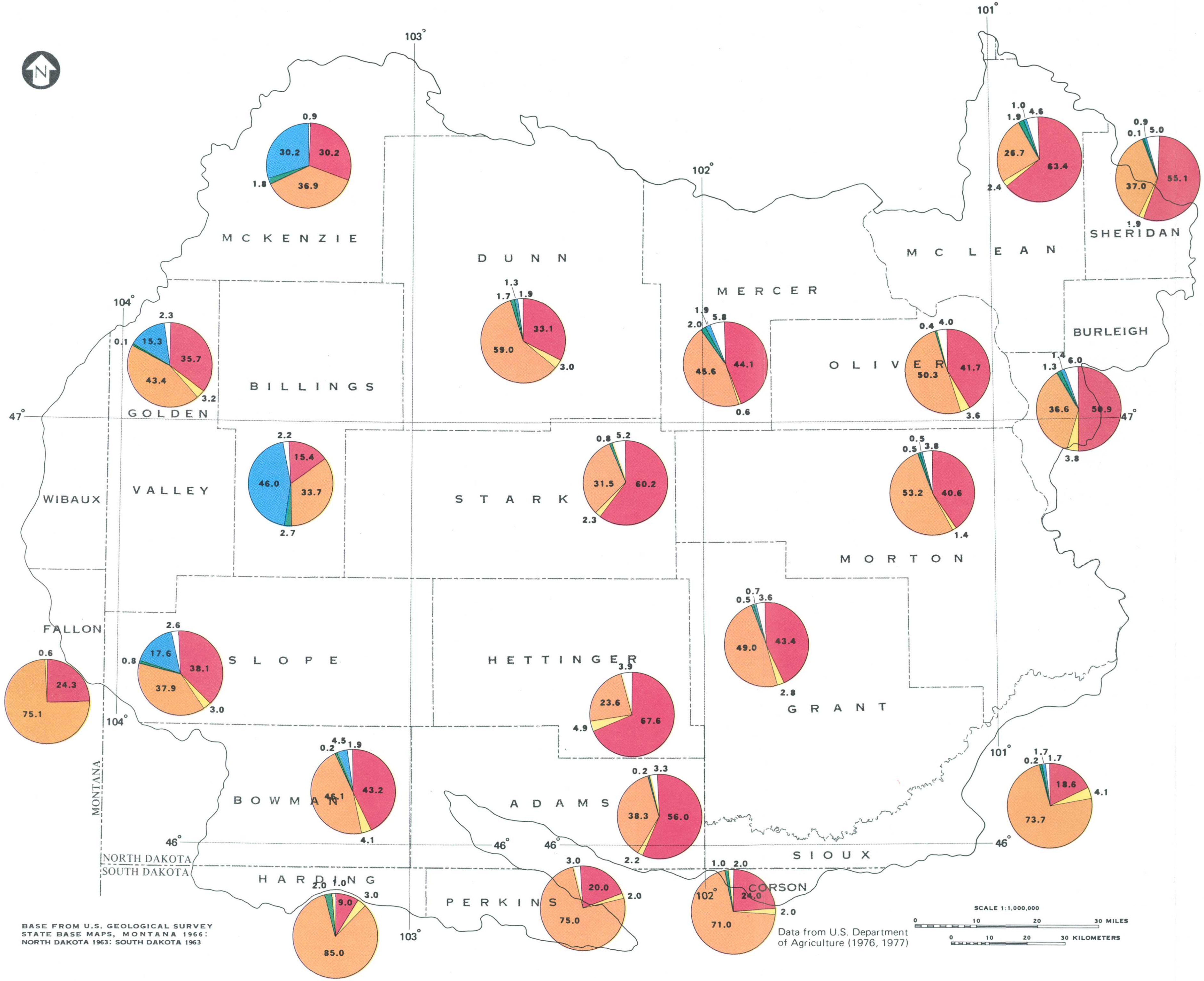
FIGURE 3.4-1—Generalized soil associations.

Range and Cropland Dominant Land Uses

Eighty-eight percent of the study area is used for range and cropland.

Area 47 includes about 19,400 square miles. About 52 percent of the land is used for rangeland and 36 percent is used for cropland (includes leased or permitted land that is federally owned). The main crops are wheat, hay, oats, and sunflowers. Land used for pasture is 2 percent, woodland is 1 percent, and other Federal land (includes national parks, rangeland, forests, and game refuges) is 6 percent. Other land use is 3 percent and includes urban and developed areas, which comprise about 1.6 percent of the area; small water areas including ponds and lakes of more than 2 acres but less than 40 acres in size; rural nonresidences; farmsteads; farm roads; feedlots; and unused marshes. Large water areas are excluded from the total land area.

The distribution of land use per county is shown in figure 3.5-1. No attempt was made to prorate land use for parts of counties in the area. The data were supplied by the U.S. Department of Agriculture, Soil Conservation Service. Land-use data for Wibaux County, Montana, were not available.



EXPLANATION

- CROPLAND
- PASTURELAND
- RANGELAND
- WOODLAND
- FEDERAL NONCROPLAND (In North Dakota only)
- OTHER LAND

50.9 NUMBER IS LAND USE PERCENTAGE OF TOTAL LAND AREA IN COUNTY

FIGURE 3.5-1—Land use by county, 1967

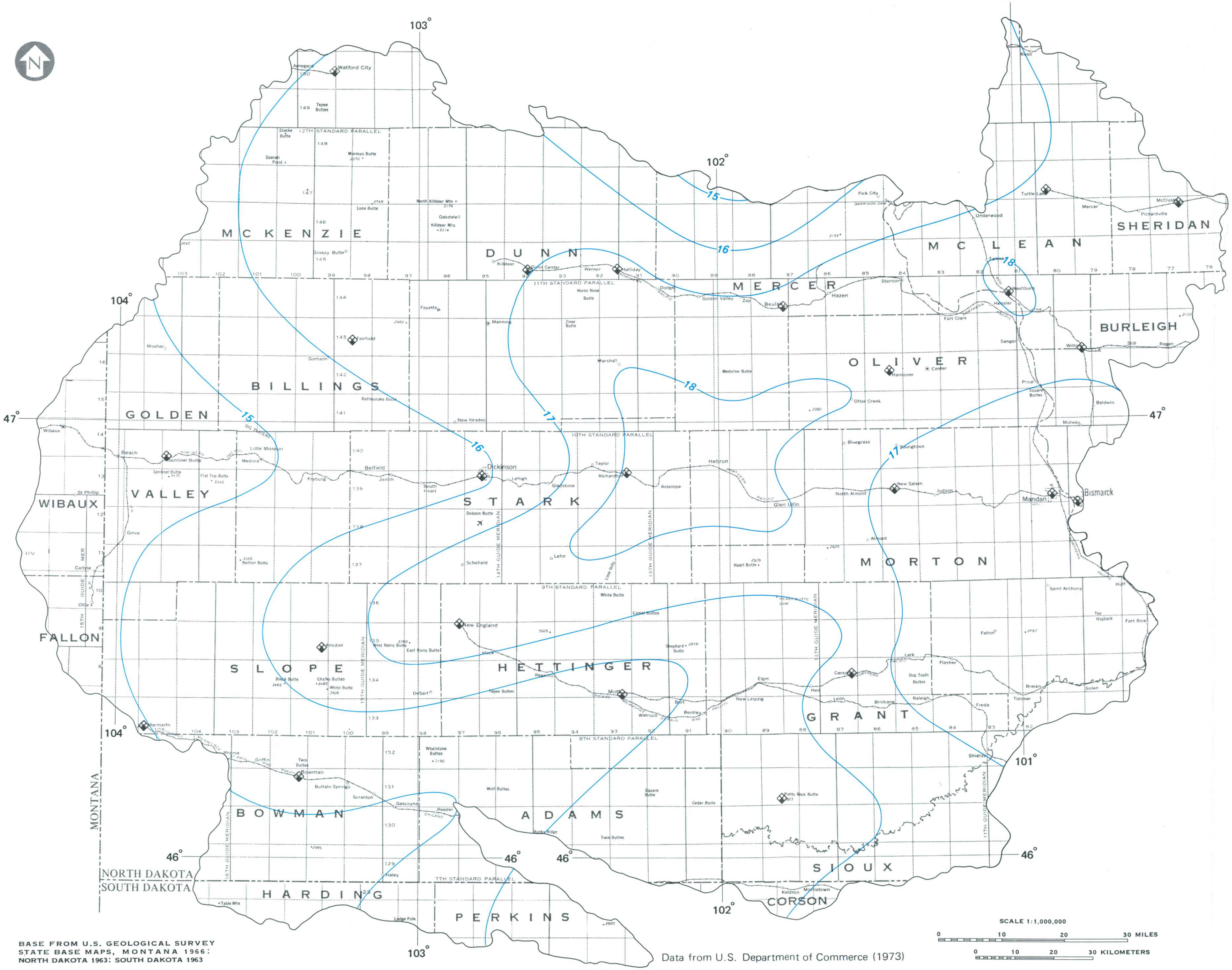
Precipitation and Evaporation Do Not Vary Greatly

The mean annual precipitation in the study area ranges from about 14 to 18 inches and mean annual lake evaporation ranges from about 36 to 42 inches.

The records from 22 National Weather Service recording precipitation stations in the area were used to calculate the distribution of the mean annual precipitation. Daily precipitation data are published monthly by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, National Climatic Center, Asheville, N.C.

The mean annual precipitation in the study area ranges from 14.35 to 18.02 inches, as shown in figure 3.6.1-1. Approximately 63 percent of the annual precipitation occurs during May through August. Most of the precipitation that falls during the summer occurs during periods of thunderstorm activity. July is the peak month for thunderstorm activity when 8 to 10 storms occur; however, thunderstorms occur nearly as often in June and August (Jensen, no date). Mean annual snowfall ranges from about 28 inches in the north-central part of the area to 38 inches in the central part (Jensen, no date).

Mean annual lake evaporation varies from about 36 inches in the northern part of the area to about 42 inches in the southern part of the area (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, 1982).



EXPLANATION

—17— LINE OF EQUAL PRECIPITATION—Interval 1 inch

◈ CLIMATOLOGICAL STATION

FIGURE 3.6.1-1—Mean annual precipitation.

Mean Annual Temperature Varies Little Throughout Area 47

The mean annual temperature in the area ranges from about 40°F to 43°F.

The mean annual temperature ranges from about 40°F in the northeastern part of the area to about 43°F in the southwestern part (fig. 3.6.2-1). January is the coldest month with mean monthly temperatures ranging from 6.8°F in the northeast part of the area to 13.9°F in the southwest part. July is the warmest month with mean monthly temperatures ranging from 70°F in the northwest to about 72°F in the extreme south and west. Summer temperatures occasionally rise above 100°F and temperatures of 0°F or less are common in the winter. The average number of days a year when the temperature reaches 90°F or more is about 25, and the average number with 0°F or less is about 45 (Jensen, no date).

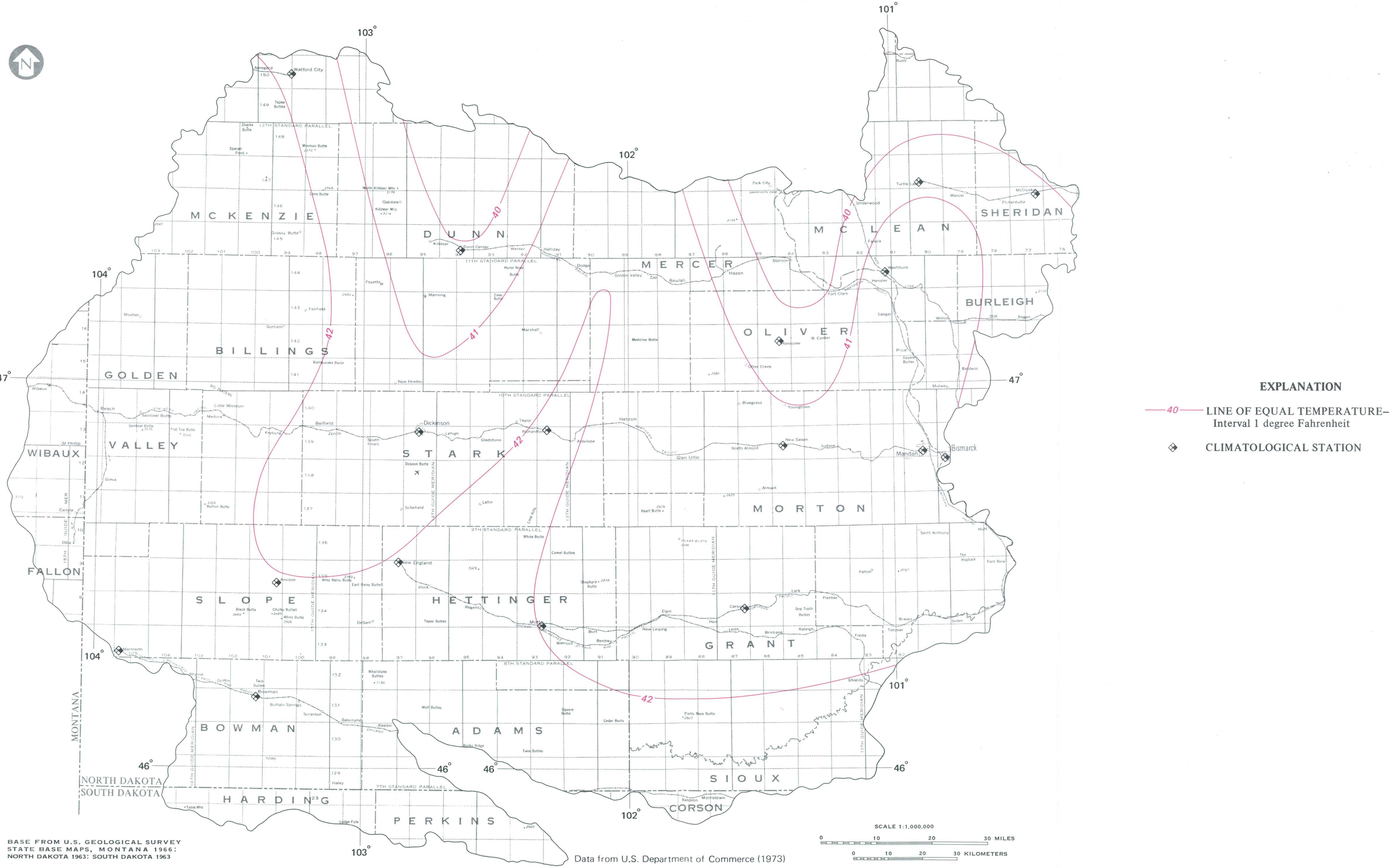


FIGURE 3.6.2-1—Mean annual temperature.

Coal Production Increased Significantly During the Past Decade

Lignite coal production in North Dakota from July 1979 to June 30, 1980, was about 16.8 million tons.

North Dakota is a major producer of lignite coal. Coal production increased from about 8.2 million tons from July 1975 to June 30, 1976, to about 16.8 million tons from July 1979 to June 30, 1980, an increase of 105 percent.

At the present time there is active strip mining in seven counties. Coal production per county is shown below.

County	Production (tons)[1]
Adams	35,433.25
Bowman	2,874,730.00
Grant	4,690.00
McLean	2,117,310.00
Mercer	4,551,977.00
Oliver	5,419,667.00
Stark	218,890.00

[1] Data from office of North Dakota State Tax Commissioner.

Most of the lignite coal mined is used for generating electricity; but some is sold locally for heating purposes, and some is used in the manufacture of charcoal briquettes and organic solvents. About 4 percent of the coal is shipped out of State.

Existing reserves are estimated to be about 350 billion tons; however, with the existing technology, only about 15 billion tons could be economically mined (North Dakota Geological Survey, 1981, p. 27). The location of active mines, known strippable lignite coal deposits, and areas where the coal deposits are known but not well defined are shown in figure 4.1-1.

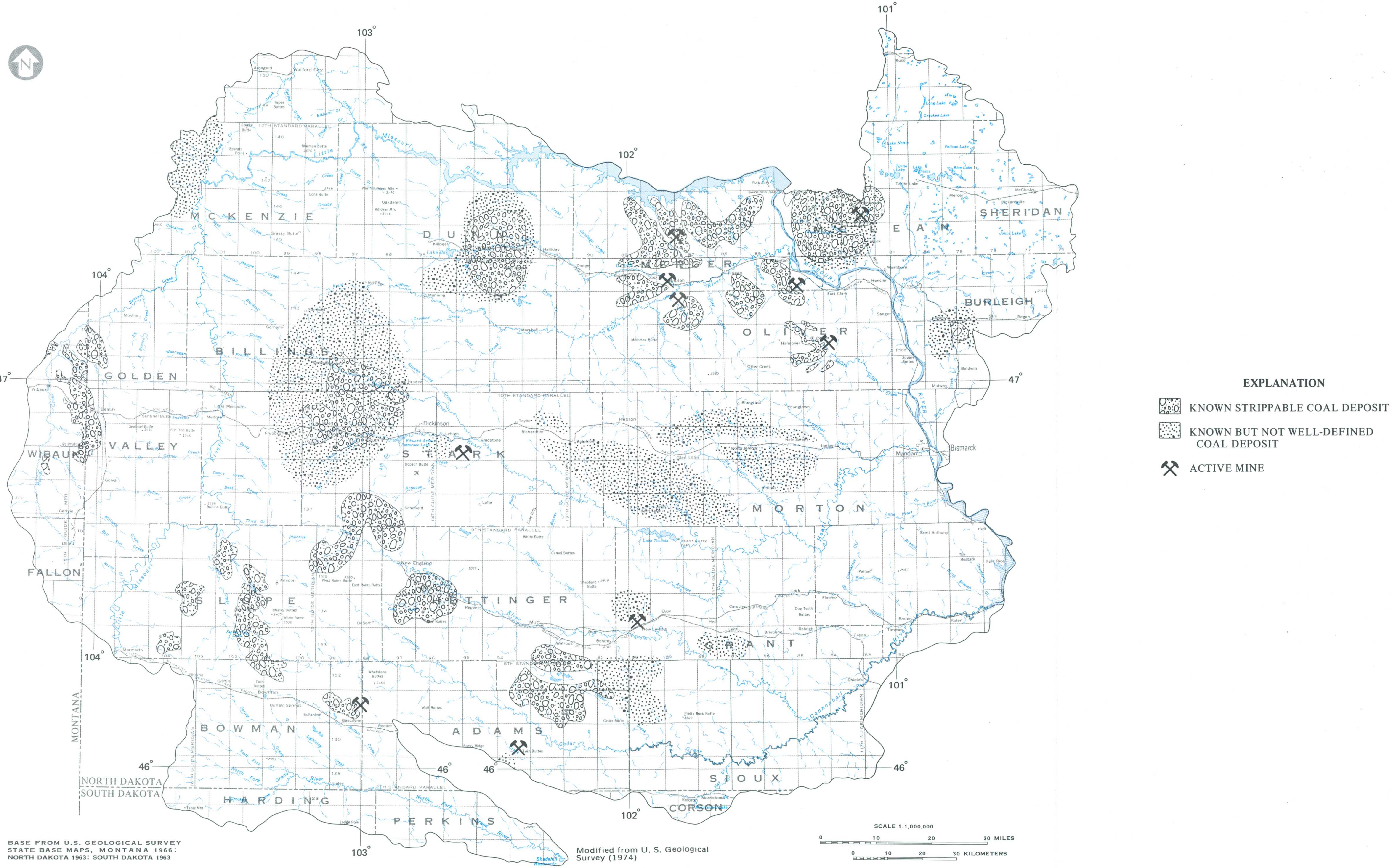


FIGURE 4.1-1—Location of known lignite coal deposits and active mines.

Lignite Coal has Diverse Ownership

About 16 percent of the lignite coal is federally owned.

Approximately 16 percent of the lignite deposits underlying 15.6 million acres in western North Dakota is federally owned. A typical pattern of Federal coal ownership is shown in figure 4.2-1. The percentage of coal owned by the Federal Government varies by county as shown by the percentages in figure 4.2-2. The State of North Dakota generally owns less than 1 percent of the coal in the counties. State ownership, for the most part, consists of school lands. The remainder of the coal is owned by private land owners including railroad companies. Ownership data are not available for Fallon County, Montana, and Corson, Harding, and Perkins Counties, South Dakota.

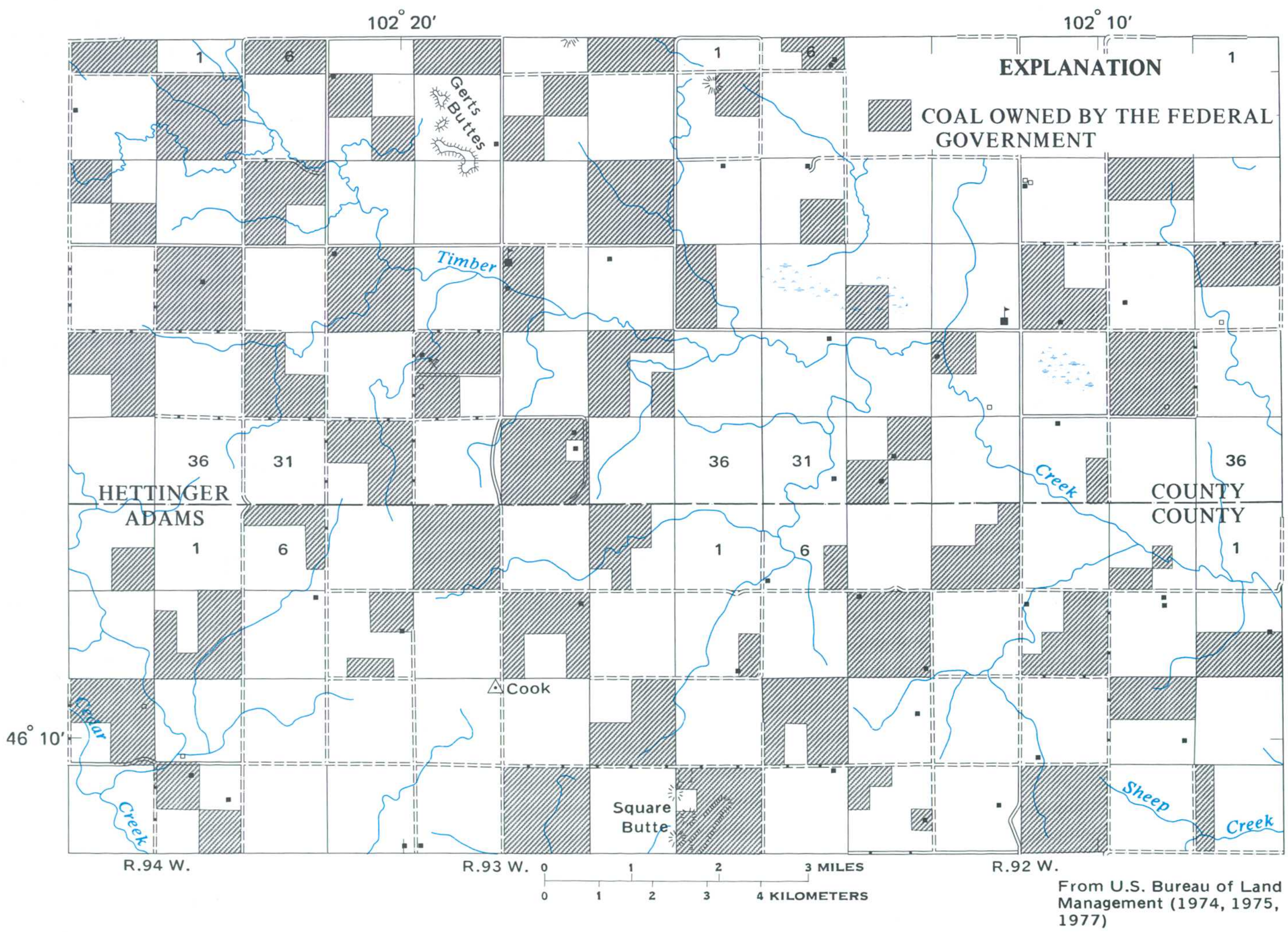


FIGURE 4.2-1—Typical distribution of Federal coal ownership.

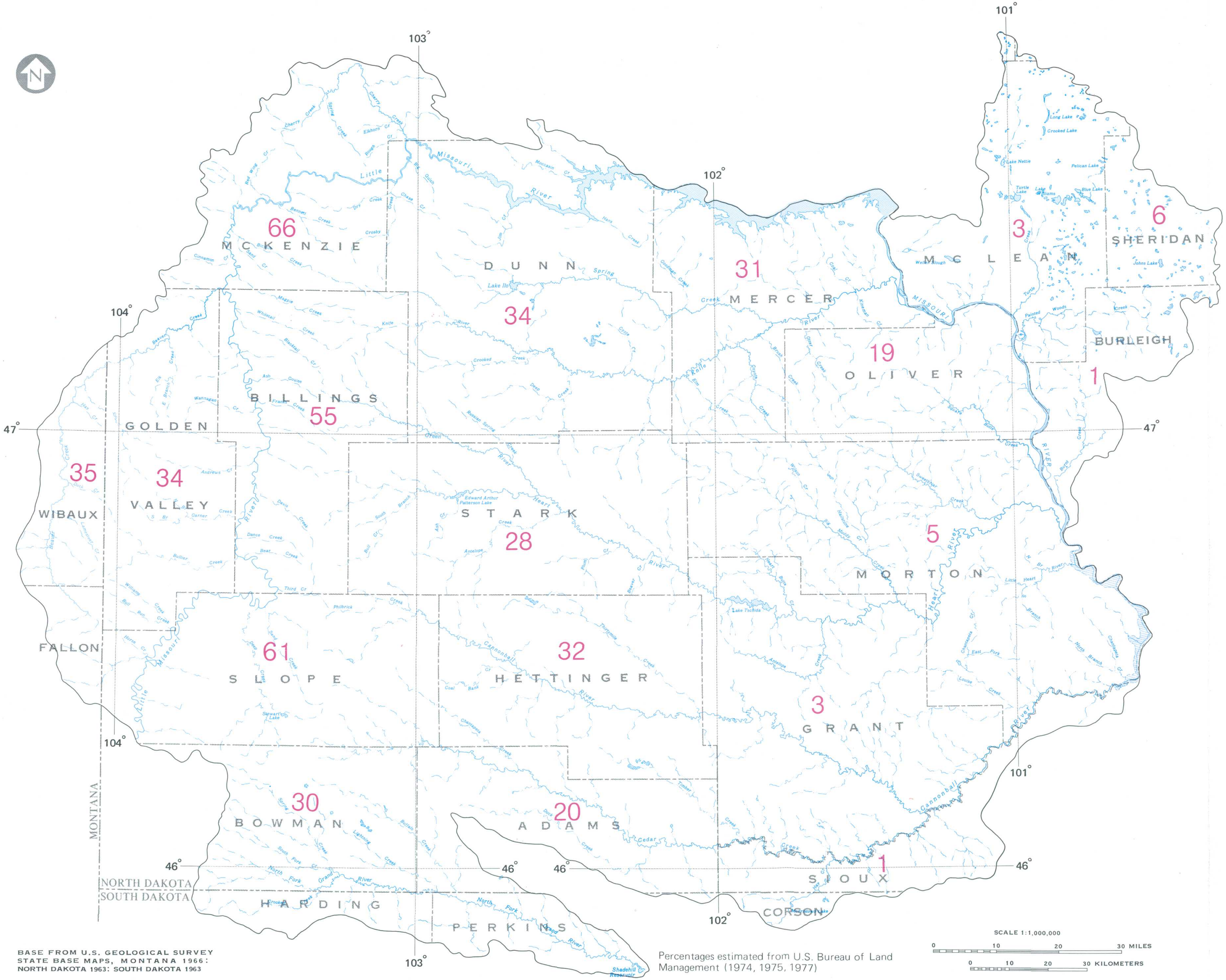


FIGURE 4.2-2—Approximate percentage of Federally owned coal by areas of county or part of county shown.

Surface-Water-Use Data for 1980 Available by County

Surface water is used for public supply, irrigation, thermoelectric, rural, and industrial purposes.

Surface-water use for different purposes is shown by county in figure 5.1-1. Data are not available for Montana and South Dakota. Approximately 12 million gallons per day of surface water was used to meet the needs of municipalities and private utilities during 1980. The Missouri River was the source of supply for 9.83 million gallons per day. Other sources of surface water for public supply were Lake Sakakawea on the north edge of the area and Edward Arthur Patterson Lake in Stark County. Both are manmade impoundments.

About 150 million gallons per day of surface water was used for irrigation. Of the total surface water used for irrigation, 76 percent was diverted from the Yellowstone River in Montana. Other sources of surface water for irrigation were the Missouri, Cannonball, Heart, Little Missouri, and North Fork Grand Rivers. About 25,000 acres of land was irrigated from surface-water sources during 1980.

About 924 million gallons per day of surface water was used by electric utilities for the generation of thermoelectric power in 1980. The major water sources for the powerplants were Lake Sakakawea and the Missouri River downstream from Garrison Dam. Most of the water was used for cooling purposes.

Although a small quantity of surface water may have been used for domestic purposes, it is assumed, for the purpose of this report, that 100 percent of rural surface-water use was for watering livestock. The total quantity used during 1980 was about 3.3 million gallons per day.

About 3 million gallons per day of surface water was used during 1980 for industrial purposes. The water was used for plant operation cooling, sand and gravel operations, and coal mining.

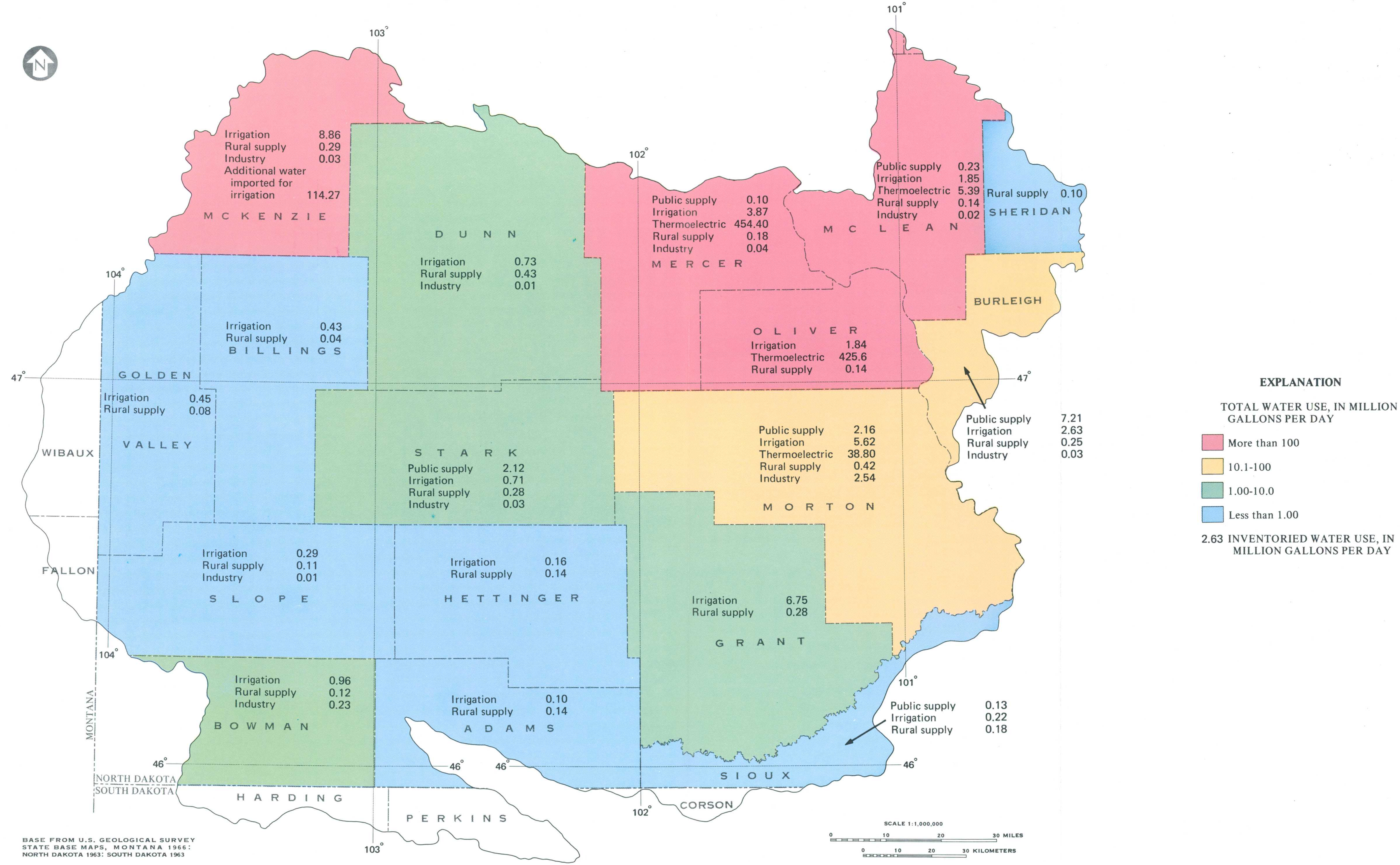


FIGURE 5.1-1—Surface-water use by county, 1980.

Ground-Water-Use Data for 1980 Available by County

Ground water is used for public supply, irrigation, rural, and industrial purposes.

Ground-water use for different purposes is shown by county in figure 5.2-1. Data are not available for Montana and South Dakota. Public-supply water systems include municipalities, rural water systems, and private utilities. About 4.4 million gallons per day of water was withdrawn from ground-water sources for public supply use during 1980. The quantity includes commercial and domestic use, water lost in the distribution system, and water supplied for such services as fire fighting, swimming pools, and irrigation of some golf courses.

Approximately 11.3 million gallons of water per day was used during 1980 to irrigate about 7,200 acres. The irrigation season generally extends from mid-May to mid-September.

Rural water use consists of self-supplied domestic use and consumption by livestock. About 9 million gallons per day of ground water was used for rural domestic and livestock supplies during 1980.

Industrial water use was about 1.3 million gallons per day during 1980; 0.26 million gallons per day was used for cooling thermoelectric powerplants and 1.05 million gallons per day was used for processing sand and gravel, coal mining, and oil exploration and refining. Ground-water use for different purposes determined by county is shown in figure 5.2-1.

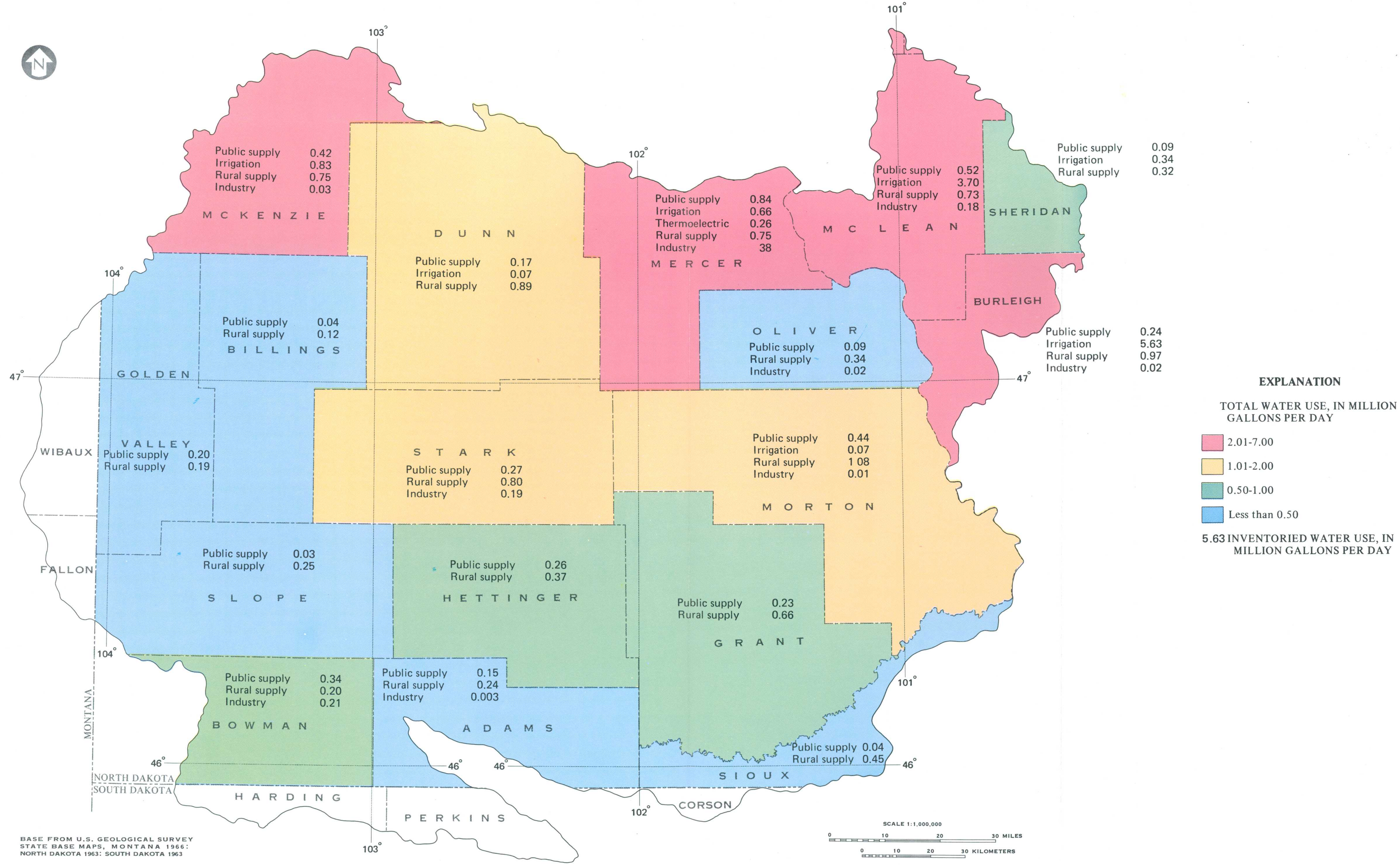


FIGURE 5.2-1—Ground-water use by county, 1980.

Streamflow Information Available for 127 Locations

Surface-water data collected through the years has resulted in a fairly comprehensive data base.

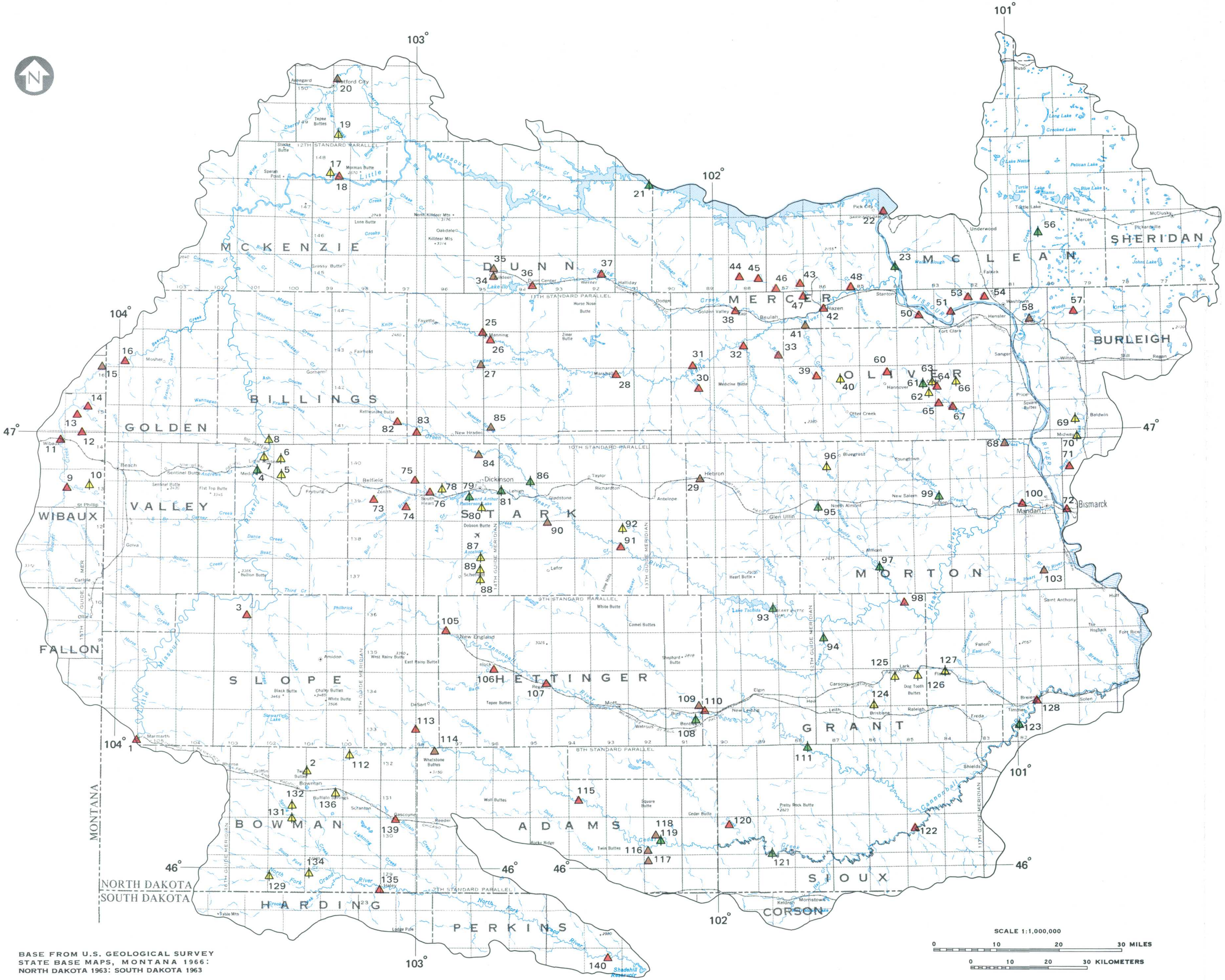
The surface-water data-collection network in Area 47 started with the establishment of four continuous-record discharge stations in 1903. The number of continuous-record stations has fluctuated, but generally increased with time to the present (1981) coverage (fig. 6.1-1 and section 11.1). The first stations were established as part of a water-accounting system and were located on the Missouri River mainstem and the major tributaries to the Missouri River. Additional stations were soon established on these tributaries and other streams as the demands on the supply of water increased. The early established stations provide a long-term record from which streamflow statistical information can be obtained. The long-term records also can be used to extend incomplete or short-term records using correlation techniques. However, regulation, storage, or diversion has occurred on many streams rendering invalid the use of parts of long-term records in defining streamflow characteristics.

Interest in low-flow characteristics during the early 1950's resulted in a program of periodic measurements of low-flow discharge on many large and small streams for 1 or more years. Owing to the ephemeral nature of the streams and varied sources of low-flow discharge, correlation of low-flow between stations is poor and onsite measurements are the only dependable source of information.

From 1954 to 1973 a network of crest-stage gaging stations was operated on a number of streams with drainage areas of less than 100 square miles. The data from these stations, together with data from the continuous-record stations, were used to develop flood-frequency and magnitude relationships. Operation of the crest-stage stations also resulted in the collection of a large quantity of periodic discharge-measurement information.

Details about period of operation and type of data collected at 127 stations are shown in section 11.1. The actual data are available from computer storage through National Water Data Exchange (NAWDEX), from the U.S. Geological Survey's WATSTORE, and in published annual U.S. Geological Survey reports.

The U.S. Geological Survey customarily uses an eight digit number to identify stations and measurement sites. For this report, for simplicity, a new, smaller station or site number has been assigned, as shown in figure 6.1-1 and section 11.1; henceforth, in this report, this is the station or site number referred to.



EXPLANATION

- ▲ CONTINUOUS-RECORD GAGING STATION
- ▲ LOW-FLOW MEASUREMENT STATION
- ▲ DISCONTINUED CONTINUOUS-RECORD GAGING STATION
- ▲ DISCONTINUED CREST-STAGE GAGING STATION
- 70 STATION NUMBER

BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, MONTANA 1966; NORTH DAKOTA 1963; SOUTH DAKOTA 1963

FIGURE 6.1-1—Location of gaging stations and other discharge-measurement stations.

Water Quality Information Available for Many Locations

Surface-water-quality sampling programs provide a data base that characterizes the chemical composition of water in the major streams and many minor tributaries.

Water-quality sampling in Area 47 by the U.S. Geological Survey began as part of a cooperative program with the U.S. Army Corps of Engineers in 1945. The program to sample the major streams for water-quality properties and common ions was continued for 5 or 6 years at most stations. A major effort was made during the late 1970's and early 1980's to acquire a more complete water-quality data base. The locations where data are available as of 1981 are shown in figure 6.2-1. The data are widely spaced with regard to time and duration of collection. The period of record and the type of data available for each station are shown in section 11.2. The station numbers shown in figure 6.2-1 and section 11.2 are the same as for those in figure 6.1-1 and section 11.1. There are additonal scattered miscellaneous one-time sample data in the U.S. Geological Survey files that are not shown. The data listed are available in published form in annual reports of the U.S. Geological Survey; in the U.S. Environmental Protection Agency's STORET computer files; and, since about 1950, in the U.S. Geological Survey's WATSTORE computer files.

A common practice for several years has been for U.S. Geological Survey investigators to obtain water-temperature and specific-conductance measurements whenever a streamflow measurement is made. These data are not listed in section 11.2 unless a sample for chemical analyses also was obtained.

Data on water quality for Area 47 also can be obtained from the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, North Dakota State Department of Health, North Dakota State Water Commission, North Dakota Game and Fish Department, and the State universities.

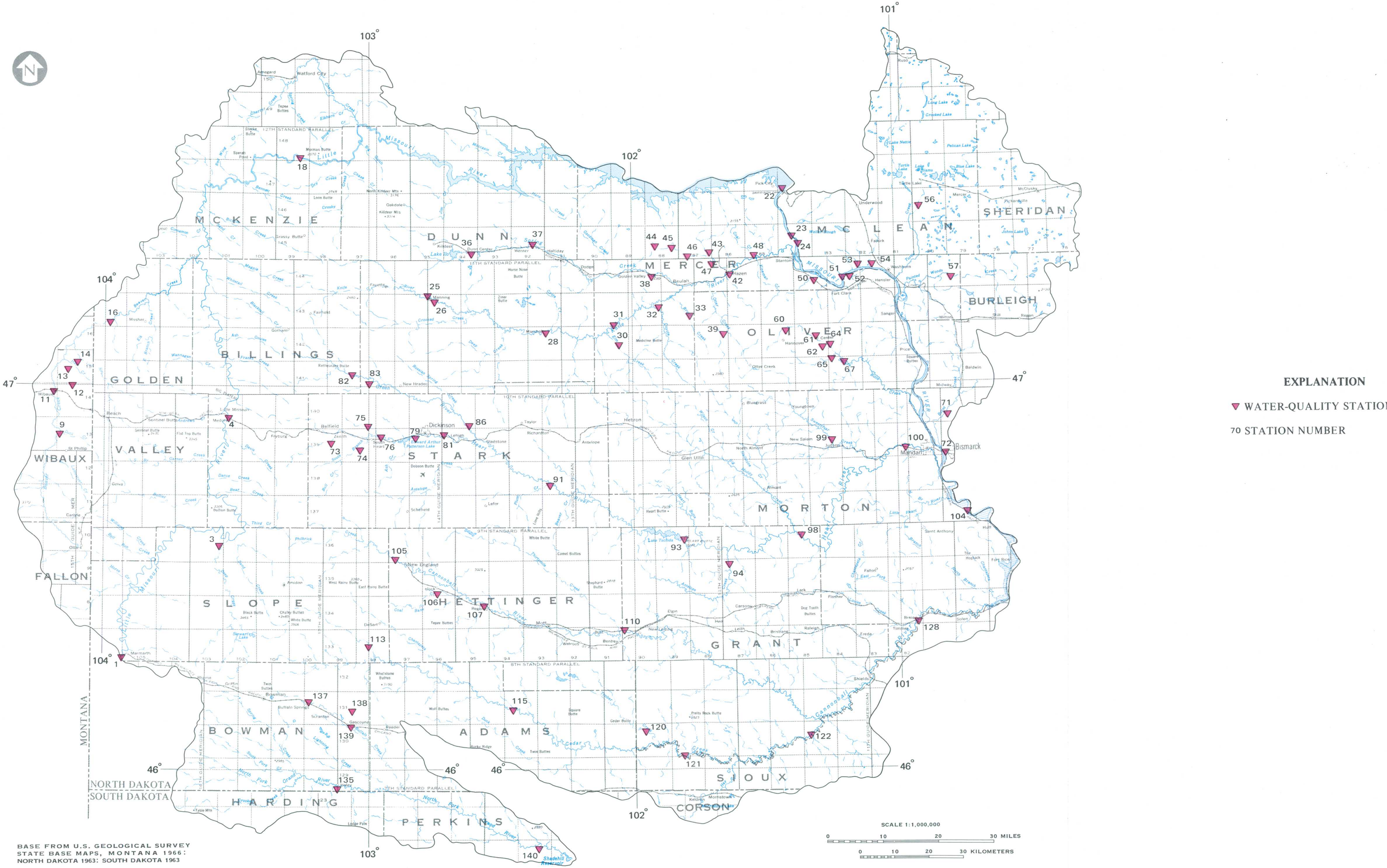
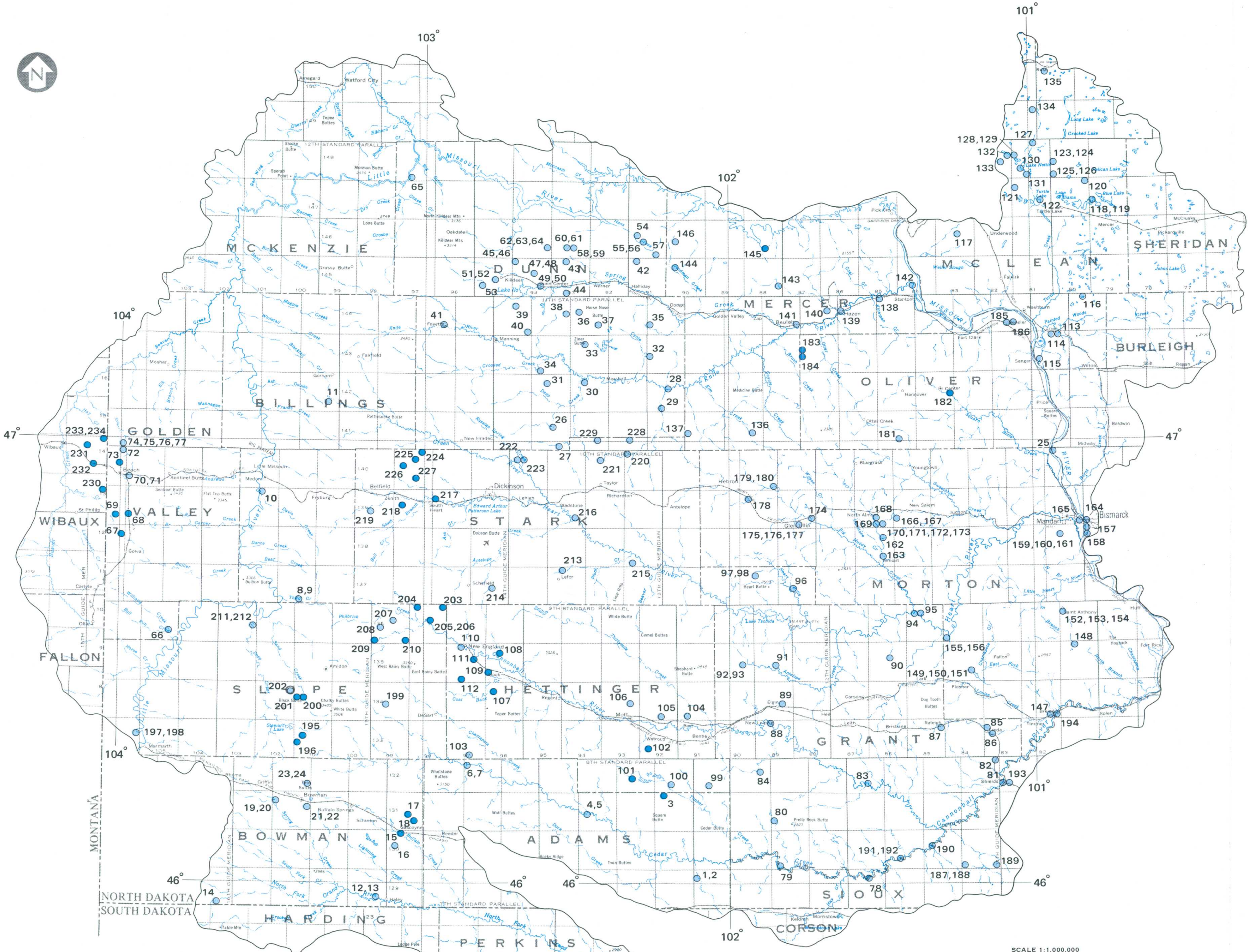


FIGURE 6.2-1—Location of surface water-quality stations.

Information on Ground-Water Levels and Quality of Water Available for Most of Area 47

The ground-water network as of September 1981 included 234 observation wells in aquifers above the Pierre Shale.

The ground-water network in Area 47 provides general water-level and ground-water quality data for most of the area. The network of observation wells being monitored is periodically reviewed and updated. The network as of September 30, 1981, is shown in figure 6.3-1. Information on location, aquifer, and period of record for each observation well is shown in section 11.3. Note that for this report a simpler numbering system is used than the local well-numbering system. The frequency of observation can vary from one annual measurement to a continuous record. Lithologic and geophysical logs are available for all observation wells. At least one chemical analysis of water from the well is available for most sites. Chemical quality is monitored at several key wells. Those wells for which a chemical analysis of the water was made during 1981 are identified in the figure. Many other wells have been constructed by the U.S. Geological Survey and cooperators that are not a part of the network. Information on these wells is available from computer storage through the National Water Data Exchange (NAWDEX) and in published reports.



BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAPS, MONTANA 1966;
NORTH DAKOTA 1963; SOUTH DAKOTA 1963

SCALE 1:1,000,000

0 10 20 30 MILES

0 10 20 30 KILOMETERS

EXPLANATION

- OBSERVATION WELL
- OBSERVATION WELL WHERE WATER–QUALITY SAMPLE WAS OBTAINED IN 1981

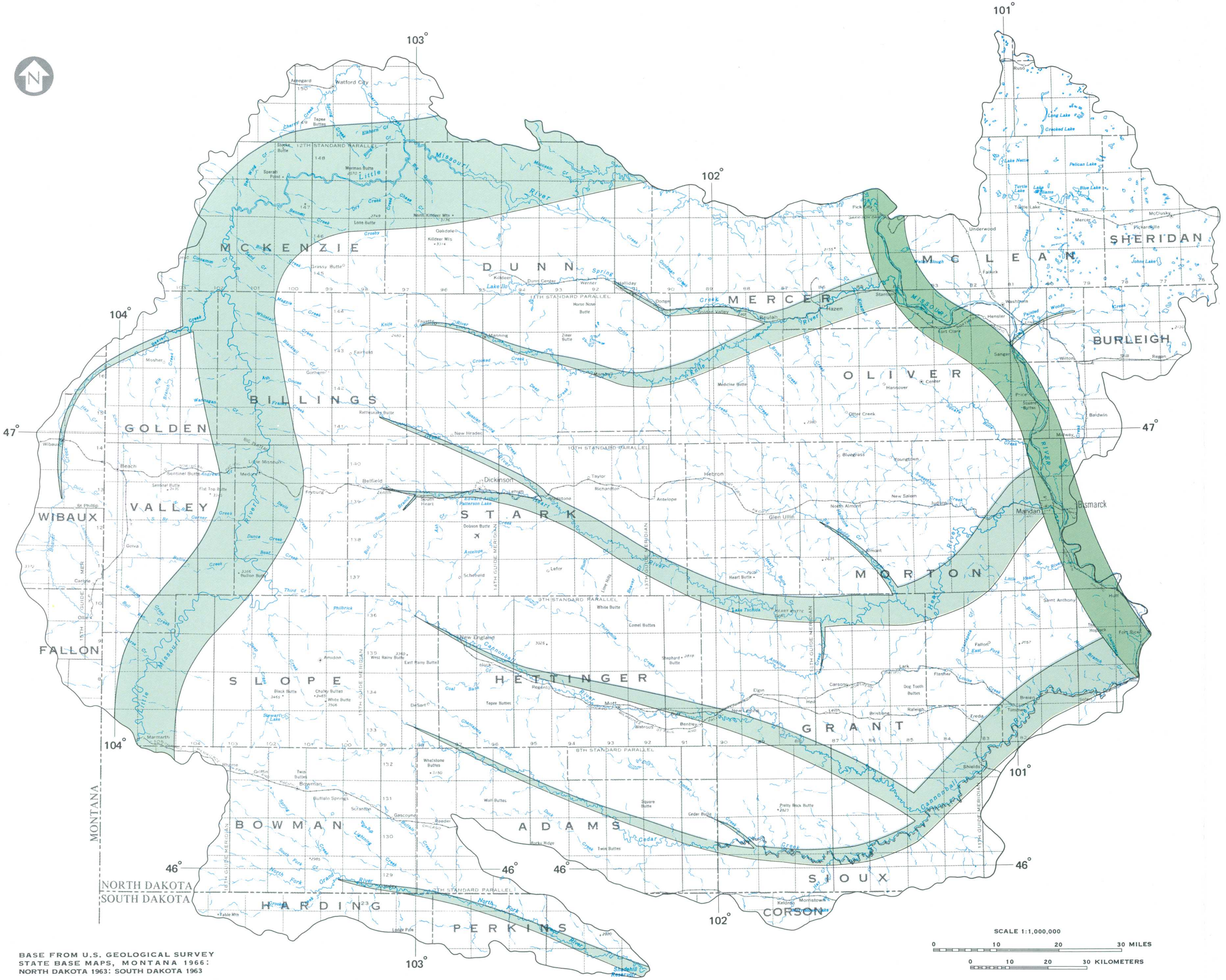
165 WELL NUMBER

FIGURE 6.3-1—Location of ground-water observation wells, September 30, 1981.

Annual Mean Flow Available for All Stations Having 5 or More Years of Continuous Record

Annual mean flows in runoff per square mile show only minor areal variation for the major tributaries of the Missouri River.

Data for annual mean flow are available for all gaging stations having 5 or more years of continuous record (see section 11.1). The annual mean flow at the downstream stations of the major tributaries is 44 acre-feet per square mile for the Cannonball River at Breien (station 128), 56 acre-feet per square mile for the Heart River near Mandan (station 100), and 58 acre-feet per square mile for the Knife River at Hazen (station 42). The annual mean flow is defined primarily by runoff from thunderstorms or spring snowmelt. The decrease in runoff per square mile from north to south could be the result of increased infiltration in the areas least affected or unaffected by glaciation. Flow is approximately proportional to drainage area and increases downstream (fig. 7.1.1-1). The annual mean flow of the Missouri River at Bismarck (station 72) is 16,400,000 acre-feet per year. Limited response to precipitation runoff occurs on the Missouri River because flow is controlled at Garrison Dam. The annual mean flow of a stream can be used to evaluate the possibility of water being available for planned development.



EXPLANATION

WIDTH PROPORTIONAL TO ANNUAL MEAN FLOW

1 inch = 40 million acre-feet

1 inch = 400,000 acre-feet

BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, MONTANA 1966: NORTH DAKOTA 1963: SOUTH DAKOTA 1963

FIGURE 7.1.1-1—Schematic of annual mean flows.

Flow-Duration Curves Integrate Hydrologic and Geologic Characteristics of Drainage Basins

The flow-duration characteristics of a stream may be used to define the characteristics of a drainage basin or to compare the characteristics of one basin with those of another.

The flow-duration curve is a cumulative frequency curve that shows the percent of time a specified discharge is equaled or exceeded during a given period. A flow-duration curve can be used in appraising the geologic characteristics of a drainage basin, particularly as they affect low flows. It also can be used in waterpower, stream-pollution, and quality-of-water studies where discharge versus time is a crucial factor. Flow-duration curves for the mainstem and some smaller tributaries of the Knife River are shown in figure 7.1.2-1. The curves are based on the mean daily flows for the period of record at a site. For example, a discharge of about 0.10 cubic foot per second per square mile for the Knife River (station 31) is expected to be equaled or exceeded about 10 percent of the time. The reliability of the frequency curve for predicting future flows depends upon the accuracy and consistency of the record and on how well the period of record represents the long-term flow of the stream.

The shape of the flow-duration curve is determined by the hydrologic and geologic characteristics of the drainage basin. A curve that is nearly vertical represents variable streamflows such as that derived from direct surface runoff. A more gently sloping curve is characteristic of streams whose flow is attenuated by surface storage or augmented by discharge from ground-water storage. The curves for the smaller streams shown in figure 7.1.2-1 show the steep slope which typifies the ephemeral nature and lack of base flow of the streams. Thus, the lower end of the curve (base flow) is a valuable means of studying the effect of geology on the ground-water discharge.

Several points on the duration curves for stations in Area 47 are listed in table 7.1.2-1. Most of the curves for the area are similar to those of the Knife River although there are greater variations at the lower end depending on ground-water discharge.

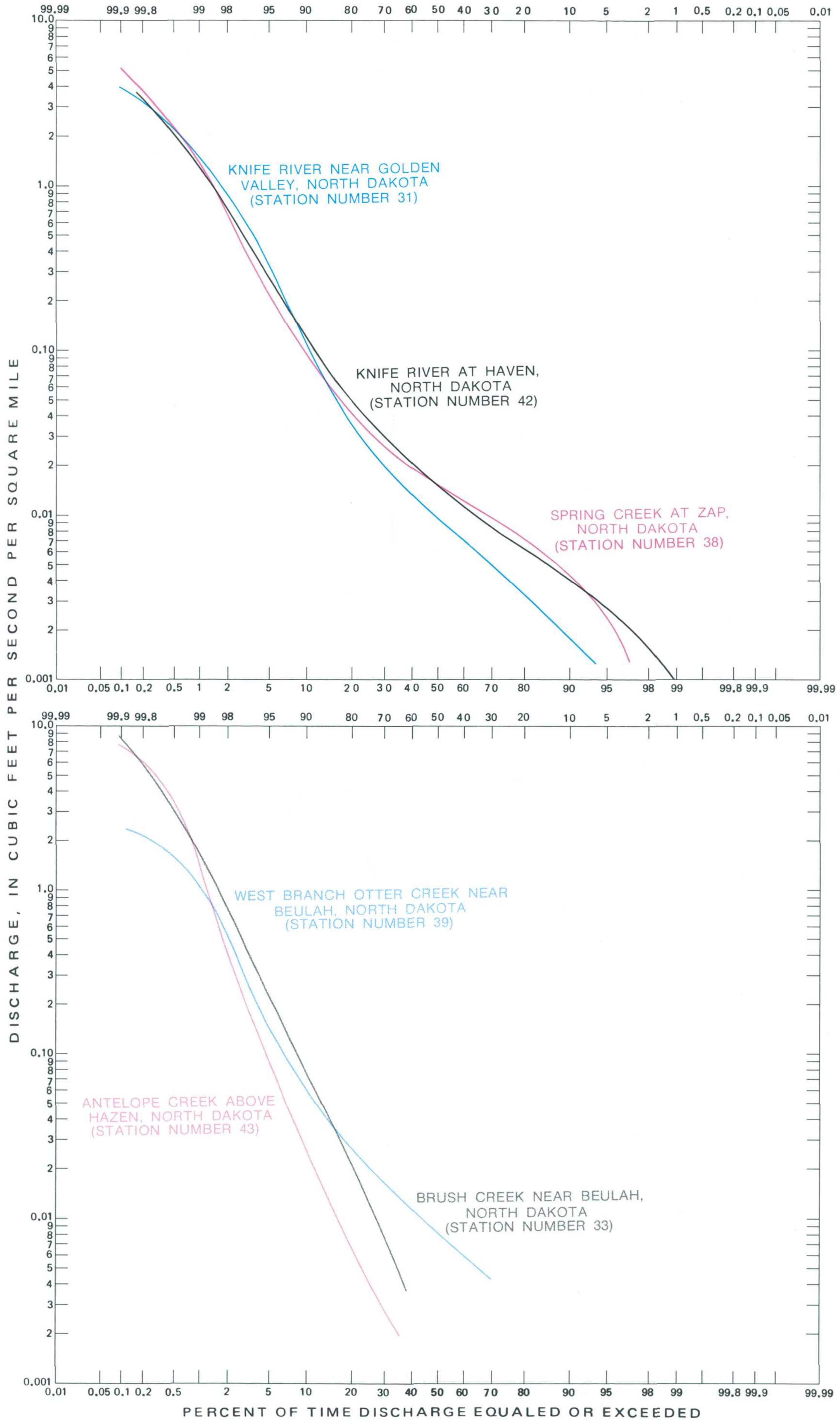


FIGURE 7.1.2-1—Duration of flow.

TABLE 7.1.2-1—Daily flow duration statistics, in cubic feet per second.

Site number	Drainage area (square miles)	Percent of time equaled or exceeded 95	75	50	25	10
1	4,640					
3	250	0.0	0.3	0.8	2.1	15
4	6,190	.0	11	55	270	1,100
9	46.5	.0	.0	.0	.0	.0
11	351	.0	.2	1.1	3.9	15
12	4.1	.0	.0	.0	.0	.0
13	11.4	.0	.0	.0	.0	.2
14	96.2	.0	.1	.1	.3	1.5
16	485	.0	.7	2.6	7.6	44
18	8,310	.0	9.7	70	350	1,300
21	179,800	5,600	11,000	20,000	30,000	42,000
22	181,400	15,000	21,000	25,000	30,000	37,000
23	181,400	7,700	13,000	21,000	28,000	35,000
25	205	.1	.9	1.8	4.8	24
26	30.3	.0	.0	.0	.1	.6
28	722	1.7	4.1	7.6	23	85
30	82	.0	.0	.0	.4	5.1
31	1,230	1.2	5.1	10	31	130
32	65.2	.0	.2	.5	1.3	8.8
33	22	.0	.1	.2	.5	1.4
36	116	.3	.5	.8	1.7	4.5
37	260	1.8	3.0	4.1	6.2	18
38	549	1.3	4.9	8.3	18	51
39	26.5	.0	.0	.0	.3	2.2
42	2,240	6.1	17	31	76	270
43	47.2	.0	.0	.0	.2	1.4
44	4.52	.0	.0	.0	.0	.0
45	8.53	.0	.0	.0	.0	.0
46	28.3	.0	.0	.0	.0	.0
47	37.7	.0	.0	.0	.0	.4
48	15.8	.0	.0	.1	.3	2.0
50	21.9	.0	.0	.1	.5	2.4
51	9.8	.0	.0	.0	.0	.6
53	7.5	.0	.0	.0	.0	1.7
54	57.3	.0	.1	.1	.2	1.2
56	310	.0	.0	.0	.1	1.5
57	427	.0	.1	.3	2.1	12
60	16.9	.0	.0	.0	.4	1.6
62	13	.0	.0	.0	.3	1.0
64	75.8	.7	1.1	1.5	2.5	6.3
65	45.6	.0	.0	.1	.9	5.0
67	146	.6	1.2	1.7	2.5	7.2
71	108	.0	.0	.1	1.3	6.4
72	186,400	6,200	13,000	21,000	30,000	38,000
73	39.8	.0	.0	.0	.0	.2
74	132	.0	.0	.0	.2	4.1
75	40.8	.0	.0	.0	.1	.3
76	311	.1	.4	.7	2.4	21
79	400	.1	.3	.7	3.3	16
81	443	.8	1.9	3.8	9.8	44
82	152	.1	.6	1.2	3.1	16
83	22.4	.1	.1	.2	.3	.6
86	356	.0	1.8	3.7	9.3	38
91	1,240	.3	4.4	11	33	140
93	1,710	.7	12	27	74	200
94	221	.0	.5	1.5	4.9	19
95	41.4	.0	.0	.0	.1	3.6
97	456	.2	.9	1.8	5.3	33
98	2,750	6.4	21	46	100	310
99	157	.1	.3	.6	1.8	7.8
100	3,310	1.3	18	47	120	380
105	285	.0	.1	.1	.7	7.7
106	70	.0	.1	.1	.3	1.8
107	580	.6	2.6	4.9	13	49
110	860	1.3	5.3	11	28	110
113	42.9	.0	.0	.1	.9	4.5
115	553	.2	1.2	2.9	8.8	40
119	901	.0	.0	.1	3.0	20
120	100	.2	.7	1.3	3.1	19
121	1,340	.0	.9	5.4	22	86
122	1,750	.0	1.2	8.6	39	160
128	4,100	.2	6.9	26	100	390
135	509	.1	.7	1.6	5.0	32
139	15.7	.0	.0	.2	.6	2.6
140	1,190	.0	.8	4.4	17	72

Urban and Rural Flooding a Problem

Flood estimates can be made from available data for gaged and ungaged streams in area.

Most of the flood damage in Area 47 is to homes and businesses in small communities or to roads and bridges in rural areas. Flood-prone areas have been delineated for those topographic quadrangles indicated in figure 7.1.3-1. The mapped areas are not the only areas subject to flooding, but were given priority for study.

The prevention of floods and the minimizing of flood damage depend on historic flood data and predictive capability. Peak-flow data have been collected at many stations and for many years (see section 11.1). The most reliable estimators of future floods generally are the frequency analyses of gaging-station records. Therefore, the estimating technique first includes a search for available flood-frequency data for a gaging station at or near the desired site. In the absence of such record, estimates can be made by relating frequency analyses at long-term stations to the particular site based on basin characteristics and climatic factors. Information for estimating floods on ungaged streams draining less than 100 square miles is given in a report by Crosby (1975). The regression equations to be used in computing floods from the 2-year to 50-year frequency are given in table 7.1.3-1. Information for estimating floods on ungaged streams draining 100 square miles or more is given in a report by Patterson (1966).

The maximum discharges on record for unregulated streams draining less than 500 square miles are plotted versus drainage area in figure 7.1.3-2. The plots also include significant maximum discharges at miscellaneous sites. The wide spread (three orders of magnitude) of flood peaks for a given drainage area indicates that adequate areal definition requires data at many sites.

TABLE 7.1.3-1—Summary of regression equations for estimating peak discharges for streams draining less than 100 square miles in Area 47

[Standard error of estimate, in percent, is the average of the positive and negative percent error, within which lie two-thirds of the measured values.]

Regression equation	Standard error of estimate (percent)
$Q_2 = 196A^{0.60}Si^{-1.74}$	74
$Q_5 = 465A^{0.63}Si^{-1.66}$	64
$Q_{10} = 626A^{0.64}Si^{-1.52}$	65
$Q_{25} = 766A^{0.65}Si^{-1.30}$	74
$Q_{50} = 848A^{0.65}Si^{-1.14}$	84

Q_n = Peak discharge with a recurrence interval "n", in cubic feet per second.

A = Drainage area, in square miles.

Si = Soil-infiltration index, in inches.

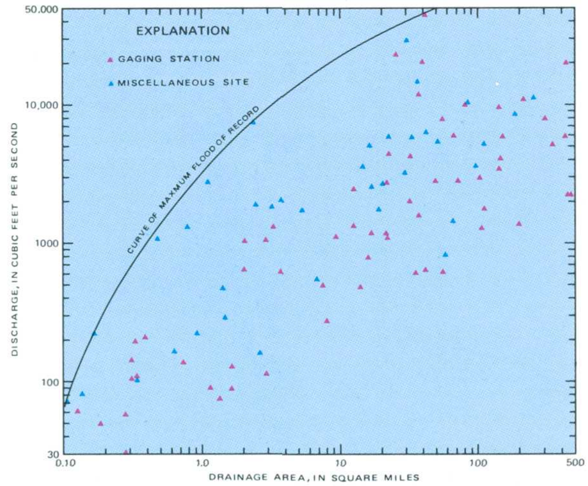
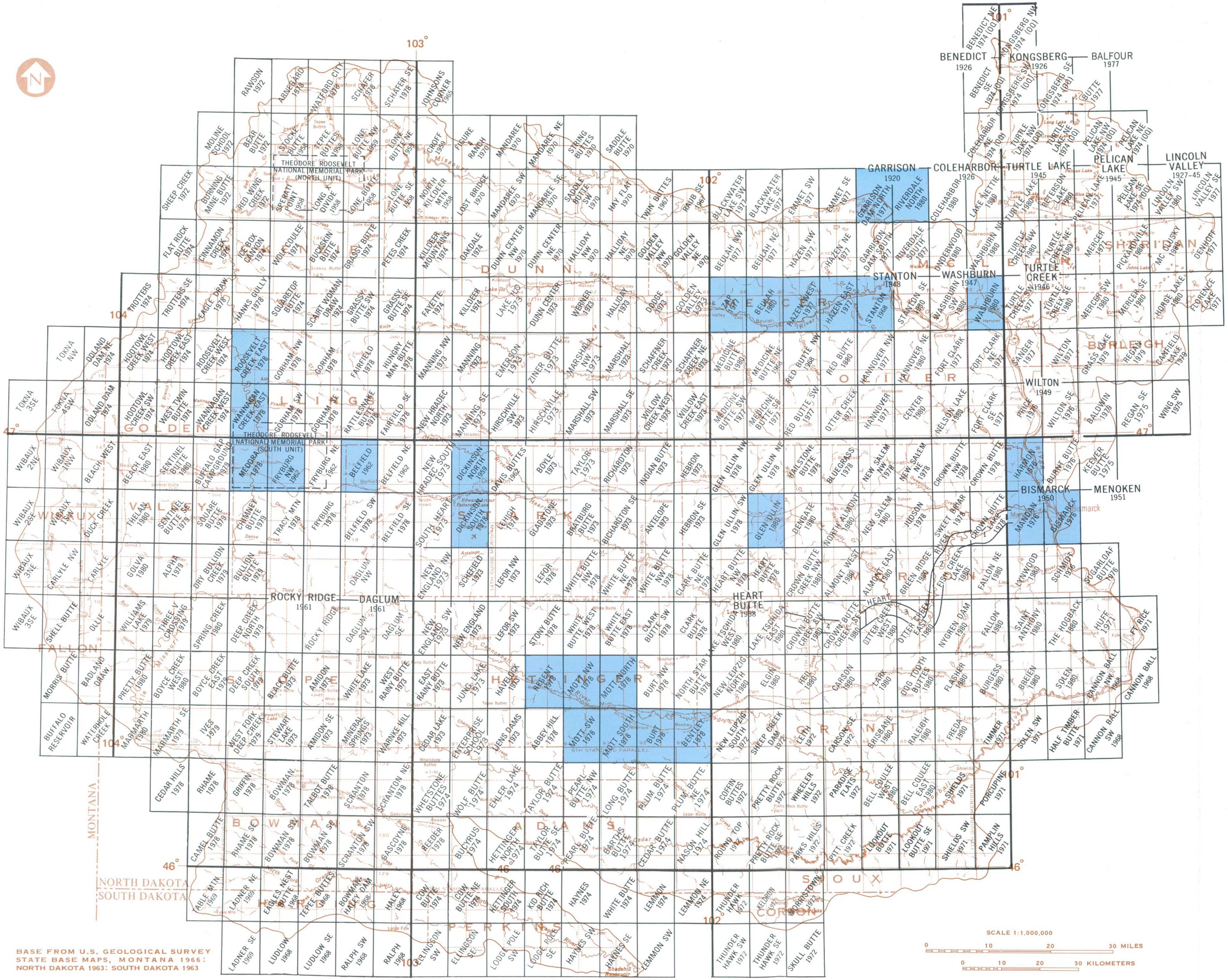


FIGURE 7.1.3-2—Maximum known instantaneous discharges in relation to drainage area.



EXPLANATION

FLOOD-PRONE MAPS AVAILABLE IN 1981—Direct inquiries to: U.S. Geological Survey, 821 East Interstate Avenue, Bismarck, ND 58501

FIGURE 7.1.3-1—Available flood-prone area maps.

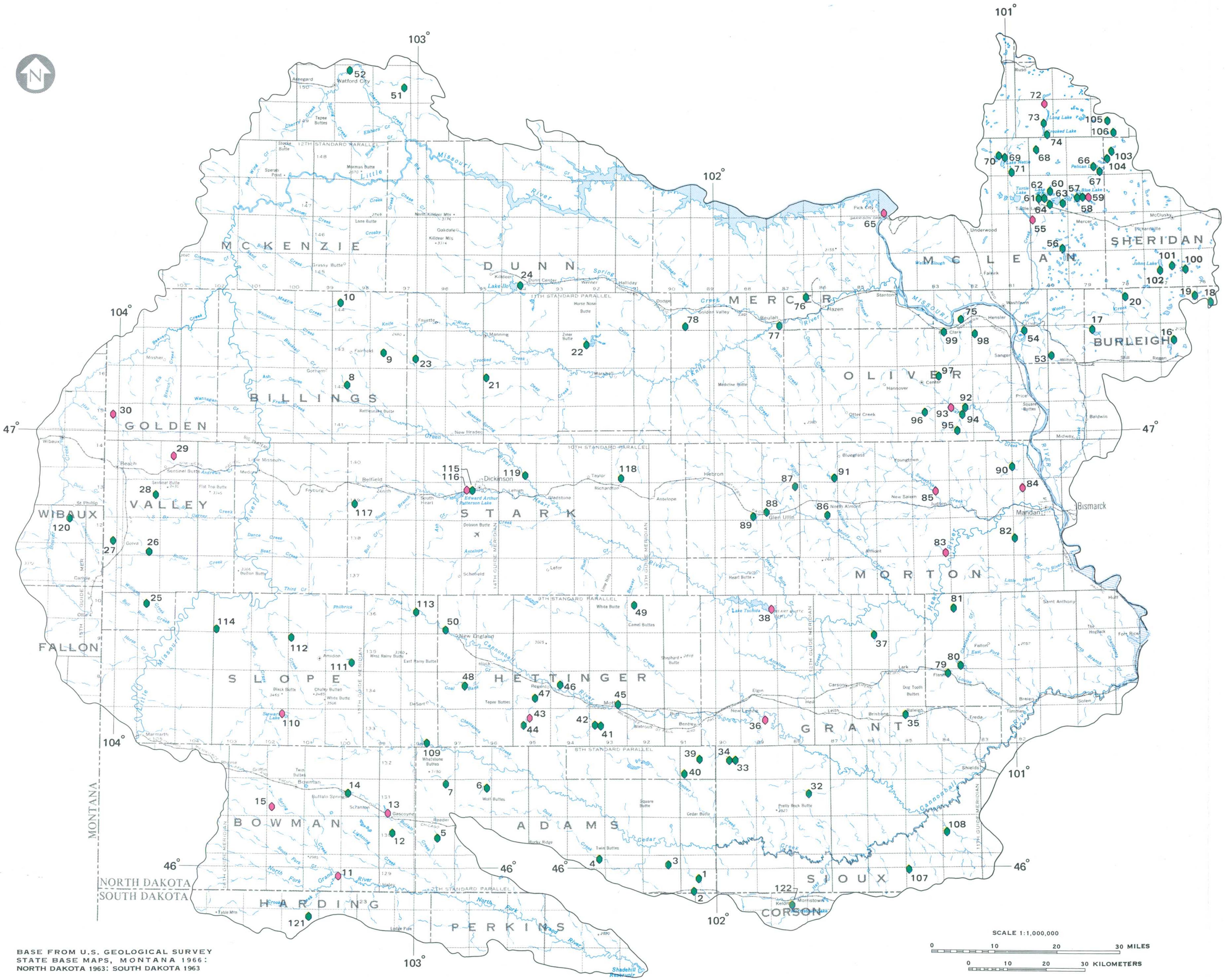
Surface Storage Important to Use of Water Resources

Natural and manmade storage are important in the use of surface water in Area 47.

Area 47 has very little natural surface-water storage except in the northeast part where lakes and prairie potholes occur in a thick layer of glacial drift. The economic development of the area has depended largely on the development of manmade storage. The location of manmade and natural reservoirs and lakes with capacities in excess of 50 acre-feet is shown in figure 7.2-1. The capacities at these locations are listed in section 11.4. In addition to those listed, there are hundreds of smaller reservoirs created by small dams for livestock use. The storage at the sites shown in figure 7.2-1 generally has multiple uses; municipal and industrial supplies, irrigation, flood control, recreation, fish and wildlife, and livestock.

Small reservoirs and lakes may be especially vulnerable to adverse effects and destruction through surface mining. The shallow ephemeral ponds, which are used primarily for waterfowl production and small animal protection, may be difficult to replace if destroyed as it has taken several hundred years to develop the present hydrologic and ecologic systems.

The larger reservoirs and lakes already are being impacted by diversion due to energy development. Municipal demands are greater than available supplies in several localities. Lake Sakakawea, bordering the area on the north, is the one large source of water considered a solution to many of the supply problems if distribution systems can be implemented.



EXPLANATION

- RESERVOIR OR LAKE SITE
- RESERVOIR OR LAKE SITE WHERE WATER-QUALITY DATA ARE AVAILABLE

85 MAP NUMBER

FIGURE 7.2-1—Location of reservoirs and lakes with capacities in excess of 50 acre-feet.

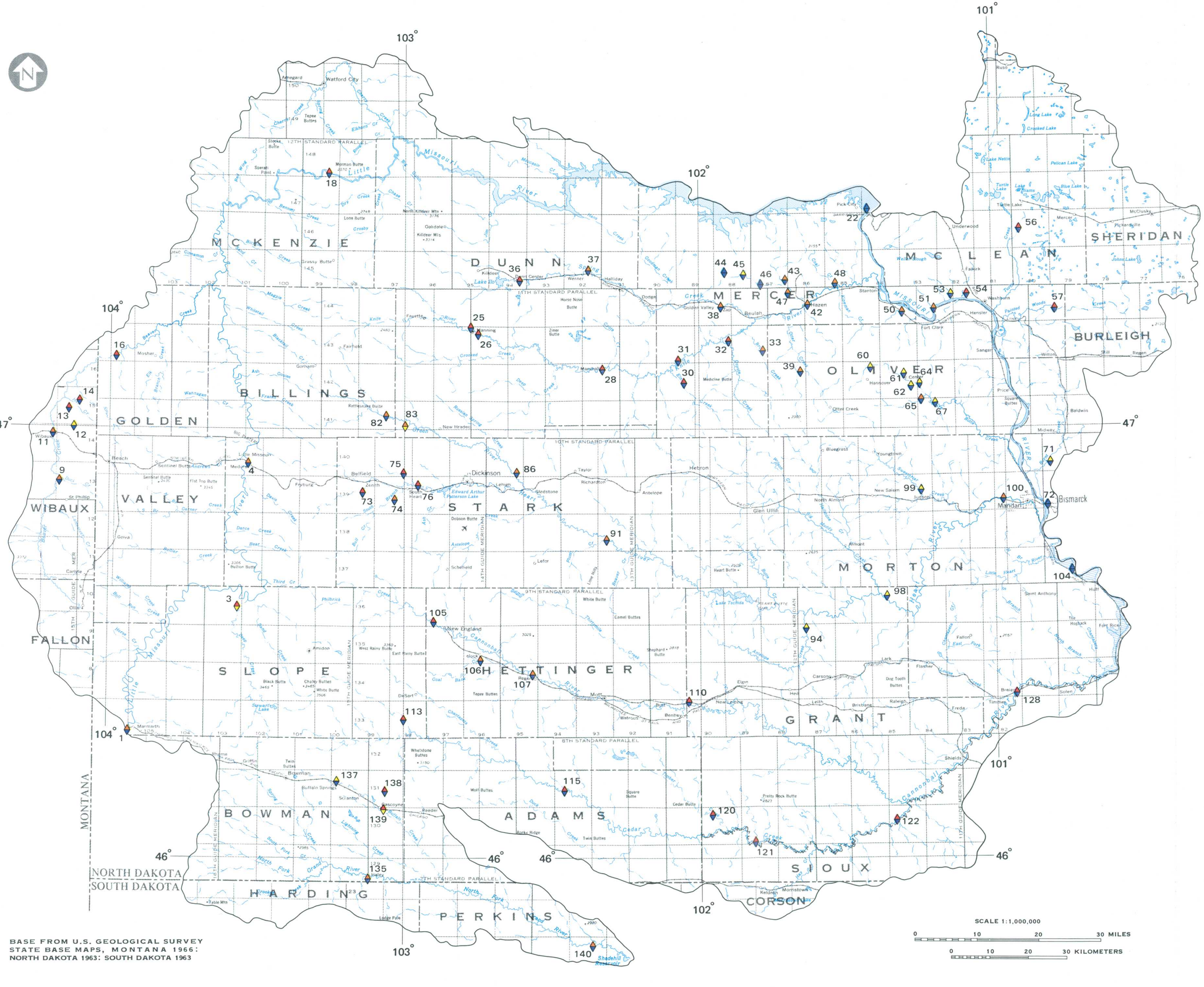
The Dissolved-Solids Concentration of Most Streams Varies with Discharge

Changes in dissolved solids due to mining could be difficult to quantify because of the natural variability in the streams.

Dissolved-solids concentrations vary greatly in water from all streams in Area 47 except the Missouri River (fig. 7.3.1-1). The most common dominant cations are calcium, magnesium, and sodium and the dominant anions are bicarbonate, sulfate, and chloride. Large dissolved-solids concentrations can be objectionable because of possible physiological effects, mineral taste, or economic problems associated with their removal.

Numerous standards have been established for dissolved solids. Generally it is desirable to have less than 500 milligrams per liter for public water supplies. During snowmelt runoff or high runoff from thunderstorms, most streams in the area have less than 500 milligrams per liter of dissolved solids. During periods of low flow, dissolved-solids concentrations in water from many of the streams will exceed 1,300 milligrams per liter, an approximate concentration at which the water will acquire a mineralized taste.

Water containing dissolved-solids concentrations in excess of 2,500 milligrams per liter has only limited use; however, livestock will tolerate as much as 4,500 milligrams per liter (McKee and Wolf, 1971). Dissolved-solids concentrations of water in many streams will exceed 2,500 milligrams per liter during extreme low flows when ground-water discharge is the primary source of water.



EXPLANATION

DISSOLVED SOLIDS, IN MILLIGRAMS PER LITER

- Greater than 2500
- 1300-2500
- 500-1300
- 0-500

WATER-QUALITY STATION

Maximum / Minimum } Dissolved solids, in milligrams per liter

99 STATION NUMBER

BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, MONTANA 1966: NORTH DAKOTA 1963: SOUTH DAKOTA 1963

FIGURE 7.3.1-1—Dissolved-solids concentrations at selected stream stations.

Alkaline pH Values Characterize Most Streams

Coal mining in the area is unlikely to cause acid drainage.

Acidity and alkalinity generally are expressed in terms of pH units. Values less than 7.0 denote acidic water and those greater than 7.0 denote alkaline water. The pH of pure water at 25°C is 7.00. Atmospheric precipitation in equilibrium with average natural atmospheric-gas concentrations will have a pH of about 5.7 (Lerman, 1979). Bulk atmospheric-precipitation pH values as small as 4.0 and as large as 8.2 have been measured in Area 47. The annual volume-weighted mean pH value for precipitation at Dunn Center, near the northern border of the area, was 4.5 during 1980 (Angelo and Anderson, 1981).

Unpolluted streams draining undisturbed basins generally will have alkaline water. Values of pH in streams commonly range from about 6.5 to 8.5. Even though there is a significant degree of basin disturbance due to mining in Area 47, the surface waters generally are still alkaline, as shown in figure 7.3.2-1. The surface waters are buffered by carbonate minerals in the prairie soils, and stream pH decreases to less than 7.0 only during major precipitation or immediately adjacent to acid sources such as coal outcrops.

The oxidation of sulfur species in the coal mining areas generally will cause a decrease in pH. However, in Area 47, the prevalence of soils with moderate buffering capacity makes acid drainage unlikely.

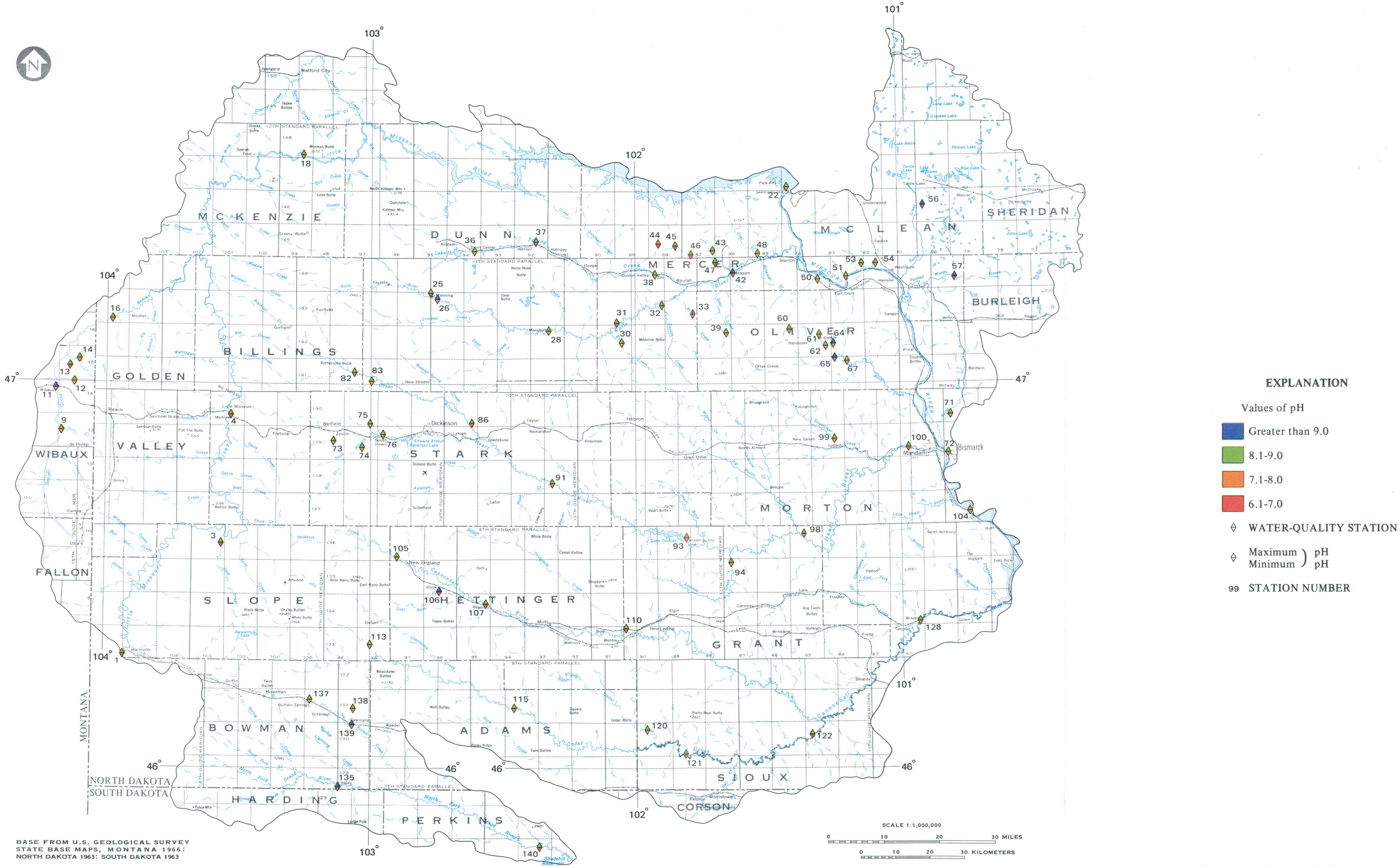


FIGURE 7.3.2-1—Values of pH at selected stream stations.

Dissolved-Sulfate Concentrations in Excess of 500 Milligrams per Liter Occur in Most Streams

Dissolved sulfate is quite variable with concentrations usually less than 250 milligrams per liter during high flows and greater than 500 milligrams per liter during low flows.

Dissolved-sulfate concentrations appear to vary greatly in the streams within the area, as shown in figure 7.3.3-1. Sulfate concentrations generally are discharge dependent with concentrations on most streams less than 250 milligrams per liter during snowmelt runoff and runoff from intense thunderstorms, and more than 500 milligrams per liter at low flows when streamflow is dominated by ground-water discharge. The U.S. Environmental Protection Agency National Secondary Drinking Water Regulations set an upper limit for sulfate concentrations in public water of 250 milligrams per liter (U.S. Environmental Protection Agency, 1977). Concentrations in excess of 250 milligrams per liter can impart a taste to the water for some people, and concentrations in excess of about 500 milligrams per liter can have laxative effects in many people. McKee and Wolf (1971) recommend a threshold limit for cattle consumption at 1,000 milligrams per liter, which generally is not exceeded except at extreme low flows in some of the small drainage basins.

The variation of sulfate concentrations with discharge makes detection of changes due to mining problematical without a record of concentration variations through a wide range of discharges. The network of stations shown in figure 7.3.3-1 provides a substantial data base for providing this background information.

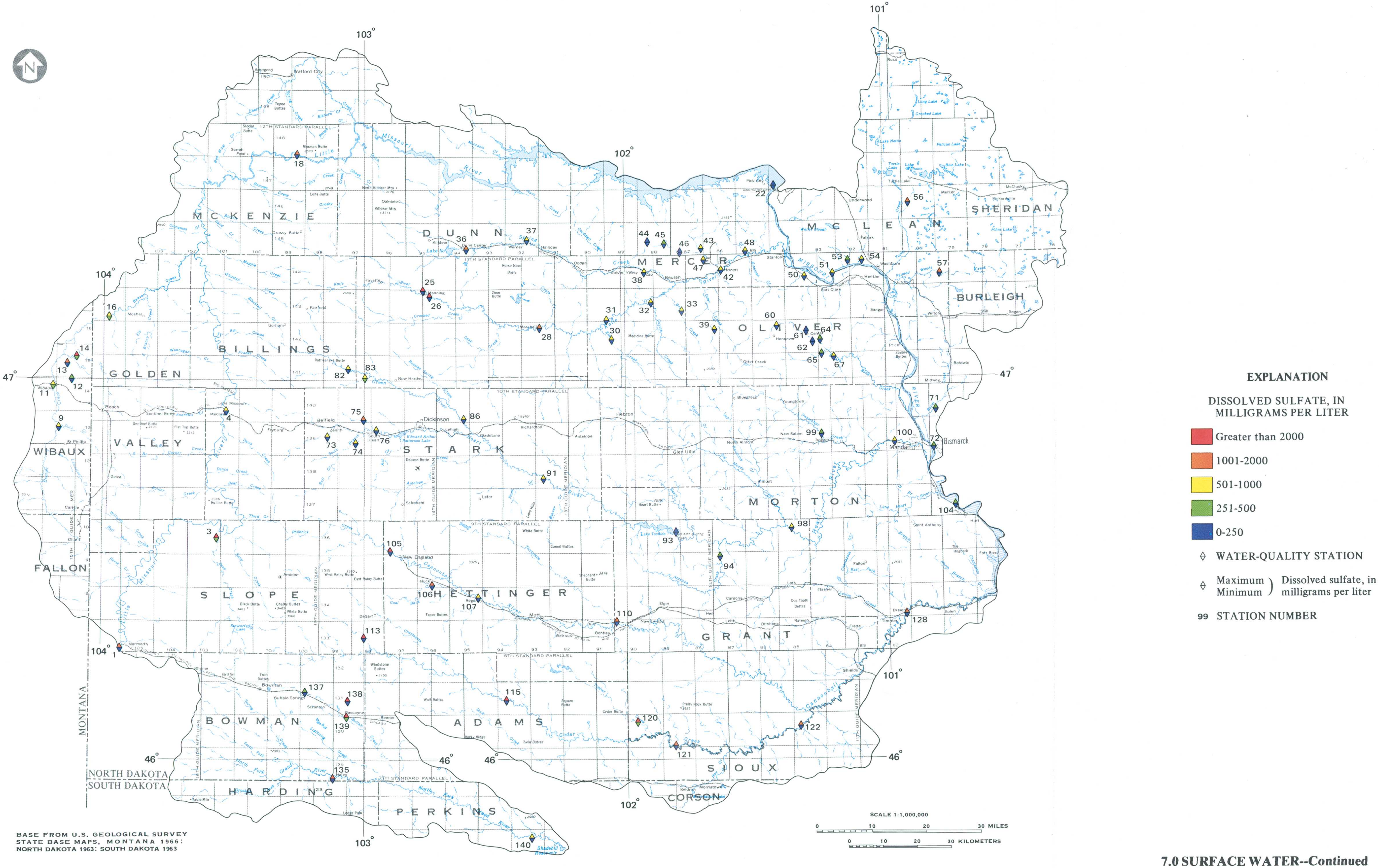


FIGURE 7.3.3-1.—Dissolved-sulfate concentrations at selected stream stations.

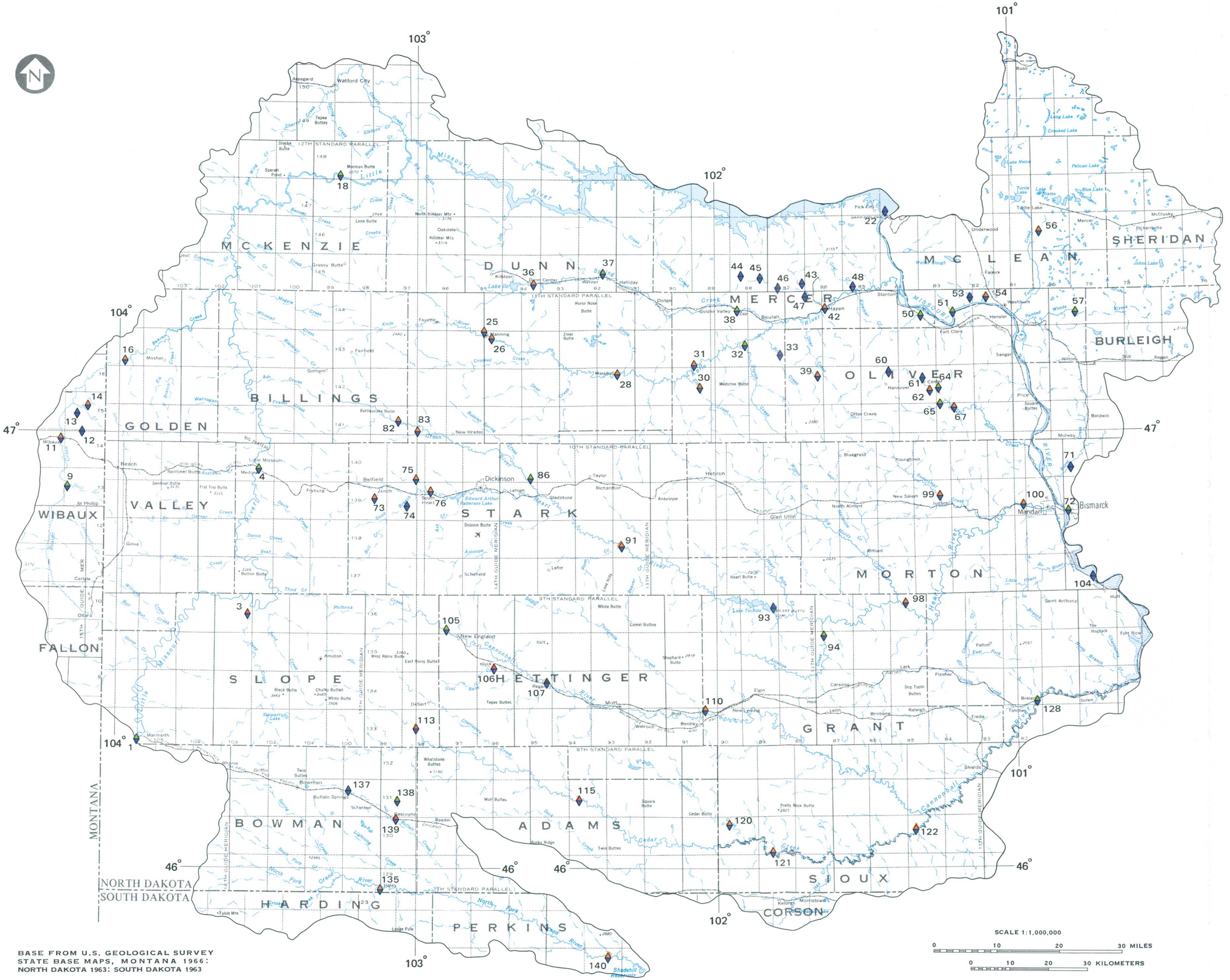
Boron May Serve as an Indicator for Trace-Element Changes

Boron concentrations generally are less than 0.5 milligrams per liter and exceed the maximum plant tolerance of 2.0 milligrams per liter in only a few scattered locations.

Changes in the concentration of boron, in the waters of the streams are suggested as an indicator of trace-element increase. Boron is an essential element for the growth of plants, but is needed only in very small concentrations. When small concentrations are exceeded, boron becomes toxic. Boron toxicity occurs in limited, scattered areas in arid or semiarid regions. Boron generally is not toxic at concentrations less than 0.5 milligrams per liter (McKee and Wolf, 1971). Sensitive plants can be damaged with concentrations from 0.5 to 1.0 milligrams per liter. The maximum concentration recommended for semitolerant plants is 1.0 milligrams per liter and for tolerant plants it is 2.0 milligrams per liter (National Academy of Sciences-National Academy of Engineering, 1972).

Excess boron frequently is present in saline soils as a result of evaporative processes. New spoils from mine areas are commonly enriched in carbonaceous material with a large boron concentration and could be a source of increased boron in the streams.

Release of water, which has had a significant residence time, from ponds whose main source of discharge is through evaporation also could cause abrupt increases in boron. Boron concentrations have been less than 0.5 milligrams per liter, at least part of the time, at all stations (fig. 7.3.4-1). The small concentrations occur during high flows. During low flows, boron occasionally increases to greater than 2.0 milligrams per liter at a few stations. These increases could be due to large boron concentrations in some ground-water discharges or sudden flushes from evaporative ponds. A history of boron concentrations would be necessary to detect changes at a selected site.



BASE FROM U.S. GEOLOGICAL SURVEY STATE BASE MAPS, MONTANA 1966: NORTH DAKOTA 1963: SOUTH DAKOTA 1963

SCALE 1:1,000,000

0 10 20 30 MILES

0 10 20 30 KILOMETERS

EXPLANATION

DISSOLVED BORON, IN MILLIGRAMS PER LITER

- Greater than 2.0
- 1.0-2.0
- 0.5-1.0
- Less than 0.5

WATER-QUALITY STATION

Maximum / Minimum — Dissolved boron, in milligrams per liter

99 STATION NUMBER

FIGURE 7.3.4-1—Dissolved boron concentrations at selected stream stations.

Suspended-Sediment Data Limited

Most sediment data available for small drainage basins have been collected only in recent years.

Prior to 1977, most sediment data were collected near the mouths of the major tributaries of the Missouri River. Since 1977, mainly in response to increased energy development, sediment data also have been collected at many other stations (fig. 7.3.5-1). The data generally are a determination of the sediment concentration at the time of streamflow-discharge measurements. In addition, occasional size analyses were made. The relationship between the sediment concentration and measured discharge at a station on Coal Bank Creek (station 106) is shown in figure 7.3.5-2. There is no curve of relationship discernible from the plotted points. The data scatter is typical for small basins in the area. The lack of correlation is due to the great variability of factors such as soil types; soil conditions (frozen, thawed, degree of saturation, and tillage); land use; precipitation intensity, rapidity of snowmelt; and the time of sampling in relation to hydrologic events.

The data available are almost all from areas of undeveloped energy resources. It would be exremely difficult, if not impossible, to extrapolate these data to estimate the effects of mining or other land-use changes. It is unlikely that cumulative effects of energy development will be detectable at the downstream stations on the major streams for many years.

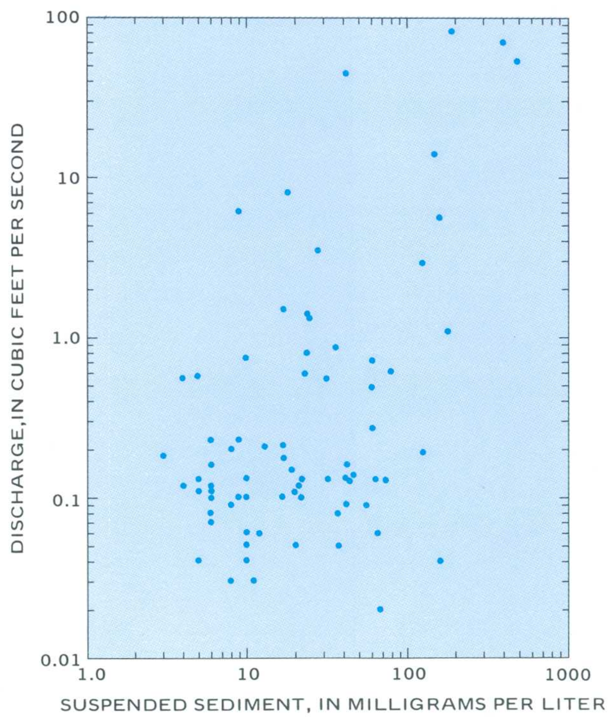
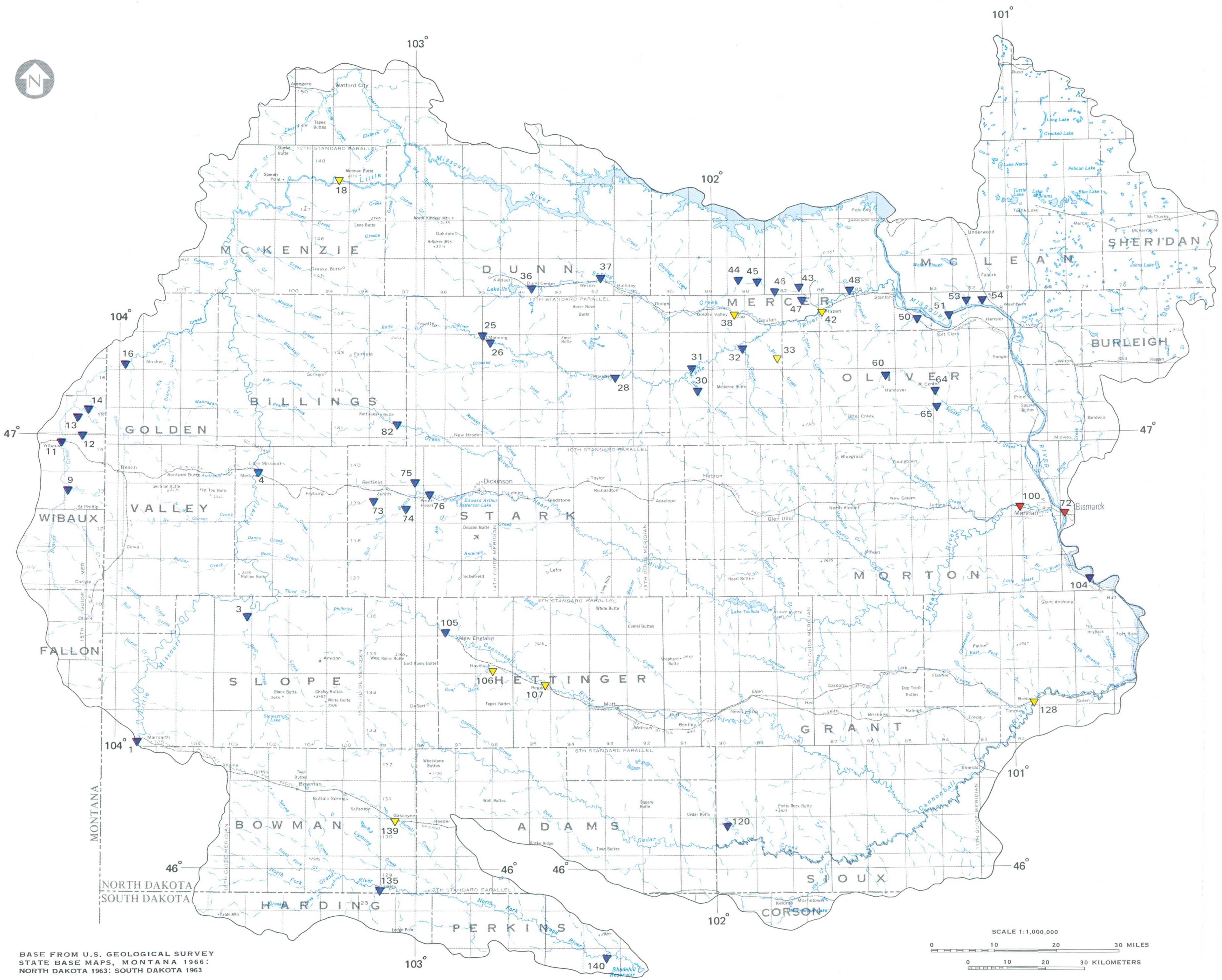


FIGURE 7.3.5-2—**Variability of suspended sediment concentrations with discharge, Coal Bank Creek near Havelock, North Dakota, May 1975 to September 1981.**



EXPLANATION

NUMBER OF YEARS FOR WHICH SEDIMENT DATA ARE AVAILABLE AS OF 1981

- Greater than 10
- 5-10
- 1-5
- ▽ WATER-QUALITY STATION
- 9 STATION NUMBER

FIGURE 7.3.5-1—Suspended-sediment records at selected stream stations.

Glacial and Alluvial Deposits Sources of Ground Water

Glacial sand and gravel deposits will yield large quantities of ground water; alluvial clay, silt, sand, and gravel deposits yield smaller quantities of water

Unconsolidated sand and gravel deposits of glacial origin are very permeable and can yield large quantities of ground water. The major glacial-drift and alluvial aquifers are shown in figure 8.1.1-1. The glacial aquifers were deposited in river valleys formed by melt water from glaciers that extended into the eastern part of the area until about 12,000 years ago. These valleys range from 0.25 to 2 miles in width and may be as much as 300 feet deep. In addition, a few preglacial river valleys contain sand and gravel aquifers. The preglacial drainages range from 0.5 to 5 miles in width and may be as much as 400 feet deep.

The glacial aquifers range in thickness from 5 to 300 feet; however, the average thickness is about 80 feet. Aquifer tests indicate that wells developed in the glacial aquifers generally will yield 50 to 500 gallons per minute. In some places, yields of as much as 1,000 gallons per minute are obtainable.

Ground water also is obtainable from isolated sand and gravel lenses in the glacial till. These lenses appear to be randomly distributed, both laterally and vertically. Yields from these isolated aquifers generally range from about 1 to 10 gallons per minute.

Alluvial deposits consisting of clay, silt, sand, and gravel occur in stream valleys throughout the area. The alluvial aquifers generally range in thickness from 5 to 30 feet. Estimated yields from these aquifers range from 1 to 100 gallons per minute.

Detailed information about the aquifers can be obtained from the North Dakota State Water Commission, 900 East Boulevard, Bismarck, N. Dak.

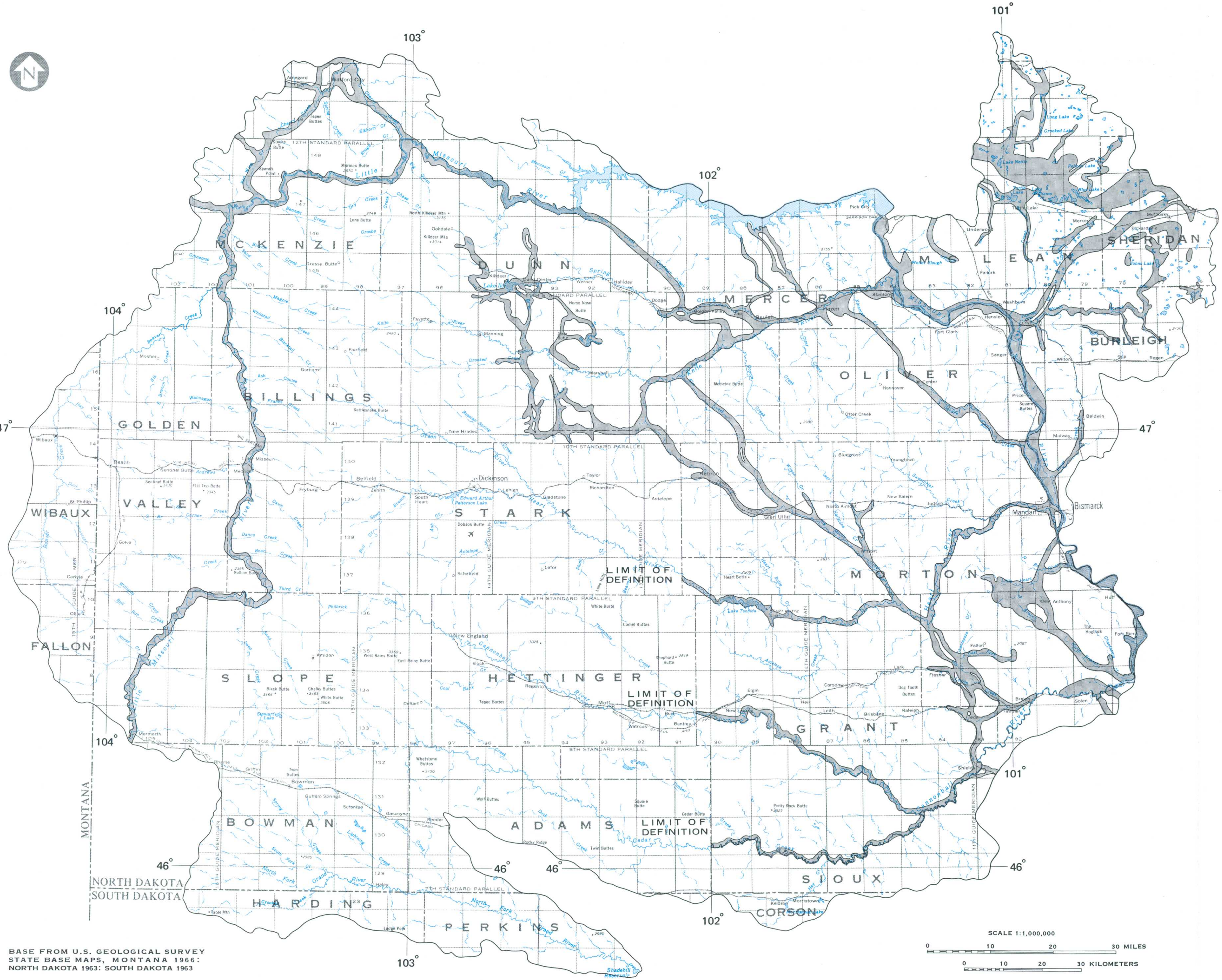


FIGURE 8.1.1-1—Glacial-drift and alluvial aquifers.

Bedrock a Dependable Source of Water

Sandstone of Late Cretaceous age and sandstone and lignite of Paleocene age are important sources of water.

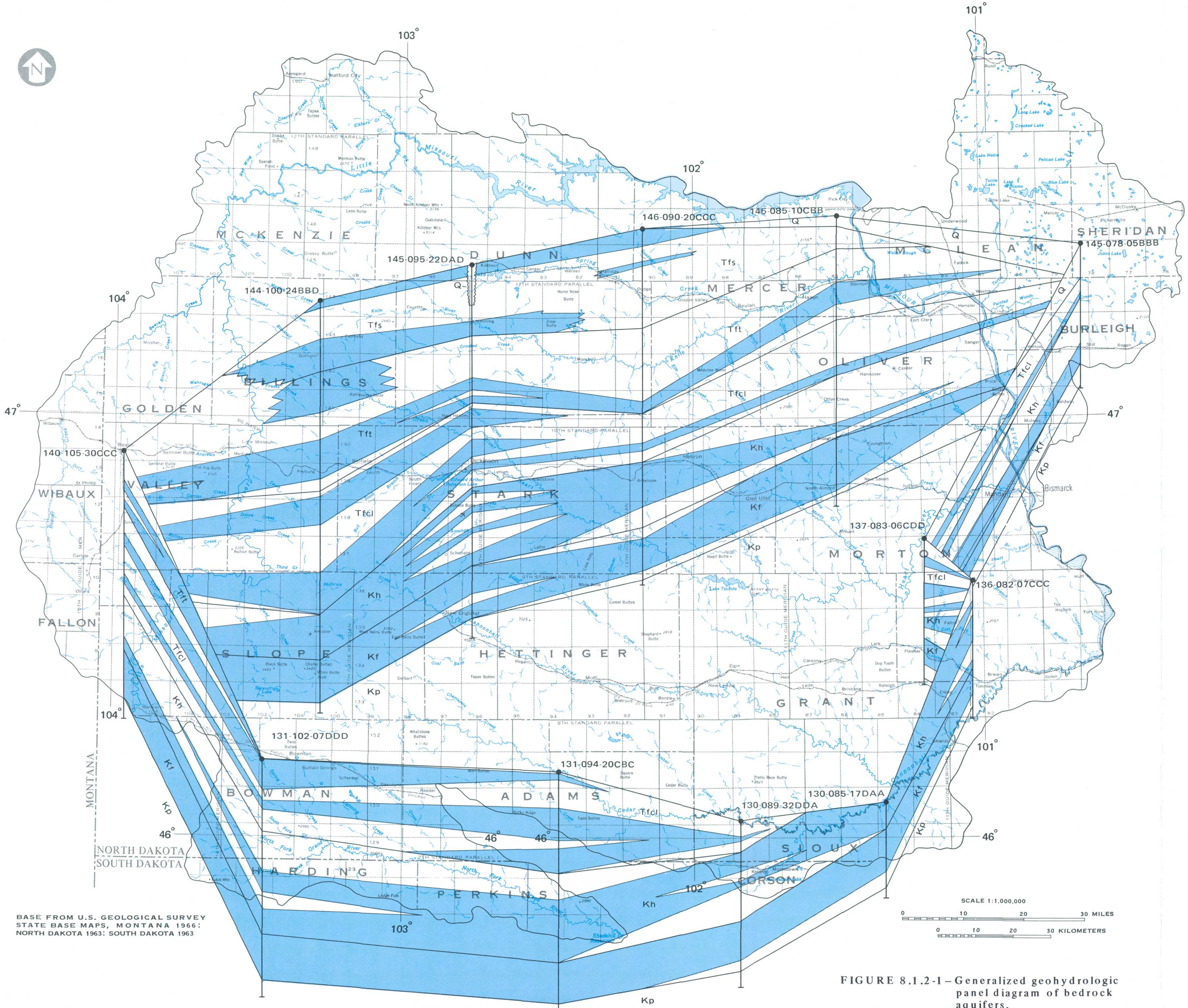
Bedrock aquifers, consisting of sandstone and lignite, underlie all of Area 47, and are the only sources of ground water throughout most of the study area. The configuration of the aquifers and the aquifer relation to named stratigraphic units are shown in figure 8.1.2-1 and table 8.1.2-1. Yields to wells developed in these aquifers will vary depending on the thickness of the aquifer and the rate at which water will move through the aquifer.

Permeable sandstones in the Upper Cretaceous Hell Creek and Fox Hills stratigraphic units will yield from 1 to as much as 300 gallons of water per minute. Aquifers in the Tertiary stratigraphic units consist of permeable, semiconsolidated sandstone and fractured lignite. The sandstone aquifers will yield from 1 to as much as 100 gallons of water per minute and yields from the lignite aquifers will range from 1 to as much as 200 gallons per minute.

Additional information about the bedrock aquifers can be obtained from the North Dakota State Water Commission, 900 East Boulevard, Bismarck, N. Dak.

TABLE 8.1.2-1 – Geohydrologic units.

System	Series	Group, formation, or member		Aquifer characteristics
Quaternary	Holocene and Pleistocene	Undifferentiated deposits		Alluvium and glacial drift: clay, silt, sand, and gravel.
			Sentinel Butte Member	Interbedded siltstone, claystone, sandstone, and lignite.
Tertiary	Paleocene	Fort Union Formation	Tongue River Member	Interbedded siltstone, claystone, sandstone, and lignite.
			Cannonball and Ludlow Members	Sandstone, mudstone, and lignitic shale.
Cretaceous	Upper Cretaceous		Hell Creek Formation	Interbedded sandstone, claystone, and lignitic shale.
		Montana Group	Fox Hills Sandstone	Sandstone interbedded with siltstone, shale and sandy shale.
			Pierre Shale	Shale, black, silty, siliceous.



EXPLANATION

Q	ALLUVIUM OR GLACIAL DRIFT	QUATERNARY
	FORT UNION FORMATION	TERTIARY
Tfs	Sentinel Butte Member	
Tft	Tongue River Member	
Tfcl	Cannonball and Ludlow Members, undifferentiated	
Kh	HELL CREEK FORMATION	CRETACEOUS
Kf	FOX HILLS SANDSTONE	
Kp	PIERRE SHALE	

SANDSTONE AND LIGNITE AQUIFERS, UNDIFFERENTIATED

FORMATION CONTACT

MEMBER CONTACT

TEST HOLE

136-082-07CCC
Location number
Total depth

VERTICAL SCALE

Feet

0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000

FIGURE 8.1.2-1 – Generalized geohydrologic panel diagram of bedrock aquifers.

Water Quality of Glacial and Alluvial Aquifers Varies

The chemical quality of water in glacial and alluvial deposits is suitable for many purposes.

The quality of water in glacial-drift and alluvial aquifers is affected by the solubility of minerals in the rocks and soil, by temperature, pressure, the length of time the water is in contact with the rocks and soil, and the acidity and degree of oxygenation of the water. Ground water that has moved a long distance from the recharge area with concomitent long residence time generally is more mineralized than water that has been in transit a short time.

Water from wells developed in glacial-drift and alluvial aquifers has considerable compositional variability. Sodium and calcium generally are the principal cations present but magnesium is sometimes abundant in waters dominated by calcium. Bicarbonate and sulfate are the dominant anions present. The most abundant water composition in these aquifers is characterized by sodium and bicarbonate dominance. Some of the shallower aquifers, which generally extend to depths of less than 100 feet, will yield water characterized by calcium or calcium and magnesium cations and bicarbonate anions.

Dissolved-solids concentrations, which ranged from about 200 to as much as 9,700 milligrams per liter, commonly increase with depth. Sulfate concentrations ranged from 0 to 6,500 milligrams per liter, and iron concentrations from 0 to 18 milligrams per liter. Values of pH ranged from 7.0 to 8.8.

The ranges of dissolved solids, sulfate, and iron concentrations and of pH values for the counties in which glacial-drift and alluvial aquifers occur are shown in figure 8.2.1-1.

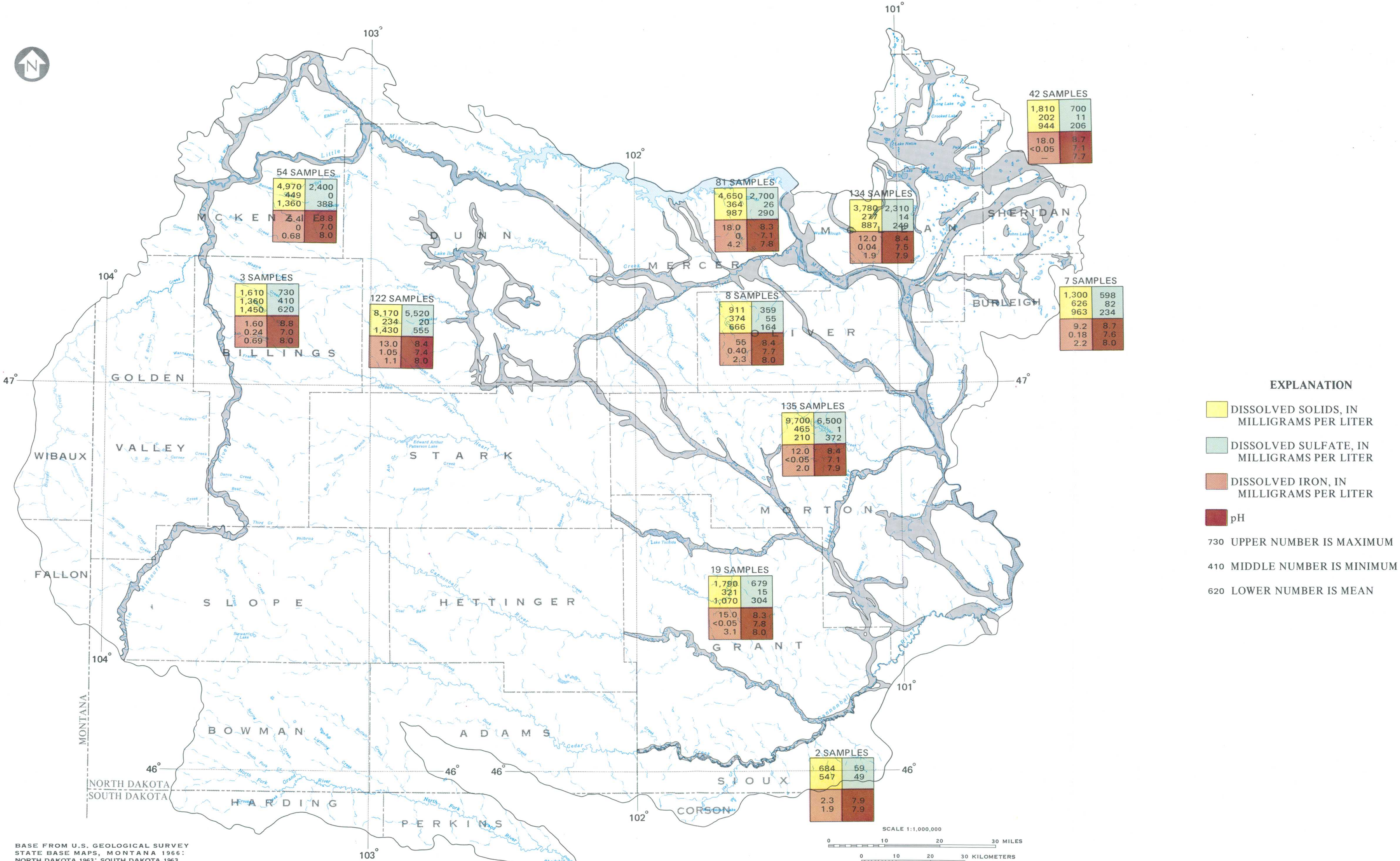


FIGURE 8.2.1-1—Water quality in glacial-drift and alluvial aquifers for counties or parts of counties in study area.

Water Quality Defined for the Upper Cretaceous Aquifers

The chemical quality of water from the Cretaceous aquifers generally is suitable for domestic and livestock uses.

Water from the Upper Cretaceous Fox Hills Sandstone and Hell Creek Formation generally is characterized by sodium and bicarbonate ions. Local exceptions are present in the recharge area in the southwest part of the area and in the discharge areas in the east. Locally large calcium, magnesium, and sulfate concentrations have been detected in water from wells deeper than 200 feet. Sodium commonly constitutes more than 90 percent of the cations where calcium and magnesium have been removed by cation exchange in the overlying beds of siltstone and claystone.

Sulfate is rapidly replaced by bicarbonate as the major anion as a result of sulfur reduction as water moves downgradient from the recharge area (to the east and northeast). Chloride concentrations also increase from southwest to northeast (fig. 8.2.2-1). Similar changes take place with increasing depth in the aquifers.

Dissolved-solids concentrations increase from southwest to northeast, but generally are smaller than in the overlying aquifers. Large dissolved-solids concentrations coupled with large sodium-adsorption ratios make the water unsuitable for irrigation, except locally near the outcrop areas. Water from Upper Cretaceous aquifers generally is suitable for domestic, livestock, and some industrial use. The water generally is soft, less than 60 milligrams per liter hardness as $CaCO_3$. Large fluoride concentrations have been detected in water from some wells. Because of large sodium concentrations, some water is unsuitable for people on sodium-restricted diets.

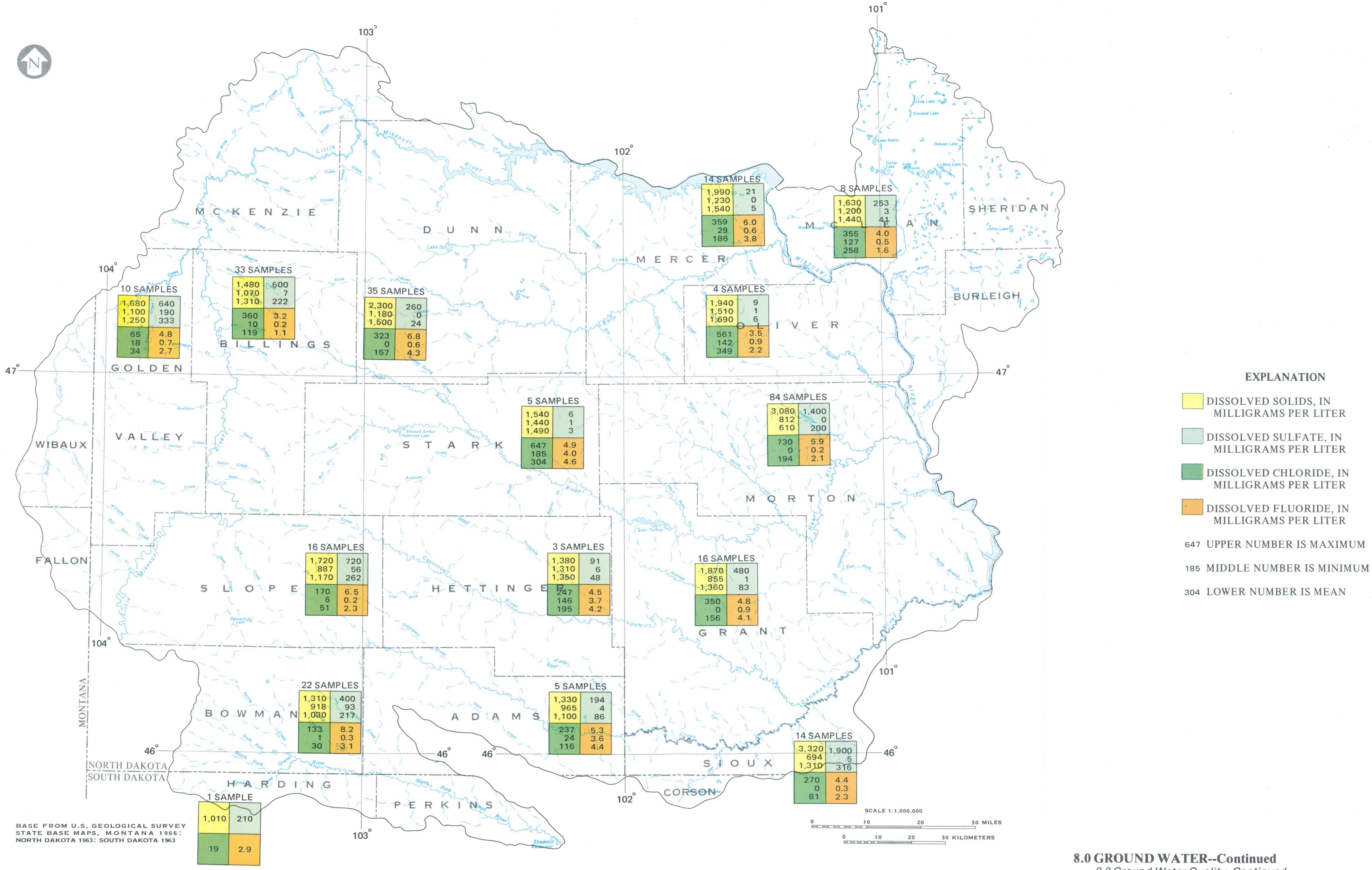


FIGURE 8.2.2-1—Water quality in aquifers of the Hell Creek Formation and Fox Hills Sandstone for counties or parts of counties in the study area.

Water Quality Well Defined for Tertiary Aquifers

The chemical quality of water from the Tertiary aquifers is quite variable but generally is suitable for domestic and livestock uses.

Water from aquifers at depths greater than about 200 feet in the Tertiary Fort Union Formation generally is dominated by sodium and bicarbonate ions. Calcium and magnesium concentrations are small due to cation exchange for sodium in the overlying siltstones and claystones. Dissolved-solids concentrations (fig. 8.2.3-1) generally are greater than in the Cretaceous aquifers, but chemical composition is similar. Sulfate is a minor constituent, with concentrations generally less than 100 milligrams per liter, due to sulfate reduction as the water moves downward. Larger sulfate concentrations characterize water beneath lignite outcrops. The water generally is soft (less than 60 milligrams per liter calcium carbonate).

The water from depths of less than 200 feet is much more variable in chemical quality. Dominant ions vary from calcium and bicarbonate to calcium and sulfate and from sodium and bicarbonate to sodium and sulfate. The water ranges from soft to very hard (more than 180 milligrams per liter calcium carbonate). Iron concentrations are large locally. Some water is undesirable for domestic or municipal use because of the large iron or sulfate concentrations, or both. Chloride concentrations are smaller than in the underlying aquifers. The water commonly is colored due to the presence of organic compounds.

Water suitable for domestic and livestock use can be found in Tertiary aquifers of the Fort Union Formation in most places. Large sulfate or iron concentrations are present locally. Fluoride increases downgradient (southwest to northeast) and can exceed the limits recommended by the U.S. Environmental Protection Agency (1976). Commonly, water with the best quality for the above uses is in the coal itself. The water from Tertiary aquifers generally is not satisfactory for irrigation due to large sodium and dissolved-solids concentrations.

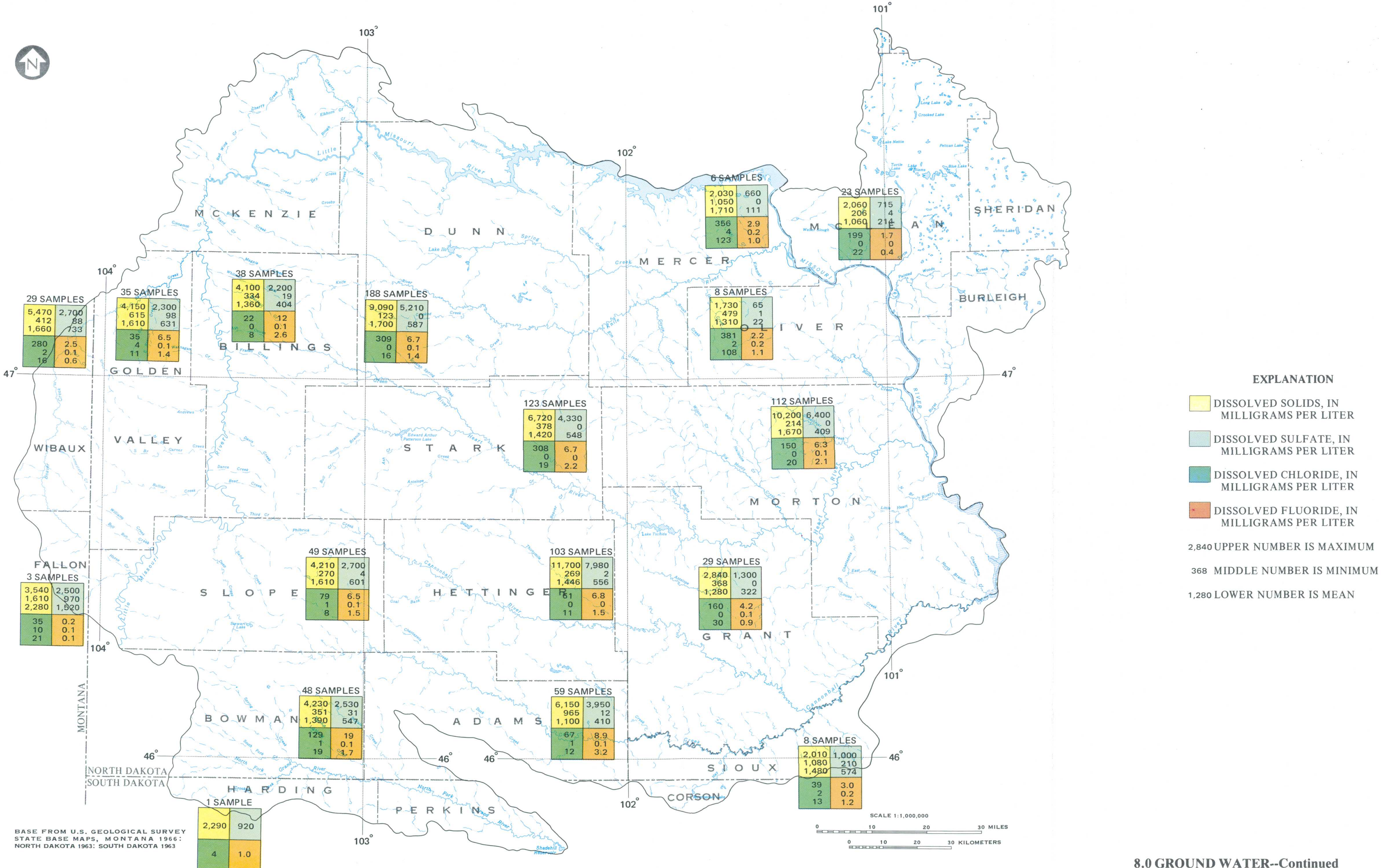


FIGURE 8.2.3-1- Water quality in aquifers of the Fort Union Formation for counties or parts of counties in the study area.

NAWDEX, WATSTORE, OWDC Have Water-Data Information

Water data are collected in coal areas by a large number of organizations in response to a wide variety of missions and needs.

Within the U.S. Geological Survey there are three activities that help to identify and improve access to the vast amount of existing water data.

(1) The National Water Data Exchange (NAWDEX), which indexes the water data available from over 400 organizations and serves as a central focal point to help those in need of water data to determine what information already is available.

(2) The National Water Data Sforage and Retrieval System (WATSTORE), which serves as the central repository of water data collected by the U.S. Geological Survey and which contains large volumes of data on the quantity and quality of both surface and ground waters.

(3) The Office of Water Data Coordination (OWDC), which coordinates Federal water-data acquisition activities and maintains a "Catalog of Information on Water Data." To assist in identifying available water-data activities in coal provinces of the United States special indexes to the Catalog are being printed and made available to the public.

A more detailed explanation of these three activities is given in sections 9.2, 9.3, and 9.4.

NAWDEX Simplifies Access to Water Data

The National Water Data Exchange (NAWDEX) is a nationwide program managed by the U.S. Geological Survey to assist users of water data or water-related data in identifying, locating, and acquiring needed data.

NAWDEX is a national confederation of water-oriented organizations working together to make their data more readily accessible and to facilitate more efficient exchange of water data.

Services are available through a Program Office located at the U.S. Geological Survey's National Center in Reston, Va., and a nationwide network of Assistance Centers located in 45 States and Puerto Rico, which provide local and convenient access to NAWDEX facilities (see fig. 9.2-1). A directory is available on request that provides names of organizations and persons to contact, addresses, telephone numbers, and office hours for each of these locations [Directory of Assistance Centers of the National Water Data Exchange (NAWDEX), U.S. Geological Survey Open-File Report 79-423 (revised)].

NAWDEX can assist any organization or individual in identifying and locating needed water data and referring the requestor to the organization that retains the data required. To accomplish this service, NAWDEX maintains a computerized Master Water Data Index (fig. 9.2-2), which identifies sites for which water data are available, the type of data available for each site, and the organization retaining the data. A Water Data Sources Directory (fig. 9.2-3) also is maintained that identifies organizations that are sources of water data and the locations within these organizations from which data may be obtained. In addition NAWDEX has direct access to some large water-data bases of its members and has reciprocal agreements for the exchange of services with others.

Charges for NAWDEX services are assessed at the option of the organization providing the requested data or data service. Search assistance services are provided free by NAWDEX to the greatest extent possible. Charges are assessed, however, for those requests requiring computer cost, extensive personnel time, duplicating services, or other costs encountered by NAWDEX in the course of providing services. In all cases, charges assessed by NAWDEX Assistance Centers will not exceed the direct costs incurred in responding to the data request. Estimates of cost are provided by NAWDEX upon request and in all cases where costs are anticipated to be substantial.

For additional information concerning the NAWDEX program or its services contact:

Program Office
National Water Data Exchange (NAWDEX)
U.S. Geological Survey
421 National Center
12201 Sunrise Valley Drive
Reston, VA 22092
Telephone (703)860-6031
FTS 928-6031
Hours: 7:45-4:15 Eastern Time

or

NAWDEX ASSISTANCE CENTER
NORTH DAKOTA
U.S. Geological Survey
Water Resources Division
821 East Interstate Avenue
Bismarck, ND 58501
Telephone (701)255-4011, extension 607
FTS 783-4607
Hours: 8:00-5:00 Central Time

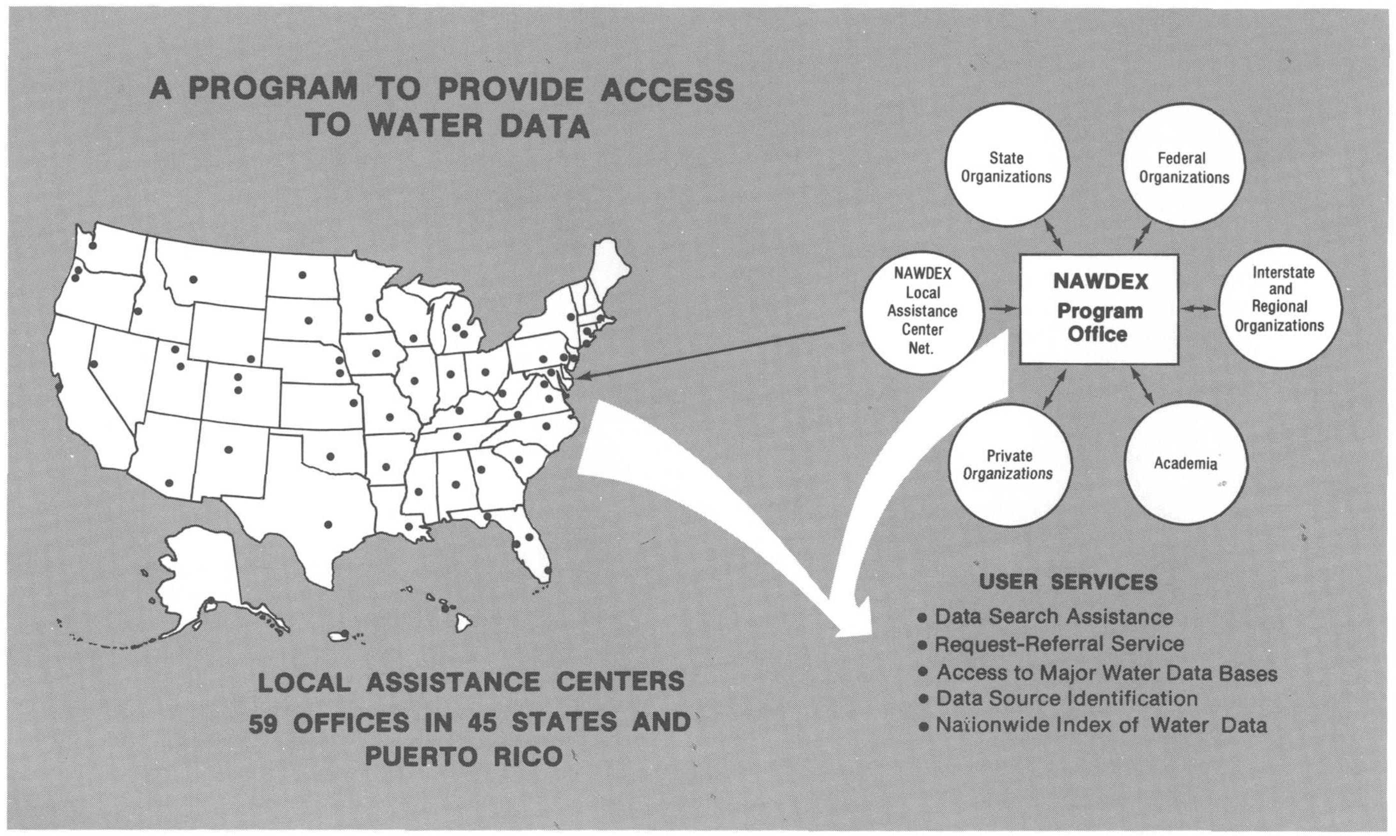


FIGURE 9.2-1—Access to water data.

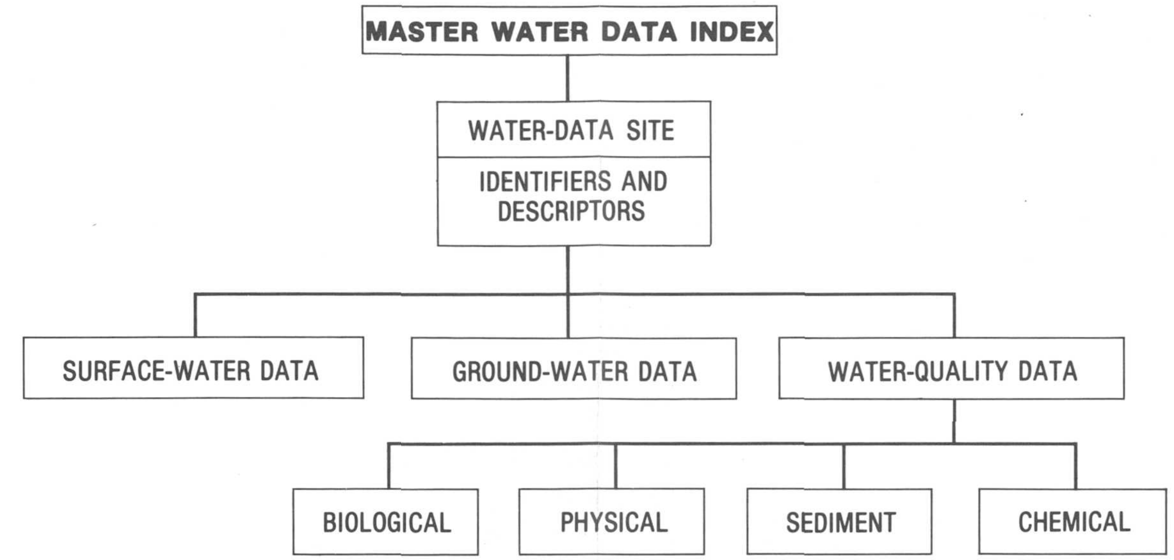


FIGURE 9.2-2—Master water-data index.

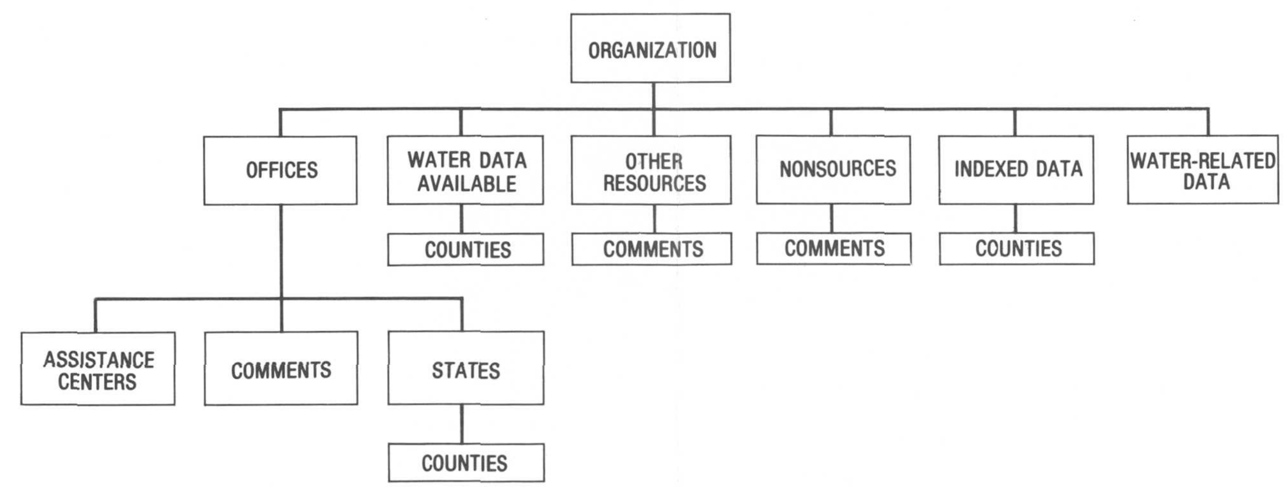


FIGURE 9.2-3—Water-data sources directory.

WATSTORE Automated Data System

The National Water Data Storage and Retrieval System (WATSTORE) of the U.S. Geological Survey provides computerized procedures and techniques for processing water data and provides effective and efficient management of data-releasing activities.

The National Water Data Storage and Retrieval System (WATSTORE) was established in November 1971 to computerize the U.S. Geological Survey's existing water-data system and to provide for more effective and efficient management of its data-releasing activities. The system is operated and maintained on the central computer facilities of the Survey at its National Center in Reston, Va. Data may be obtained from WATSTORE through the Water Resources Division's 46 district offices. General inquires about WATSTORE may be directed to:

Chief Hydrologist
U.S. Geological Survey
437 National Center
Reston, VA 22092

or

U.S. Geological Survey
Water Resources Division
821 East Interstate Avenue
Bismarck, ND 58501

The Geological Survey currently (1982) collects data at approximately 16,000 stream-gaging stations, 1,000 lakes and reservoirs, 5,200 surface-water quality stations, 1,020 sediment stations, 30,000 water-level observation wells, and 12,500 ground-water quality wells. Each year many water-data collection sites are added and others are discontinued; thus, large amounts of diversified data, both current and historical, are amassed by the Survey's data-collection activities.

The WATSTORE system consists of several files in which data are grouped and stored by common characteristics and data-collection frequencies. The system also is designed to allow for the inclusion of additional data files as needed. Currently, files are maintained for the storage of: (1) Surface-water, quality-of-water, and ground-water data measured on a daily or a more frequently than daily basis; (2) annual peak values for streamflow stations; (3) chemical analyses for surface- and ground-water sites; (4) water parameters measured more frequently than daily; and (5) geologic and inventory data for ground-water sites. In addition, an index file of sites for which data are stored in the system is also maintained (fig. 9.3-1). A brief description of each file is as follows:

Station Header File: All sites for which data are stored in the Daily Values, Peak Flow, Water-Quality, and Unit Values files of WATSTORE are indexed in this file. It contains information pertinent to the identification, location, and physical description of nearly 220,000 sites.

Daily Values File: All water-data parameters measured or observed either on a daily or on a more frequently than daily basis and numerically reduced to daily values are stored in this file. Instantaneous measurements at fixed-time intervals, daily mean values, and statistics such as daily maximum and minimum values also may be stored. This file currently contains over 200 million daily values including data on streamflow, river stages, reservoir contents, water temperatures, specific-conductance, sediment concentrations, sediment discharges, and ground-water levels.

Peak Flow File: Annual maximum (peak) streamflow (discharge) and gage height (stage) values at surface-water sites comprise this file, which currently contains over 400,000 peak observations.

Water-Quality File: Results of over 1.4 million analyses of water samples that describe the chemical, physical, biological, and radiochemical characteristics of both surface and ground waters are contained in this file. These analyses contain data for 185 different constituents.

Unit Values File: Water parameters measured on a schedule more frequent than daily are stored in this file. Rainfall, stream discharge, and temperature data are examples of the types of data stored in the Unit Values File.

Ground-Water Site-Inventory File: This file is maintained within WATSTORE independent of the files discussed above, but it is cross referenced to the Water-Quality File and the Daily Values File. It contains inventory data about wells, springs, and other sources of ground water. The data included are site location and identification, geohydrologic characteristics, well-construction history, and one-time field measurements such as water temperature. The file is designed to accommodate 255 data elements and currently contains data for nearly 700,000 sites.

All data files of the WATSTORE system are maintained and managed on the central computer facilities of the Geological Survey at its National Center. However, data may be entered into or retrieved from WATSTORE at a number of locations that are part of a nationwide telecommunications network.

Remote Job Entry Sites: Almost all of the Water Resources Division's district offices are equipped with high-speed computer terminals for remote access to the WATSTORE system. These terminals allow each site to put data into or retrieve data from the system within several minutes to overnight, depending upon the priority placed on the request.

Digital Transmission Sites: Digital recorders are used at many field locations to record values for parameters such as river stages, conductivity, water temperature, turbidity, wind direction, and chlorides. Data are recorded on 16-channel paper tape, which is removed from the recorder and transmitted over telephone lines to the receiver at Reston, Va. The data are recorded on magnetic tape for use on the central computer. Extensive testing of satellite data-collection platforms indicates their feasibility for collecting real-time hydrologic data on a national scale. Battery-operated radios are used as the communication link to the satellite. About 200 data relay stations are being operated currently (1982).

Central Laboratory System: The Water Resources Division's two water-quality laboratories located in Denver, Colo., and Atlanta, Ga., analyze more than 150,000 water samples per year. These laboratories are equipped to automatically perform chemical analyses ranging from determinations of simple inorganic compounds, such as chloride, to complex organic compounds, such as pesticides. As each analysis is completed, the results are verified by laboratory personnel and transmitted via a computer terminal to the central computer facilities to be stored in the Water-Quality File of WATSTORE.

Water data are used in many ways by decision makers for the management, development, and monitoring of our water resources. In addition to its data processing, storage, and retrieval capabilities, WATSTORE can provide a variety of useful products ranging from simple data tables to complex statistical analysis. A minimal fee, plus the actual computer cost incurred in producing a desired product, is charged to the requester.

Computer-Printed Tables: Users most often request data from WATSTORE in the form of tables printed by the computer. These tables may contain lists of actual data or condensed indexes that indicate the availability of data stored in the files. A variety of formats is available to display the many types of data.

Computer-Printed Graphs: Computer-printed graphs for the rapid analysis or display of data are another capacity of WATSTORE. Computer programs are available to produce bar graphs (histograms), line graphs, frequency distribution curves, X-Y point plots, site-location map plots, and other similar items by means of line printers.

Statistical Analyses: WATSTORE interfaces with a proprietary statistical package (SAS) to provide extensive analyses of data such as regression analyses, the analysis of variance, transformations, and correlations.

Digital Plotting: WATSTORE also makes use of software systems that prepare data for digital plotting on peripheral offline plotters available at the central computer site. Plots that can be obtained include hydrographs, frequency distribution curves, X-Y point plots, contour plots, and three-dimensional plots.

Data in Machine-Readable Form: Data stored in WATSTORE can be obtained in machine-readable form for use on other computers or for use as input to user-written computer programs. These data are available in the standard storage format of the WATSTORE system or in the form of punched cards or card images on magnetic tapes.

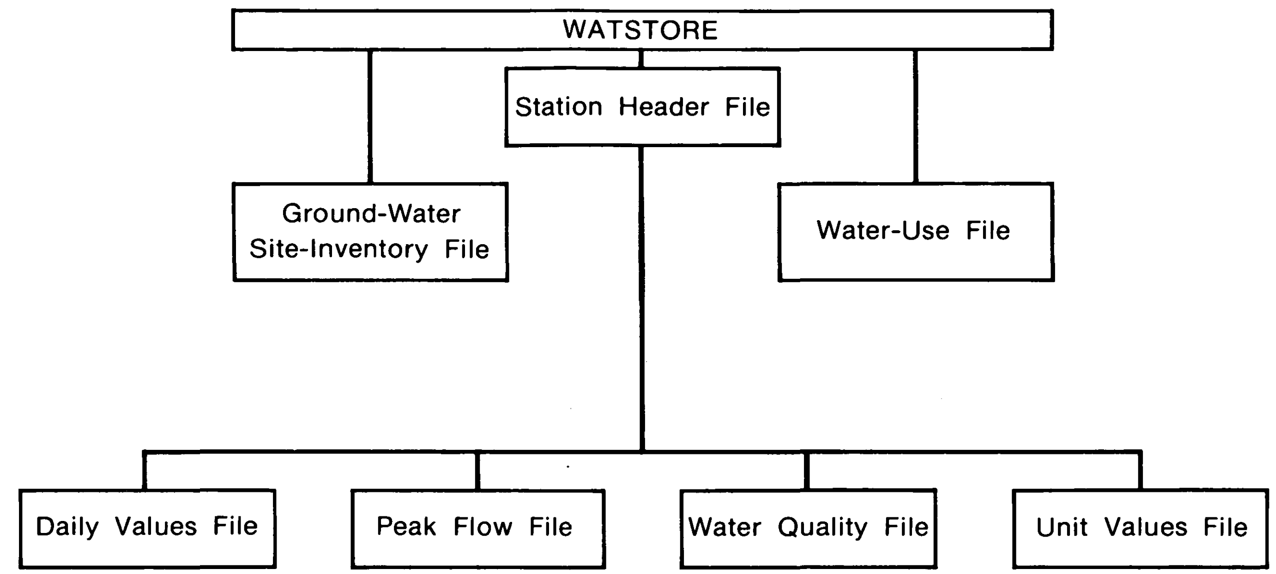


FIGURE 9.3-1—Index file stored data.

Water Data Indexed for Coal Provinces

A special index, "Index to Water-Data Activities in Coal Provinces of the United States," has been published by the U.S. Geological Survey's Office of Water Data Coordination (OWDC).

The "Index to Water-Data Activities in Coal Provinces of the United States" was prepared to assist those involved in developing, managing, and regulating the Nation's coal resources by providing information on the availability of water-resources data in the major coal provinces of the United States. It is derived from the "Catalog of Information on Water Data," which is a computerized information file about water-data acquisition activities in the United States and its territories and possessions, with some international activities included.

This special index consists of five volumes (fig. 9.4-1): Volume I, Eastern Coal province, volume II, Interior Coal province; volume III, Northern Great Plains and Rocky Mountain Coal provinces; volume IV, Gulf Coast Coal provinces; and volume V, Pacific Coast and Alaska Coal provinces. The information presented will aid the user in obtaining data for evaluating the effects of coal mining on water resources and in developing plans for meeting additional water-data needs. The report does not contain the actual data; rather, it provides information that will enable the user to determine if needed data are available.

Each volume of this special index consists of four parts: Part A, Streamflow and Stage Stations; Part B, Quality of Surface-Water Stations; Part C, Quality of Ground-Water Stations; and Part D, Areal Investigations and Miscellaneous Activities. Information given for each activity in Parts A-C includes: (1) The identification and location of the station, (2) the major types of data collected, (3) the frequency of data collection, (4) the form in which the data are stored, and (5) the agency or organization reporting the activity. Part D summarizes areal hydrologic investigations and water-data activities not included in the other parts of the index. The agencies that submitted the information, agency codes, and the number of activities reported by type are shown in a table.

Those who need additional information from the Catalog file or who need assistance in obtaining water data should contact the National Water Data Exchange (NAWDEX). (See section 9.2.)

Further information on the index volumes and their availability may be obtained from:

U.S. Geological Survey
Water Resources Division
821 East Interstate Avenue
Bismarck, ND 58501
Telephone: (701)255-4011, extension 604
FTS 783-4604

or

Office of Surface Mining
U.S. Department of the Interior
1st Floor, Thomas Hill Building
950 Kanawha Boulevard East
Charleston, WV 25301
Telephone: (304)344-3481

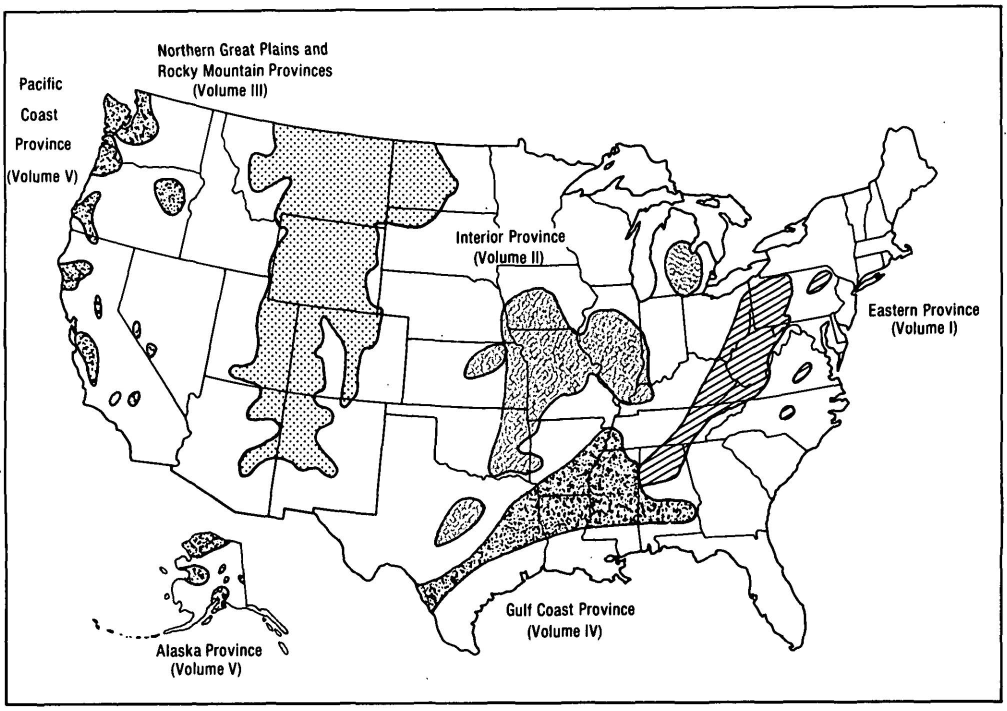


FIGURE 9.4-1—Index volumes and related provinces.

10.0 SUPPLEMENTAL INFORMATION FOR AREA 47

10.1 Streamflow Quantity Stations

Station						Periods of record		
Report station number	USGS station number	Name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (square miles)	Daily or monthly values (calendar years)	Annual peaks and high-flow measurements (water years)	Low-flow measurements (water years)
1	06335500	Little Missouri River at Marmarth, N. Dak.	46 17 44	103 55 06	4,640	1938-81	--	--
2	06335700	Deep Creek near Bowman, N. Dak.	46 13 55	103 22 05	.20	--	1955-73	--
3	06335750	Deep Creek near Amidon, N. Dak.	47 34 37	103 33 26	250	1977-81	--	--
4	06336000	Little Missouri River at Medora, N. Dak.	46 55 10	103 31 40	6,190	1903-08, 1921-24, 1928-34, 1945-74	--	--
5	06336100	Sheep Creek tributary near Medora, N. Dak.	46 54 00	103 26 53	.32	--	1955-73	1955-56
6	06336200	Sheep Creek tributary No. 2 near Medora, N. Dak.	46 55 32	103 28 23	.40	--	1955-73	1955-56
7	06336300	Little Missouri River tributary near Medora, N. Dak.	46 57 05	103 30 20	.34	--	1955-73	--
8	06336400	Jules Creek near Medora, N. Dak.	46 59 39	103 29 13	3.8	--	1955-73	1955-56
9	06336447	Duck Creek near Wibaux, Mont.	46 52 30	104 09 18	46.5	1978-81	--	--
10	06336450	Spring Creek near Wibaux, Mont.	46 53 04	104 12 02	3.88	--	1956-81	--
11	06336500	Beaver Creek at Wibaux, Mont.	46 59 24	104 11 00	351	1938-69, 1978-81	--	--
12	06336510	Hay Creek No. 2 near Wibaux, Mont.	46 59 31	104 06 12	4.1	1978-81	--	--
13	06336515	Hay Creek near Wibaux, Mont.	47 02 26	104 08 04	11.4	1978-81	--	--
14	06336545	Little Beaver Creek near Wibaux, Mont.	47 03 44	104 05 30	96.2	1978-81	--	--
15	06336550	Beaver Creek near Wibaux, Mont.	47 09 09	104 02 40	--	--	--	1958-64
16	06336600	Beaver Creek near Trotters, N. Dak.	47 09 47	103 59 32	485	1977-81	--	--
17	06336980	Little Missouri River tributary near Watford City, N. Dak.	47 36 07	103 16 41	2.1	--	1960-73	--
18	06337000	Little Missouri River near Watford City, N. Dak.	47 35 25	103 15 05	8,310	1934-81	--	--
19	06337100	Spring Creek near Watford City, N. Dak.	47 41 18	103 15 53	22.7	--	1960-73	--
20	06337200	Cherry Creek near Watford City, N. Dak.	47 49 07	103 16 05	--	--	--	1953-54
21	06337500	Missouri River near Elbowoods, N. Dak.	47 34 25	102 13 29	179,800	1939-53	--	--
22	06338490	Missouri River at Garrison Dam, N. Dak.	47 30 08	101 25 50	181,400	1969-81	--	--
23	06339000	Missouri River below Garrison Dam, N. Dak.	47 23 08	101 23 36	181,400	1948-76	--	--
25	06339100	Knife River at Manning, N. Dak.	47 14 10	102 46 10	205	1967-81	--	1953-56
26	06339180	Stray Creek near Manning, N. Dak.	47 12 47	102 37 22	30.3	1978-81	--	--
27	06339200	Crooked Creek near Manning, N. Dak.	47 09 47	102 46 45	108	--	--	1953-56

Station					Drainage area (square miles)	Periods of record		
Report station number	USGS station number	Name	Latitude (° ' ")	Longitude (° ' ")		Daily or monthly values (calendar years)	Annual peaks and high-flow measurements (water years)	Low-flow measurements (water years)
28	06339300	Knife River at Marshall, N. Dak.	47 08 17	102 20 00	722	1970-81	--	--
29	06339330	Little Knife River at Hebron, N. Dak.	46 53 55	102 02 44	41	--	--	1954-56
30	06339490	Elm Creek near Golden Valley, N. Dak.	47 06 25	102 03 05	82	1967-81	--	--
31	06339500	Knife River near Golden Valley, N. Dak.	47 09 40	102 03 39	1,230	1903-06, 1907-15, 1916-19, 1921-24, 1943-81	--	--
32	06339550	Coyote Creek near Zap, N. Dak.	47 11 57	101 54 42	65.2	1977-81	--	--
33	06339560	Brush Creek near Beulah, N. Dak.	47 10 43	101 47 05	22	1974-81	--	--
34	06339600	South Fork Spring Creek below Killdeer, N. Dak.	47 22 42	102 44 07	39	--	--	1953-55
35	06339700	North Fork Spring Creek below Killdeer, N. Dak.	47 22 49	102 44 07	29	--	--	1953-56
36	06339800	Spring Creek below Lake Ilo at Dunn Center, N. Dak.	47 20 34	102 37 03	116	1977-81	--	--
37	06339900	Spring Creek near Halliday, N. Dak.	47 21 56	102 22 35	260	1977-81	--	1953-56
38	06340000	Spring Creek at Zap, N. Dak.	47 17 10	101 55 31	549	1924, 1945-81	--	--
39	06340200	West Branch Otter Creek near Beulah, N. Dak.	47 08 05	101 39 35	26.5	1965-81	--	--
40	06340300	Otter Creek near Hannover, N. Dak.	47 06 40	101 35 55	42.9	--	1965-73	--
41	06340490	Otter Creek near Beulah, N. Dak.	47 15 10	101 41 44	132	--	--	1953-56
42	06340500	Knife River at Hazen, N. Dak.	47 17 07	101 37 18	2,240	1928, 1929-33, 1937-81	--	--
43	06340520	Antelope Creek above Hazen, N. Dak.	47 20 07	101 47 41	47.2	1977-81	--	--
44	06340524	West Branch Antelope Creek No. 5 near Zap, N. Dak.	47 23 10	101 50 04	4.52	1977-81	--	--
45	06340528	West Branch Antelope Creek No. 4 near Zap, N. Dak.	47 21 21	101 51 16	8.53	1976-81	--	--
46	06340536	West Branch Antelope Creek No. 2 near Beulah, N. Dak.	47 19 45	101 47 06	28.3	1976-80	--	--
47	06340540	West Branch Antelope Creek near Hazen, N. Dak.	47 19 00	101 41 27	37.7	1977-81	--	--
48	06340580	Coal Creek near Stanton, N. Dak.	47 20 03	101 31 38	15.8	1977-81	--	--
50	06340780	Alderin Creek near Ft. Clark, N. Dak.	47 16 09	101 18 34	21.9	1977-81	--	--
51	06340890	Missouri River tributary No. 2 near Hensler, N. Dak.	47 16 31	101 11 49	9.8	1978-81	--	--
53	06340905	Coal Lake Coulee near Hensler, N. Dak.	47 18 09	101 07 52	7.5	1977-81	--	--
54	06340930	Buffalo Creek near Washburn, N. Dak.	47 18 12	101 05 20	57.3	1978-81	--	--
56	06341400	Turtle Creek near Turtle Lake, N. Dak.	47 27 30	100 55 15	310	1956-76	--	--
57	06341800	Painted Woods Creek near Wilton, N. Dak.	47 16 30	100 47 30	427	1957-81	--	--

Station						Periods of record		
Report station number	USGS station number	Name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (square miles)	Daily or monthly values (calendar years)	Annual peaks and high-flow measurements (water years)	Low-flow measurements (water years)
58	06341950	Painted Woods Creek near Washburn, N. Dak.	47 15 39	100 55 09	--	--	--	1953-56
60	06342040	Square Butte Creek near Hannover, N. Dak.	47 08 06	101 25 31	16.9	1977-81	--	--
61	06342050	Square Butte Creek at Center, N. Dak.	47 06 40	101 17 55	56.8	--	1956-73	--
62	06342100	Square Butte Creek tributary No. 2 near Center, N. Dak.	47 06 40	101 15 05	13	1965-76	1955-65	--
63	06342150	Square Butte Creek tributary near Center, N. Dak.	47 06 20	101 15 30	.19	--	1955-73	--
64	06342200	Square Butte Creek above Nelson Lake near Center, N. Dak.	47 06 08	101 15 22	75.8	1977-81	--	--
65	06342230	Hagel Creek near Center, N. Dak.	47 03 58	101 14 11	45.6	1977-81	--	--
66	06342250	Square Butte Creek tributary No. 3 near Center, N. Dak.	47 06 20	101 10 35	1.68	--	1955-73	--
67	06342260	Square Butte Creek below Center, N. Dak.	47 03 25	101 11 35	146	1965-81	--	--
68	06342270	Square Butte Creek near Harmon, N. Dak.	46 58 42	101 01 47	234	--	--	1953-56
69	06342300	Burnt Creek tributary near Baldwin, N. Dak.	47 01 25	100 47 30	2.98	--	1956-73	--
70	06342350	Burnt Creek tributary No. 2 near Baldwin, N. Dak.	46 59 05	100 47 25	2.12	--	1956-73	--
71	06342450	Burnt Creek near Bismarck, N. Dak.	46 54 54	100 48 48	108	1967-81	--	--
72	06342500	Missouri River at Bismarck, N. Dak.	46 48 51	100 49 12	186,400	1927, 1928-81	--	--
73	06342850	Norwegian Creek near Belfield, N. Dak.	46 51 12	103 08 51	39.8	1978-81	--	--
74	06342900	South Branch Heart River near South Heart, N. Dak.	46 50 24	103 01 12	132	1978-81	--	--
75	06342970	North Creek near South Heart, N. Dak.	46 53 44	102 59 55	40.8	1978-81	--	--
76	06343000	Heart River near South Heart, N. Dak.	46 51 56	102 56 53	311	1947-70, 1977-81	1970-73	--
78	06343200	Heart River tributary near South Heart, N. Dak.	46 52 35	102 55 10	.12	--	1955-73	--
79	06344000	Heart River below Dickinson Dam near Dickinson, N. Dak.	46 52 11	102 49 37	400	1951-72	--	--
80	06344200	Heart River tributary near Dickinson, N. Dak.	46 50 21	102 47 22	1.72	--	1955-73	--
81	06344500	Heart River at Lehigh, N. Dak.	46 52 12	102 42 23	443	1943-52	--	--
82	06344600	Green River near New Hradec, N. Dak.	47 01 40	103 03 10	152	1964-81	--	--
83	06344610	Green River tributary near New Hradec, N. Dak.	47 00 25	102 59 24	22.4	1978-81	--	--
84	06344700	Green River near Dickinson, N. Dak.	46 57 54	102 47 14	264	--	--	1953-56
85	06344900	Russian Spring near New Hradec, N. Dak.	47 00 46	102 46 33	--	--	--	1954
86	06345000	Green River near Gladstone, N. Dak.	46 53 40	102 37 25	356	1945-75	--	--

Station						Periods of record		
Report station number	USGS station number	Name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (square miles)	Daily or monthly values (calendar years)	Annual peaks and high-flow measurements (water years)	Low-flow measurements (water years)
87	06345100	Antelope Creek near Dickinson, N. Dak.	46 43 15	102 47 25	69.2	--	1955-73	--
88	06345200	Antelope Creek tributary near New England, N. Dak.	46 40 05	102 47 25	13	--	1955-73	--
89	06345300	Antelope Creek tributary (site No. 2) near New England, N. Dak.	46 41 20	102 47 25	22.4	--	1955-73	--
90	06345400	Antelope Creek near Gladstone, N. Dak.	46 48 13	102 34 02	228	--	--	1953-56
91	06345500	Heart River near Richardton, N. Dak.	46 44 46	102 18 27	1,240	1903-22, 1943-81	--	--
92	06345700	Government Creek near Richardton, N. Dak.	46 48 15	102 18 35	33.4	--	1950, 1955-73	--
93	06346500	Heart River below Heart Butte Dam near Glen Ullin, N. Dak.	46 35 50	101 48 05	1,710	1943-72	--	--
94	06347000	Antelope Creek near Carson, N. Dak.	46 31 50	101 38 25	221	1948-75	--	--
95	06347100	Wilson Creek near Glen Ullin, N. Dak.	46 49 53	101 39 23	41.4	1964-70	1971	--
96	06347200	Hailstone Creek near Blue Grass, N. Dak.	46 55 20	101 38 15	38.7	--	1965-73	--
97	06347500	Big Muddy Creek near Almont, N. Dak.	46 41 30	101 28 10	456	1946-70	1971-73	--
98	06348000	Heart River near Lark, N. Dak.	46 36 37	101 22 54	2,750	1946-81	--	--
99	06348500	Sweetbriar Creek near Judson, N. Dak.	46 51 05	101 15 15	157	1951-79	1950	--
100	06349000	Heart River near Mandan, N. Dak.	46 50 02	100 58 27	3,310	1924, 1928-33, 1937-81	--	--
103	06349600	Little Heart River near St. Anthony, N. Dak.	46 40 54	100 54 06	189	--	--	1953-56
105	06349900	Cannonball River at New England, N. Dak.	46 32 35	102 53 16	285	1978-81	--	1953-56
106	06349930	Coal Bank Creek near Havelock, N. Dak.	46 27 50	102 44 20	70	1974-81	--	--
107	06350000	Cannonball River at Regent, N. Dak.	46 25 36	102 33 05	580	1950-81	--	--
108	06350500	Cannonball River at Bentley, N. Dak.	46 20 39	102 04 05	860	1951	--	--
109	06350800	Thirty Mile Creek near Bentley, N. Dak.	46 22 17	102 03 26	249	--	--	1953-56
110	06351000	Cannonball River below Bentley, N. Dak.	46 21 30	102 02 30	1,140	1943-81	--	--
111	06351500	Cannonball River near Heil, N. Dak.	46 16 45	101 42 29	1,340	1950-53	--	--
112	06351650	Middle Fork Cedar Creek near Buffalo Springs, N. Dak.	46 15 55	103 13 30	32.9	--	1965-73	--
113	06351680	White Butte Fork Cedar Creek near Scranton, N. Dak.	46 19 20	102 59 45	42.9	1965-81	--	--
114	06351700	Cedar Creek below Cedar Creek Dam near Reeder, N. Dak.	46 16 54	102 55 34	238	--	--	1953-55
115	06352000	Cedar Creek near Haynes, N. Dak.	46 09 15	102 28 25	553	1950-81	--	--

Station						Periods of record		
Report station number	USGS station number	Name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (square miles)	Daily or monthly values (calendar years)	Annual peaks and high-flow measurements (water years)	Low-flow measurements (water years)
116	06352150	Cedar Creek above Duck Creek near North Lemmon, N. Dak.	46 02 53	102 13 41	703	--	--	1959-60
117	06352250	Duck Creek near North Lemmon, N. Dak.	46 01 09	102 13 31	175	--	--	1959
118	06352280	Cedar Creek tributary near North Lemmon, N. Dak.	46 03 52	102 11 29	13	--	--	1959
119	06352300	Cedar Creek near North Lemmon, N. Dak.	46 03 58	102 11 01	901	1959-63	--	--
120	06352400	Timber Creek near Bentley, N. Dak.	46 06 05	101 57 26	100	1977-81	--	--
121	06352500	Cedar Creek near Pretty Rock, N. Dak.	46 01 55	101 49 55	1,340	1943-76	--	--
122	06353000	Cedar Creek near Raleigh, N. Dak.	46 05 30	101 20 00	1,750	1939, 1962-81	--	--
123	06353500	Cannonball River near Timmer, N. Dak.	46 19 --	101 00 --	3,670	1903-08, 1911-18, 1921-22, 1923-24, 1928-34	--	--
124	06353600	Louise Creek tributary near Brisbane, N. Dak.	46 22 25	101 29 20	.29	--	1956-73	--
125	06353700	Louise Creek tributary near Lark, N. Dak.	46 26 30	101 25 00	.76	--	1956-73	--
126	06353800	Louise Creek tributary No. 2 near Lark, N. Dak.	46 26 35	101 19 55	7.7	--	1956-73	--
127	06353900	Louise Creek above Flasher, N. Dak.	46 27 15	101 14 55	110	--	1955-73	--
128	06354000	Cannonball River at Breien, N. Dak.	46 22 33	100 56 03	4,100	1934-81	--	--
129	06354885	North Fork Grand River tributary near Bowman, N. Dak.	45 59 20	103 28 55	36.7	--	1965-73	--
131	06354900	Spring Creek near Bowman, N. Dak.	46 07 30	103 24 35	51.2	--	1955-73	--
132	06354950	Spring Creek tributary near Bowman, N. Dak.	46 08 55	103 24 35	11.4	--	1955-73	--
134	06354985	Alkali Creek near Bowman, N. Dak.	46 00 00	103 22 05	58.1	--	1965-73	--
135	06355000	North Fork Grand River at Haley, N. Dak.	45 57 39	103 07 09	509	1908-17, 1945-81	--	--
136	06355200	Buffalo Creek tributary near Buffalo Springs, N. Dak.	46 10 30	103 16 35	3.39	--	1955-73	--
139	06355310	Buffalo Creek tributary near Gascoyne, N. Dak.	46 06 40	103 02 20	15.7	1974-81	--	--
140	06355500	North Fork Grand River near White Butte, S. Dak.	45 85 10	102 21 45	1,190	1945-81	--	--

Report station number	USGS station number	Name	Period of record	Type of data available
1	06335500	Little Missouri River at Marmarth, N. Dak.	1946-54, 1970-81	F, C, N, T, S
3	06335750	Deep Creek near Amidon, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
4	06336000	Little Missouri River at Medora, N. Dak.	1946-51, 1969-70, 1972-77, 1979	F, C, N, T, S, O
9	06336447	Duck Creek near Wibaux, Mont.	1978-79	F, C, N, T, S, O
11	06336500	Beaver Creek at Wibaux, Mont.	1977-81	F, C, N, T, S, O
12	06336510	Hay Creek No. 2 near Wibaux, Mont.	1978-79	F, C, N, T, S, O
13	06336515	Hay Creek near Wibaux, Mont.	1978-81	F, C, N, T, S, O
14	06336545	Little Beaver Creek near Wibaux, Mont.	1978-81	F, C, N, T, S, O
16	06336600	Beaver Creek near Trotters, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
18	06337000	Little Missouri River near Watford City, N. Dak.	1946-49, 1972-81	F, C, N, T, P, S, M, B, O
22	06338490	Missouri River at Garrison Dam, N. Dak.	1971-81	F, C, N, T, R, S, M, B, O
23	06339000	Missouri River below Garrison Dam, N. Dak.	1952-72	F
24	06339010	Missouri River above Stanton, N. Dak. (temperature station)	1973-77	F
25	06339100	Knife River at Manning, N. Dak.	1972-81	F, C, N, T, R, S, M, B, O
26	06339180	Stray Creek near Manning, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
28	06339300	Knife River at Marshall, N. Dak.	1972-81	F, C, N, T, R, S, M, B, O
30	06339490	Elm Creek near Golden Valley, N. Dak.	1973-81	F, C, N, T, R, S, M, B, O
31	06339500	Knife River near Golden Valley, N. Dak.	1950, 1964-65, 1972-81	F, C, N, S
32	06339550	Coyote Creek near Zap, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
33	06339560	Brush Creek near Beulah, N. Dak.	1975-81	F, C, N, T, R, S, M, B, O
36	06339800	Spring Creek below Lake Ilo at Dunn Center, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
37	06339900	Spring Creek near Halliday, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
38	06340000	Spring Creek at Zap, N. Dak.	1946, 1969-81	F, C, N, T, R, S, B, O
39	06340200	West Branch Otter Creek near Beulah, N. Dak.	1972-81	F, C, N
42	06340500	Knife River at Hazen, N. Dak.	1946-51, 1969-81	F, C, N, T, R, S, M, B, O
43	06340520	Antelope Creek above Hazen, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
44	06340524	West Branch Antelope Creek tributary No. 5 near Zap, N. Dak.	1977-81	F, C, N, T, S, O

Report station number	USGS station number	Name	Period of record	Type of data available
45	06340528	West Branch Antelope Creek tributary No. 4 near Zap, N. Dak.	1977-81	F, C, N, T, S, O
46	06340536	West Branch Antelope Creek tributary No. 2 near Beulah, N. Dak.	1977-81	F, C, N, T, S, O
47	06340540	Antelope Creek tributary near Hazen, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
48	06340580	Coal Creek near Stanton, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
50	06340780	Alderin Creek near Ft. Clark, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
51	06340890	Missouri River tributary No. 2 near Hensler, N. Dak.	1979-81	F, C, N, T, R, S, M, B, O
52	06340900	Missouri River near Hensler, N. Dak.	1967-77	F
53	06340905	Coal Lake Coulee near Hensler, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
54	06340930	Buffalo Creek near Washburn, N. Dak.	1979-81	F, C, N, T, R, S, M, B, O
56	06341400	Turtle Creek near Turtle Lake, N. Dak.	1972-76	F, C, N, T
57	06341800	Painted Woods Creek near Wilton, N. Dak.	1959-81	F, C, N, T
60	06342040	Square Butte Creek near Hannover, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
61	06342050	Square Butte Creek at Center, N. Dak.	1965, 1974-76	F, C, N, T, O
62	06342100	Square Butte Creek tributary No. 2 near Center, N. Dak.	1972-76	F, C, N, T
64	06342200	Square Butte Creek above Nelson Lake near Center, N. Dak.	1977-81	F, C, N, T, R, S, M, B, O
65	06342230	Hagel Creek near Center, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
67	06342260	Square Butte Creek below Center, N. Dak.	1965, 1972-81	F, C, N, T
71	06342450	Burnt Creek near Bismarck, N. Dak.	1972-81	F, C, N
72	06342500	Missouri River at Bismarck, N. Dak.	1969-81	F, C, N, T, R, S, M, B, O
73	06342850	Norwegian Creek near Belfield, N. Dak.	1979-81	F, C, N, T, R, S, M, B, O
74	06342900	South Branch Heart River near South Heart, N. Dak.	1979-81	F, C, N, T, R, S, M, B, O
75	06342970	North Creek near South Heart, N. Dak.	1979-81	F, C, N, T, R, S, M, B, O
76	06343000	Heart River near South Heart, N. Dak.	1947-51, 1975-81	F, C, N, T, R, S, M, B, O
79	06344000	Heart River below Dickinson Dam near Dickinson, N. Dak.	1972	F, C, N
81	06344500	Heart River at Lehigh, N. Dak.	1946-47	F, C
82	06344600	Green River near New Hradec, N. Dak.	1972-81	F, C, N, T, R, S, M, B, O
83	06344610	Green River tributary near New Hradec, N. Dak.	1979-81	F, C
86	06345000	Green River near Gladstone, N. Dak.	1971-76	F, C, N

Report station number	USGS station number	Name	Period of record	Type of data available
91	06345500	Heart River near Richardton, N. Dak.	1946-52, 1972-81	F, C, N
93	06346500	Heart River below Heart Butte Dam near Glen Ullin, N. Dak.	1946-52, 1972-73	F, C, N
94	06347000	Antelope Creek near Carson, N. Dak.	1972-76	F, C, N
98	06348000	Heart River near Lark, N. Dak.	1972-81	F, C, N
99	06348500	Sweetbriar Creek near Judson, N. Dak.	1972-79	F, C, N
100	06349000	Heart River near Mandan, N. Dak.	1946-50, 1972-81	F, C, N, T, P, S, M, B, O
104	06349700	Missouri River near Schmidt, N. Dak.	1974-79	F, C, N, T, R, S, M, B, O
105	06349900	Cannonball River at New England, N. Dak.	1979-81	F, C, N, T, R, S, M, B, O
106	06349930	Coal Bank Creek near Havelock, N. Dak.	1975-81	F, C, N, T, R, S, M, B, O
107	06350000	Cannonball River at Regent, N. Dak.	1964-66, 1971-81	F, C, N, T, R, S, M, B, O
110	06351000	Cannonball River below Bentley, N. Dak.	1946-51, 1972-81	F, C, N
113	06351680	White Butte Fork Cedar Creek near Scranton, N. Dak.	1972-81	F, C, N
115	06352000	Cedar Creek near Haynes, N. Dak.	1971-81	F, C, N, T
120	06352400	Timber Creek near Bentley, N. Dak.	1978-81	F, C, N, T, R, S, M, B, O
121	06352500	Cedar Creek near Pretty Rock, N. Dak.	1946-51, 1972-76	F, C, N
122	06353000	Cedar Creek near Raleigh, N. Dak.	1972-81	F, C, N
128	06354000	Cannonball River at Breien, N. Dak.	1946-50, 1971-81	F, C, N, T, S, M, B, O
135	06355000	North Fork Grand River at Haley, N. Dak.	1951-52, 1972-81	F, C, N
137	06355250	Buffalo Creek tributary No. 2 at Buffalo Springs, N. Dak.	1977-78	F, C, N, T, O
138	06355308	Buffalo Creek tributary No. 2 near Gascoyne, N. Dak.	1977-78	F, C, N, T, R, O
139	06355310	Buffalo Creek tributary near Gascoyne, N. Dak.	1975-81	F, C, N, T, R, S, M, B, O
140	06355500	North Fork Grand River near White Butte, S. Dak.	1950-51	F, C, S

10.3 Ground-Water Observation Wells

Report well number	Local well number	Aquifer	Period of record
ADAMS COUNTY (001)			
1	129-091-07AAA1	Ludlow-Hell Creek	1971-
2	129-091-07AAA2	Ludlow	1971-
3	131-092-05DDD	Tongue River	1976, 1979-
4	131-094-20CBC2	Ludlow-Hell Creek	1971-
5	131-094-20CBC3	Ludlow	1971-
6	132-097-07CAB2	Ludlow-Hell Creek	1971-
7	132-097-07CAB3	Ludlow	1971-
BILLINGS COUNTY (007)			
8	137-101-34ABA1	Tongue River-Ludlow	1977-
9	137-101-34ABA3	Tongue River-Ludlow	1977-
10	139-102-03BCB2	Alluvium	1977-
11	142-100-25DDA	Hell Creek-Ludlow	1976-
BOWMAN COUNTY (011)			
12	129-100-25DAA1	Lower Hell Creek	1971-
13	129-100-25DAA2	Lower Hell Creek	1971-
14	129-104-34ADA	Hell Creek-Fox Hills	1971-
15	130-099-04BAA	Upper Ludlow-Tongue River	1978-
16	130-099-17AAA2	Ludlow	1972-
17	131-099-22DCC	Upper Ludlow-Tongue River	1976-
18	131-099-26DDD	Upper Ludlow-Tongue River	1976-
19	131-102-07DDD1	Hell Creek-Fox Hills	1972-
20	131-102-07DDD3	Upper Ludlow-Tongue River	1972-
21	131-102-13CCC1	Lower Hell Creek	1971-
22	131-102-13CCC2	Ludlow	1971-
23	132-102-24BBB1	Ludlow	1972-
24	132-102-24BBB3	Upper Ludlow-Tongue River	1972-
BURLEIGH COUNTY (015)			
25	140-081-05AAA	Wagonsport	1962-
DUNN COUNTY (025)			
26	141-094-15ABB	Buried glaciofluvial	1974-
27	141-094-35BBC	Buried glaciofluvial	1971-
28	142-091-15CCC	Buried glaciofluvial	1971-
29	142-091-33DCC	Buried glaciofluvial	1974-
30	142-093-09BBA	Sentinel Butte lignite	1974-
31	142-094-09CDD	Buried glaciofluvial	1974-
32	143-091-19AAA1	Tongue River sandstone	1974-
33	143-093-09BCB	Sentinel Butte sandstone	1974-
34	143-094-32CCC	Buried glaciofluvial	1971-
35	144-091-30AAA2	Sentinel Butte sandstone	1974-
DUNN COUNTY (025), Continued			
36	144-093-17ADA	Sentinel Butte lignite	1974-
37	144-093-26BCC	Buried glaciofluvial	1974-
38	144-094-13CCC	Sentinel Butte lignite	1974-
39	144-095-10CBC	Sentinel Butte lignite	1974-
40	144-095-36AAA	Buried glaciofluvial	1972-
41	144-097-26CBD1	Tongue River sandstone	1974-
42	145-091-05DDD2	Sentinel Butte sandstone	1974-
43	145-093-04DDD	Sentinel Butte lignite	1974-
44	145-093-33BAA	Sentinel Butte lignite	1974-
45	145-094-06CCC1	Sentinel Butte lignite	1974-
46	145-094-06CCC2	Sentinel Butte lignite	1974-
47	145-094-15DDD1	Sentinel Butte lignite	1974-
48	145-094-15DDD2	Sentinel Butte lignite	1974-
49	145-094-26AAA3	Sentinel Butte lignite	1974-
50	145-094-26AAA4	Sentinel Butte lignite	1974-
51	145-095-22DAD2	Buried glaciofluvial	1972-74, 1979-
52	145-095-22DAD3	Buried glaciofluvial	1972-74, 1979-
53	145-095-29AAA	Buried glaciofluvial	1971-
54	146-091-17CDC	Buried glaciofluvial	1974-
55	146-091-21CDD1	Buried glaciofluvial	1971-
56	146-091-21CDD2	Buried glaciofluvial	1971-
57	146-091-35BBC	Buried glaciofluvial	1974-
58	146-093-27CCC	Sentinel Butte lignite	1974-
59	146-093-27CDD	Sentinel Butte lignite	1974-
60	146-093-28AAA1	Sentinel Butte lignite	1975-
61	146-093-28AAA2	Sentinel Butte lignite	1974-
62	146-094-25AAA	Sentinel Butte lignite	1974-
63	146-094-25ABA	Sentinel Butte lignite	1974-
64	146-094-25BAA	Buried glaciofluvial	1974-
65	148-097-33ABB	Fox Hills Sandstone	1972-
GOLDEN VALLEY COUNTY (033)			
66	136-105-26ACA	Hell Creek-Fox Hills	1976-
67	138-106-11AAA	Tongue River	1976, 1979-
68	139-105-30CCD	Tongue River	1976, 1979-
69	139-106-27AAD	Tongue River	1976, 1979-
70	140-105-30CCC1	Hell Creek-Fox Hills	1977-
71	140-105-30CCC3	Tongue River-Ludlow	1977-
72	140-106-01AAA	Tongue River-Ludlow	1976-
73	140-106-14BBB	Tongue River	1976, 1979-

Report well number	Local well number	Aquifer	Period of record
GOLDEN VALLEY COUNTY (033), Continued			
74	143-105-33ACA1	Tongue River-Ludlow	1977-
75	143-105-33ACA2	Alluvium	1977-
76	143-105-33BAA	Hell Creek-Ludlow	1975-
77	143-105-33BAB	Hell Creek-Fox Hills	1975-
GRANT COUNTY (037)			
78	129-087-10BBC	Fox Hills Sandstone	1972-
79	130-089-32DDA	Fox Hills Sandstone	1972-
80	131-089-30AAA	Fox Hills Sandstone	1973-
81	132-083-30BCB	Shields	1971-
82	132-084-01DAA	Shields	1971-
83	132-087-27ADA	Hell Creek Formation	1972-
84	132-090-14AAB2	Tongue River Member	1973-
85	133-083-07CCB1	Shields	1971-
86	133-083-17DAA	Shields	1971-
87	133-085-12AAD	Fox Hills Sandstone	1972-
88	133-089-04DAD	Hell Creek Formation	1972-
89	134-089-23CCB	Cannonball Member	1972-
90	135-086-15DDD1	Hell Creek Formation	1973-
91	135-089-22CDD	Tongue River Member	1972-
92	135-090-23BBB1	Fox Hills Sandstone	1973-
93	135-090-23BBB2	Tongue River Member	1973-
94	136-085-08DDD	Elm Creek	1971-
95	136-085-09BCD	Elm Creek	1971-
96	137-088-21DDC	Fox Hills Sandstone	1972-
97	137-089-09ABA1	Hell Creek Formation	1973-
98	137-089-09ABA2	Tongue River Member	1973-
HETTINGER COUNTY (041)			
99	132-091-28DDD	Fox Hills Sandstone	1968-
100	132-092-28BCB	Tongue River	1976, 1979-
101	132-093-21BBB	Tongue River	1976, 1979-
102	133-092-29CCC	Tongue River	1976, 1979-
103	133-097-34BBB	Ludlow Member	1967-
104	134-091-32CCC	Basal Tongue River	1967-
105	134-092-34DDC	Basal Tongue River	1968-
106	134-093-23ADD	Tongue River Member	1969-
107	134-096-08BAB	Tongue River	1976, 1979-
108	135-096-09ABA	Tongue River	1976, 1979-
109	135-096-30AAA	Tongue River	1976, 1979-
110	135-097-04DCA	Fox Hills Sandstone	1968-
111	135-097-14AAA	Tongue River	1976, 1979-
112	135-097-33DDC	Tongue River	1976, 1979-

Report well number	Local well number	Aquifer	Period of record
McLEAN COUNTY (055)			
113	143-081-02BCC1	Lost Lake	1978-
114	143-081-03BAA	Lost Lake	1978-
115	143-081-29BBA2	Painted Woods Lake	1967-
116	144-080-04CCC	Lost Lake	1970-
117	146-083-15CCC	Weller Slough	1970-
118	147-079-19BAA1	Lake Nettie	1967-
119	147-079-19BAA2	Lake Nettie	1967-
120	147-080-01CCC2	Lake Nettie	1969-
121	147-081-07DDD	Turtle Lake	1970-
122	147-081-23AAA	Turtle Lake	1967-
123	148-080-19CCC1	Lake Nettie	1967-
124	148-080-19CCC2	Lake Nettie	1967-
125	148-080-31AAA1	Lake Nettie (?)	1967-
126	148-080-31AAA2	Lake Nettie (?)	1967-
127	148-081-03AAB	Horseshoe Valley	1967-
128	148-081-18DCD1	Lake Nettie	1967-
129	148-081-18DCD2	Lake Nettie	1967-
130	148-081-29CAA	Lake Nettie	1970-
131	148-081-33CDD	Lake Nettie	1967-
132	148-082-13BBB	Lake Nettie	1969-
133	148-082-23BBB	Lake Nettie	1969-
134	149-082-12BAB2	Snake Creek	1969-
135	150-080-08BBB	Horseshoe Valley	1975-
MERCER COUNTY (057)			
136	141-089-23BAA	Elm Creek	1968-
137	141-090-19CCD	Hell Creek Formation	1967-
138	144-085-06ABB	Knife River	1967-
139	144-086-18ADC2	Knife River	1967-
140	144-087-14AAA	Knife River	1968-
141	144-088-25CCC3	Knife River	1970-
142	145-084-28BAD	Knife River	1967-
143	145-088-25ABB	Antelope Creek	1968-
144	145-090-08CBB	Goodman Creek	1968-
145	146-088-27CDD2	Upper Antelope Creek	1976, 1979-
146	146-090-20CCC	Fox Hills Sandstone	1968-
MORTON COUNTY (059)			
147	134-082-35DAA	Buried glaciofluvial or alluvium	1973-
148	135-081-04BAB	Little Heart	1973-
149	135-084-26DAA1	Elm Creek	1973-
150	135-084-26DAA2	Elm Creek	1973-

Report well number	Local well number	Aquifer	Period of record
MORTON COUNTY (059), Continued			
151	135-084-26DAA3	Elm Creek	1973-
152	136-081-07AAA	Little Heart	1975-
153	136-081-07DDC1	Fox Hills Sandstone	1974-
154	136-081-07DDC2	Hell Creek Formation	1974-
155	136-084-31ADD1	Elm Creek	1973-
156	136-084-31ADD2	Elm Creek	1973-
157	138-080-06BCC	Buried glaciofluvial or alluvium	1968-
158	138-080-07CCC	Heart River	1979-
159	138-081-09ABB1	Fox Hills Sandstone	1974-
160	138-081-09ABB2	Hell Creek Formation	1974-
161	138-081-09ABB4	Cannonball-Ludlow	1974-
162	138-086-11DDB	Sims	1974-
163	138-086-26CCC	Elm Creek	1973-
164	139-080-31CAD	Heart River	1979-
165	139-081-36BDD	Heart River	1979-
166	139-085-30AAB2	Cannonball-Ludlow	1974-
167	139-084-30AAB	Tongue River Member	1974-
168	139-086-27BAA	Sims	1974-
169	139-086-34ADC	Sims	1974-
170	139-086-35BCC	Sims	1974-
171	139-086-35BDA	Sims	1974-
172	139-086-35CBC	Sims	1974-
173	139-086-35CCC	Sims	1974-
174	139-088-25BAD	Elm Creek	1973-
175	139-088-34BCC1	Fox Hills Sandstone	1974-
176	139-088-34BCC2	Hell Creek Formation	1974-
177	139-088-34BCC3	Tongue River Member	1974-
178	139-089-08DDC	Killdeer	1973-
179	140-089-36ADD1	Elm Creek	1973-
180	140-089-36ADD2	Elm Creek	1973-
OLIVER COUNTY (065)			
181	141-085-27DDD	Tongue River Member	1969-
182	142-084-24BBA	Fox Hills Sandstone	1968-
183	143-087-18BCC	Sentinel Butte	1975, 1979-
184	143-087-19BBB2	Sentinel Butte	1975, 1979-
185	144-082-27BBB2	Missouri River	1970-
186	144-082-28CBA	Missouri River	1968-
SIOUX COUNTY (085)			
187	130-084-31AAA1	Hell Creek Formation	1973-
188	130-08431AAA2	Hell Creek Formation	1973-
SIOUX COUNTY (085), Continued			
189	130-084-36ABA	Fox Hills Sandstone	1972-
190	130-085-17DAA1	Fox Hills Sandstone	1972-
191	130-086-28CCC1	Fox Hills Sandstone	1973-
192	130-086-28CCC2	Hell Creek Formation	1973-
193	132-083-29CCC	Shields	1971-
194	134-082-36DCD	Fox Hills Sandstone	1971-
SLOPE COUNTY (087)			
195	133-101-17ABB	Tongue River	1976, 1979-
196	133-101-19DCC	Tongue River	1976, 1979-
197	133-106-13ADB2	Hell Creek-Fox Hills	1977-
198	133-106-13ADB3	Hell Creek-Fox Hills	1977-
199	134-099-21DCC	Tongue River-Ludlow	1977-
200	134-101-17DDD	Tongue River	1976, 1979-
201	134-101-18ABB	Tongue River	1976, 1979-
202	134-102-12DDA	Tongue River-Ludlow	1977-
203	136-098-01BAA	Tongue River	1976, 1979-
204	136-098-05AAA	Tongue River	1976, 1979-
205	136-098-15AAA	Tongue River	1976, 1979-
206	136-098-15CBB	Tongue River	1976, 1979-
207	136-099-15ADD	Tongue River	1976, 1979-
208	136-099-20DDD	Tongue River	1976, 1979-
209	136-099-31BCC	Tongue River	1976, 1979-
210	136-099-36CCC	Tongue River	1976, 1979-
211	136-103-24DAA	Tongue River-Ludlow	1977-
212	136-103-24DBA	Alluvium	1977-
STARK COUNTY (089)			
213	137-094-04CBC	Basal Tongue River sandstone	1969-
214	137-096-22CCC2	Sentinel Butte Member	1967-
215	138-092-32DDD	Basal Tongue River sandstone	1969-
216	139-094-23DCC	Basal Tongue River sandstone	1967-
217	139-097-07CCC	Sentinel Butte	1976, 1979-
218	139-098-17CCD	Sentinel Butte	1976, 1979-
219	139-099-21CCC	Tongue River Member	1967-
220	140-092-06DAA	Buried valley	1967-
221	140-093-9BBC	Basal Tongue River sandstone	1968-
222	140-095-08AAA	Sentinel Butte Member	1968-

Report well number	Local well number	Aquifer	Period of record
STARK COUNTY (089), Continued			
223	140-095-09BBB	Basal Tongue River sandstone	1968-
224	140-098-02CBB	Sentinel Butte	1976, 1979-
225	140-098-10DDD	Sentinel Butte	1976, 1979-
226	140-098-17AAA	Sentinel Butte	1976, 1979-
227	140-098-27AAA	Sentinel Butte	1976, 1979-
228	141-092-27CCC3	Basal Tongue River sandstone	1967-
STARK COUNTY (089), Continued			
229	141-093-26BBB2	Outwash	1968-
WIBAUX COUNTY, MONTANA			
230	13-61-18CCA		
231	14-60-10DDD		
232	14-60-26BAA		
233	14-61-06CCA1		
234	14-61-06CCA2		

Map number	Name	Location of outlet	Capacity at spillway level (acre-feet)	Quality information available
ADAMS COUNTY (001)				
1	Orange Reservoir	129-091-22CCB	150	
2	Unnamed reservoir	129-091-33ACC	300	
3	North Lemmon Lake	129-092-11BC	650	
4	Duck Creek Reservoir	129-094-01CBB	200	
5	Unnamed lake	130-098-22BDA	--	
6	Wolf Butte Reservoir	131-097-12BAA	200	
7	Lemon Ranch Reservoir	131-098-02DBB	92	
BILLINGS COUNTY (007)				
8	Kardonowy Reservoir	142-099-16---	60	
9	Unnamed reservoir	143-098-21ADD	135	
10	Palunak Reservoir	144-099-08---	115	
BOWMAN COUNTY (011)				
11	Bowman Haley Lake	129-101-24ADD	21,950	X
12	Gascoyne Reservoir	130-099-16ABC	126	
13	Gascoyne Lake	131-099-32BDD	1,300	X
14	Buffalo Springs Lake	131-100-17BBC	92	
15	Kalina Lake	131-102-30AAA	215	X
BURLEIGH COUNTY (015)				
16	Canfield Lake	143-077-20CAA		
17	Grass Lake	143-079-05CDD		
18	Florence Lake	144-076-16BBB		
19	Pelican Lake	144-077-12DCC		
20	New Johns Lake	144-078-07BAC		
DUNN COUNTY (025)				
21	Gustafson Reservoir	142-095-07---	90	
22	Unnamed lake	143-093-14AAA	--	
23	Chalupnik Reservoir	143-097-29---	60	
24	Lake Ilo	145-094-27CAA	7,130	
GOLDEN VALLEY COUNTY (033)				
25	Williams Lake	136-105-08DCD	67	
26	Bosserman Lake	138-105-35DDD	1,030	
27	Unnamed reservoir	138-106-23DDA	175	
28	Uekert Reservoir	139-105-13---	118	
29	Camels Hump Lake	140-104-16BAC	760	X
30	Odland Reservoir	141-105-08CDA	1,080	X

Map number	Name	Location of outlet	Capacity at spillway level (acre-feet)	Quality information available
GRANT COUNTY (037)				
32	Howard Reservoir	131-099-16ABB	181	
33	Pretty Rock Reservoir	132-090-16DAD	500	
34	Unnamed lake	132-090-16DDB	--	
35	Raleigh Reservoir	133-085-09ACC	125	
36	Sheep Creek Reservoir	133-089-15ABB	1,160	X
37	Cat Coulee Reservoir	135-086-03AAA	50	
38	Lake Tschida	136-089-13BD	75,800	X
HETTINGER COUNTY (041)				
39	Kilzer Reservoir	132-091-15---	130	
40	Brown Reservoir	132-091-30DCC	178	
41	Castle Rock Reservoir	133-093-17---	162	
42	Roemick Reservoir	133-093-17---	190	
43	Lake Iris	133-095-09---	2,430	X
44	Lien Reservoir	133-095-17DBB	75	
45	Mott Reservoir	134-093-35AC	200	
46	Larsen Lake	134-094-17AAA	1,167	
47	Squaw Creek Reservoir	134-095-27ADA	87	
48	Jung Reservoir	134-097-14BAB	182	
49	Steiner Reservoir	136-092-08---	72	
50	Karey Reservoir	136-097-32---	72	
McKENZIE COUNTY (053)				
51	Siverston Reservoir	150-097-24BBD	70	
52	Arnegard Reservoir	150-100-04DCC	320	
McLEAN COUNTY (055)				
53	Yanktoni Lake	143-080-30CBA	180	
54	Katz Reservoir	143-081-04---	152	
55	Lake Ordway	146-080-06CBB	--	X
56	Unnamed lake	146-080-36CCD	185	
57	Pelican lake	147-079-20CBA	--	
58	Blue Lake	147-079-21CDB	--	
59	Brush Lake	147-079-22CCB	--	X
60	Lake Margaret	147-080-15DBB	468	
61	Lake Brekken	147-080-20BAC	--	
62	Lake Holmes	147-080-21DBD	--	
63	Peterson Lake	147-080-25BBD	--	
64	Lake Williams	147-080-27ABB	--	
65	Lake Sakakawea	147-084-31---	24,200,000	X

Map number	Name	Location of outlet	Capacity at spillway level (acre-feet)	Quality information available
McLEAN COUNTY (055), Continued				
66	Postel Lake	148-079-26AAA	--	
67	Pelican Lake	148-079-36DCC	--	
68	Crooked Lake	148-080-08CBB	2,850	
69	Crooked Lake	148-081-20ADD	--	
70	Lake Nettie	148-081-21DAA	--	
71	Mud Lake	148-081-34BCB	--	
72	Strawberry Lake	149-080-02DBD	1,270	X
73	Long Lake	149-080-23DDD	1,060	
74	Camp Lake	150-080-36CAB	--	
MERCER COUNTY (057)				
75	Cullen Brothers Reservoir	144-083-26---	76	
76	Schramm Reservoir	144-087-03DDB	--	
77	Colt Reservoir	144-088-36---	100	
78	Wolff Reservoir	144-090-33---	90	
MORTON COUNTY (059)				
79	Unnamed reservoir	134-084-03---	82	
80	Lake Patricia	135-084-36DBD	906	
81	Nygren Reservoir	136-084-14---	92	
82	Unnamed reservoir	138-082-23BAD	90	
83	Fish Creek Reservoir	138-084-36CAA	994	X
84	Crown Butte Reservoir	139-082-12ADD	410	X
85	Sweetbriar Lake	139-084-11CCC	3,300	X
86	Unnamed reservoir	139-087-30---	60	
87	Unnamed reservoir	139-088-01---	60	
88	Glen Ullin Reservoir	139-088-30DAD	111	
89	Schato Reservoir	139-089-35---	242	
90	Danielson Reservoir	140-082-26BCC	60	
91	Storm Creek Lake	140-087-36DCA	700	
OLIVER COUNTY (065)				
92	Unnamed reservoir	141-083-02---	80	
93	Nelson Lake	141-083-04BAD	5,000	X
94	Square Butte 5 Reservoir	141-083-11---	495	
95	A. Mosbrucker Reservoir	141-083-27AAD	301	
96	Square Butte 4 Reservoir	141-084-11ABB	380	
97	Square Butte 2 Reservoir	142-083-07DBD	209	
98	Van Oosting Reservoir	143-082-06BBB	141	
99	Daug Reservoir	143-083-05ADC	732	

Map number	Name	Location of outlet	Capacity at spillway level (acre-feet)	Quality information available
SHERIDAN COUNTY (083)				
100	Horse Lake	145-076-19ABA	--	
101	Pop Lake	145-077-14DCC	--	
102	Johns Lake	145-077-21AAA	--	
103	Alkali Lake	148-078-17DBB	--	
104	Cherry Lake	148-078-19CCC	--	
105	Harchenke Lake	149-078-21ADD	--	
106	Norberg Lake	149-078-34ACD	--	
SIOUX COUNTY (085)				
107	Unnamed reservoir	129-085-18---	130	
108	Unnamed reservoir	130-084-18DDB	60	
SLOPE COUNTY (087)				
109	Cedar Lake	133-098-35BBC	2,750	
110	Stewart Lake	133-102-01CDC	802	X
111	White Lake	135-100-26CDD	760	
112	Hamann Reservoir	135-101-06DDA	325	
113	Unnamed reservoir	136-098-16ADA	--	
114	Speck Davis Pond	136-103-31DAC	194	
STARK COUNTY (089)				
115	Queen City Reservoir	139-096-08ADA	190	
116	Edward Arthur Patterson Lake	139-096-08BCC	6,680	X
117	Mesling Reservoir	139-099-20---	88	
118	Assumption Abbey Reservoir	140-092-32ABC	230	
119	Green River Reservoir	140-095-27CAD	60	
WIBAUX COUNTY, MONTANA				
120	Lame Steer Reservoir	60-12-15BBD	--	
HARDING COUNTY, SOUTH DAKOTA				
121	Beermug Lake	22-06-11BDD	--	
CORSON COUNTY, SOUTH DAKOTA				
122	Morristown Lake	23-19-34BBA	--	

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