WATER-RESOURCES ACTIVITIES OF

THE U.S. GEOLOGICAL SURVEY IN

SOUTH DAKOTA--FISCAL YEARS 1986-87

Compiled by E. M. Decker

U.S. GEOLOGICAL SURVEY

Open-File Report 87-383

Huron, South Dakota
1987

DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

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U.S. Geological Survey
Books and Open-File Reports
Federal Center, Bldg. 810
Box 25425
Denver, CO 80225-0425

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CONVERSION FACTORS

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

Multiply	By	To obtain
acre-foot	1,233	cubic meter
cubic foot per second	0.02832	cubic meter per second
foot per day	0.3048	meter per day
inch	25.40	millimeter
square foot	0.0920	square meter
square mile	2.590	square kilometer

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN SOUTH DAKOTA--FISCAL YEARS 1986-87

Compiled by Ella M. Decker

THE U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain. An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resource appraisals in order to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.

- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing "Earth science in the public service."

THE WATER RESOURCES DIVISION

The mission of the U.S. Geological Survey's Water Resources Division is to provide the hydrologic information and understanding needed for the optimum use and management of the Nation's water resources for the overall benefit of the people of the United States. For more than 93 years, the U.S. Geological Survey has studied the occurrence, quantity, quality, distribution, and movement of the surface and underground water that composes the Nation's water resources. As the principal Federal water-data agency, the Geological Survey collects and disseminates about 70 percent of the water data currently being used by numerous State, local, private, and other Federal agencies to develop and manage our water resources. This nationwide program, which is carried out through the Water Resources Division's 43 District offices and 4 Regional offices, includes the collection, analysis, and dissemination of hydrologic data and water-use information, areal resource appraisals and other interpretive studies, and research projects. Much of this work is a cooperative effort in which planning and financial support are shared by State and local governments and other Federal agencies.

The Geological Survey, through its Office of Water Data Coordination (OWDC), also coordinates the water-data-acquisition activities of other Federal agencies. Information on these Federal activities is made available to all users of water data by means of a national network of assistance centers managed by the Geological Survey's National Water Data Exchange (NAWDEX). In South Dakota, NAWDEX services can be obtained from the District Chief, U.S. Geological Survey, Water Resources Division, Federal Building, Huron, SD 57350. A leaflet explaining NAWDEX services is available from the Assistance Center or from the NAWDEX Program Office, U.S. Geological Survey, 421 National Center, Reston, VA 22092.

HISTORICAL SUMMARY - SOUTH DAKOTA DISTRICT

During 1979, the U.S. Geological Survey observed its 100th anniversary. In South Dakota, the first collection of streamflow data by the U.S. Geological Survey was in 1903. The early records collected during 1903-06 were from Black Hills area streams, and from 1912-20 data were collected at sites in the Standing Rock, Rosebud, and Pine Ridge Indian Reservations. During 1928-30, the U.S. Army Corps of Engineers provided financial support for the establishment and operation of 18 gaging stations in the Missouri River basin in South Dakota. One station has been in operation on the Missouri River continuously since 1930.

Despite its early beginning, it was not until October 16, 1944, that the Bismarck District, comprising the states of North Dakota and South Dakota, was created to assess the water resources of the two states with R. E. Marsh as District Engineer. To operate the South Dakota stream-gaging stations, a subdistrict office, with W. M. Littlefield in charge, was established in Pierre, South Dakota. The Pierre office was virtually independent of Bismarck, except for major questions of policy. Marsh and Littlefield were the only experienced men in the District yet it was a period of expansion and in less than three years the number of stream-gaging stations increased from 28 to 63. A second subdistrict office in South Dakota was later opened in Rapid City to establish and maintain stations on streams and ditches in the Black Hills area.

The next major increase in collection of surface-water records occurred during the mid-1940's as a result of the Pick-Sloan Plan for Missouri Basin development. Most of the stations established during this period were financed by Interior Department Missouri Basin funds and were primarily associated with U.S. Bureau of Reclamation studies.

Attempts had been made by State officials at various times to obtain State funds for cooperation in stream gaging but without success as the Legislature, reflecting the attitude of the citizens, was not water-minded. However, in 1944, the new Governor became convinced that with the proposed development of the Missouri Basin, then coming actively into the picture, the State should participate in the inventory of its water resources. Having no specific appropriation for that purpose, he decided that a number of State agencies should contribute from their general funds, and as the work would be done in cooperation with the U.S. Geological Survey, it seemed logical to him that the State Geological Survey should be designated as the cooperating State agency. Accordingly, that agency, the Highway Commission, and the Department of Game and Fish, each contributed equal amounts of funding totaling $2,400 for the years 1944 and 1945. By 1958 the cooperative surface-water program had grown to $57,000 in cooperation with the State Water Resources Commission. The network of gaging stations has continued to expand and presently records of daily flow are collected at about 106 sites.

In addition, in 1955, a cooperative program was begun with the South Dakota Highway Commission to determine the magnitude and frequency of floods in South Dakota. It was recognized that hydrologic data for floods from small drainage areas were lacking and provision was made for establishment of approximately 60 crest-stage gages in 16 areas in the State, mostly on basins of less than 10 square miles.

The State Geologist started a small observation-well program in 1936 and in the fall of 1939, he began cooperation with the USGS for the purpose of enlarging that program; $400 was allotted annually through the fiscal year 1945, when cooperation ceased. At that time, Missouri Basin funds for ground-water investigations became available.

A formal program of ground-water investigation was begun in South Dakota in 1946, with investigations in a proposed unit of the Oahe Irrigation Project. The Oahe Unit studies were begun under the supervision of the district engineer at Bismarck, North Dakota. A field office was established in Huron on May 13, 1947. This office conducted the ground-water activities while surface-water activities in South Dakota continued to be supervised from the Bismarck office. The early ground-water studies were made in cooperation with the U.S. Bureau of Reclamation (USBR) and were financed by funds appropriated for studies in the Missouri River basin. In addition to the long-range investigations in the Oahe area, several smaller projects were initiated in cooperation with the USBR between 1946 and 1956. The first ground-water studies in South Dakota utilizing the State-Federal Cooperative Program began in 1955 when the South Dakota State Water Resources Commission entered into a cooperative agreement with the U.S. Geological Survey to investigate the large and wasteful uncontrolled flow from artesian wells throughout the State. In 1958, the South Dakota State Geological Survey entered into a cooperative agreement for a study of ground-water resources with particular emphasis to be placed upon the determination of ground-water resources primarily in the eastern counties of the State.

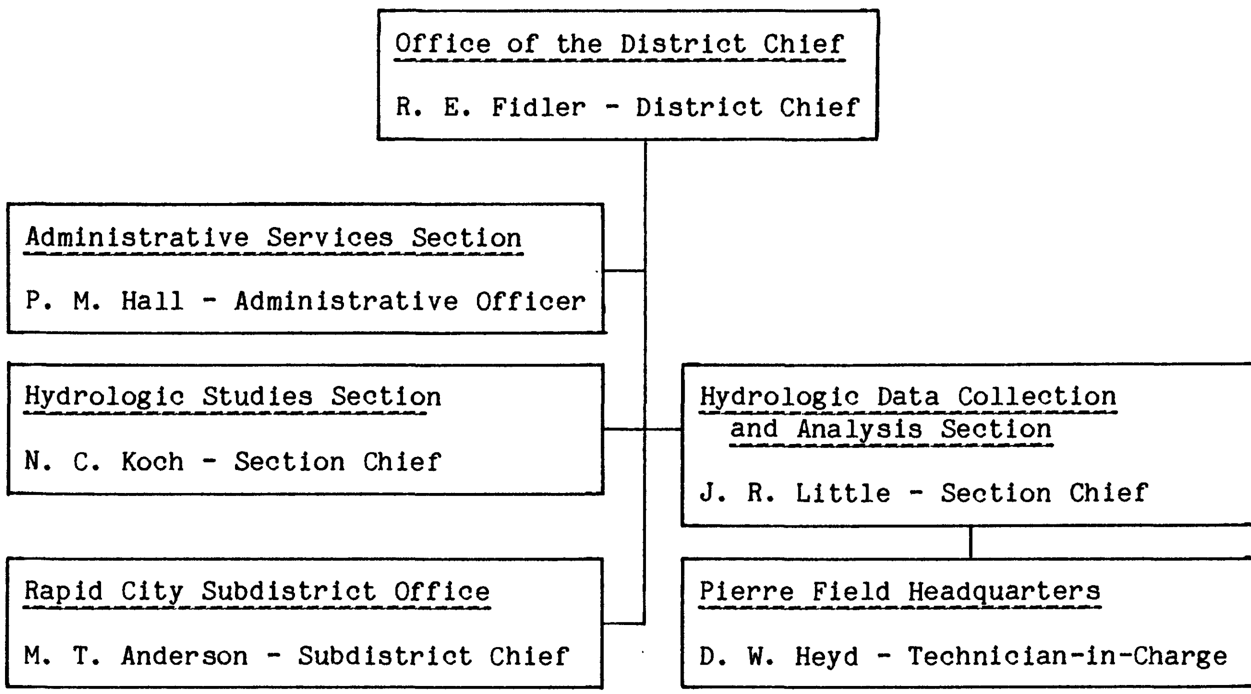
As part of the reorganization of the Water Resources Division in 1966, South Dakota was separated from the Bismarck District and both surface- and ground-water activities were supervised from Huron. John E. Powell was the first District Chief.

During the early years of USGS activity in South Dakota, interest in water quality centered on ground water, and studies of the chemical quality of water were made as integral parts of ground-water investigations. Laboratory work was done either in the Geological Survey Laboratory in Washington, D.C., or was contracted to other laboratories. Because of the need for large amounts of water-quality information in connection with plans for development of the Missouri River basin, the Quality of Water Branch of the U.S. Geological Survey established laboratories in Lincoln, Nebraska, in 1945, which served the South Dakota District for many years. One Central Laboratory, located in Arvada, Colorado, provides analytical services for the Geological Survey offices today.

Since 1944, about 98 water-resources studies have been made in South Dakota. These range from reconnaissance-type studies of counties and Indian reservations to research on small-basin runoff and toxic wastes, the quality of water in lakes, the use of remote sensing for defining aquifers, and studies using digital models to describe the ground-water regimen and surface-water hydraulics such as those currently underway in the James River basin and the Big Sioux River basin. During the past 20 years, 140 formal reports describing the studies and results of investigations have been prepared to inform the public and the scientific community.

DISTRICT ORGANIZATION

The South Dakota District of the Water Resources Division consists of two operating sections and one support unit. Water-resources projects conducted by the District are assigned an operating section with the responsibility for a project assigned to a project chief. Personnel are based at the District office in Huron, the Subdistrict office in Rapid City, and the Field Headquarters in Pierre. The District is assisted and advised by research centers, laboratories, technical consultants, and training centers maintained throughout the United States by the Water Resources Division.



Inquiries regarding work of the U.S. Geological Survey, Water Resources Division, in South Dakota may be directed to the following offices:

Huron District Office

U.S. Geological Survey
Water Resources Division
Room 317, Federal Building
200 4th St. SW
Huron, SD 57350
(605) 353-7176

Rapid City Subdistrict

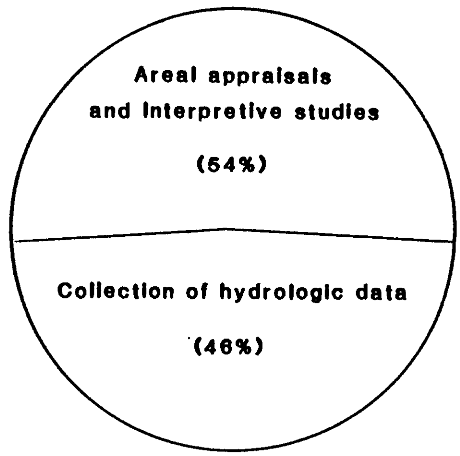
U.S. Geological Survey
Water Resources Division
Federal Building/Courthouse
Room 237 - 515 9th St.
Rapid City, SD 57701
(605) 394-1781

Pierre Field Headquarters

U.S. Geological Survey
Water Resources Division
Room 344, Federal Building
P.O. Box 220
Pierre, SD 57501
(605) 773-5388

TYPES OF INVESTIGATIONS

The diagram below shows the percentage of water resources investigations in South Dakota for fiscal year 1986 in the broad categories of collection of hydrologic data, and areal appraisals and interpretive studies, as a percent of total budget.



The investigations are directed toward obtaining the information needed by managers and planners for the solution or alleviation of water problems in the State.

The investigations are supported (table 1) by services and (or) funds provided by State and local agencies, matched on a 50-50 basis by Federal/State cooperative program funds; by funds transferred from other Federal agencies (OFA program); and by funds appropriated directly to the Geological Survey for research, data collection, and special projects (Federal program). In fiscal year 1986, the financial support for these programs in South Dakota was about $2,440,000 which was distributed as follows:

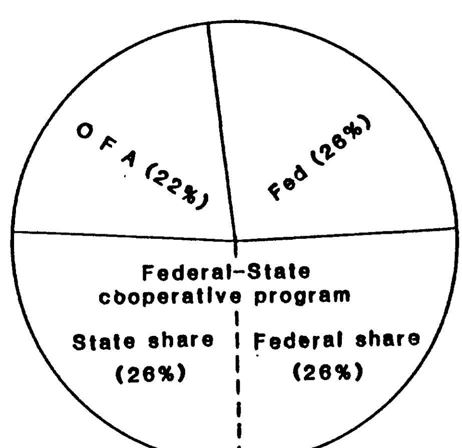


Table 1.--Agencies supporting water-resources investigations in South Dakota during fiscal years 1986-87

State Agencies

South Dakota Department of Transportation

South Dakota Department of Game, Fish & Parks

South Dakota Department of Water and Natural Resources
- Division of Water Rights
- Division of Water Quality
- Geological Survey

South Dakota School of Mines & Technology

Local Agencies

East Dakota Water Development District

West Dakota Water Development District

Counties of:			
	Brookings	Kingsbury	Moody
	Codington	Lincoln	Turner
	Grant	Minnehaha	Union
	Hutchinson		

City of Aberdeen

City of Rapid City

City of Sioux Falls

City of Watertown

Oglala Sioux Tribe

Federal Agencies

Department of the Army
- Corps of Engineers, Omaha District

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Reclamation
- EROS Data Center

Tennessee Valley Authority

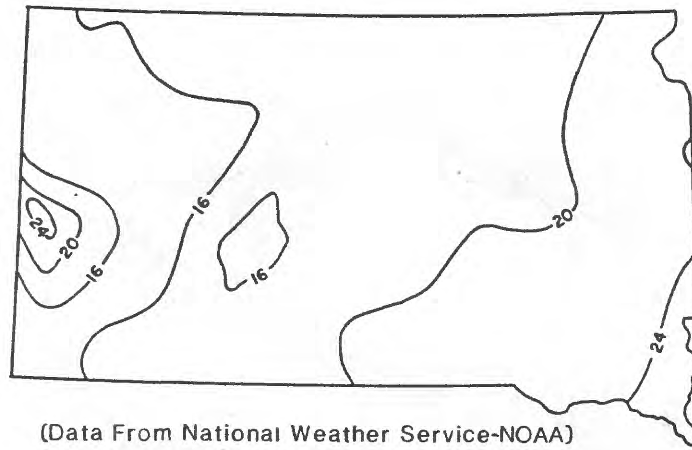
WATER RESOURCES SUMMARY

South Dakota has an average annual precipitation of about 18 inches, ranging from about 13 inches in the northwest to about 25 inches in the southeast (fig. 1). In most years, 75 to 85 percent of the precipitation falls between April and September. Droughts, especially those of the 1930's, 1950's, and 1970's, have been disastrous to agriculture, the State's dominant industry. With the exception of the Missouri River, where 31 million acre-feet of water can be stored in four large reservoirs in South Dakota, streamflow during low flows generally is not dependable for continued irrigation or for municipal or industrial withdrawals (fig. 2).

The large dams on the Missouri River, built under the Pick-Sloan Missouri River Program, provide flood protection and navigation benefits for the basin States downstream. However, the tributary streams experience periodic flooding, resulting from spring snowmelt and intense summer thunderstorms. The majority of damage is to lands used for agriculture. The U.S. Geological Survey outlines flood-prone areas on topographic maps as part of a nationwide Federal program for managing flood losses. Parts of these topographic maps showing flood-prone urban areas have also been published in urban-area pamphlets. In South Dakota, 311 topographic maps and 45 urban-area pamphlets have been completed (fig. 3). Information on these maps and pamphlets is available on request from the District Chief, U.S. Geological Survey, Huron, South Dakota.

Ground-water reservoirs constitute a large and reliable source of water for domestic, industrial, stock, and municipal use. Historically, water from confined (artesian) bedrock aquifers has been very important in the settlement of the State, and in the development of its chief industry, agriculture. Although artesian aquifers from which water flows, or can be pumped from moderate depth, underlie nearly all the State, shallow ground water is absent or scarce in much of the State, especially the unglaciated western part. Hence, the availability of artesian water and the development of inexpensive methods of drilling deep wells were of special importance in bringing about early settlement, which otherwise might have been restricted to river valleys where water is available from shallow alluvium. Much of the artesian water is of inferior chemical quality, but it has been used nevertheless.

The other major ground-water source in the State is the glacial drift that blankets South Dakota east of the Missouri River. Several hundred million acre-feet of water, much of it suitable for irrigation, is stored in glacial outwash and alluvium. These deposits are irregular in shape and size, and are scattered throughout the area. Figure 4 shows areas in the State where glacial deposits containing large amounts of ground water are known to occur. The major glacial drift aquifers have been mapped as a result of cooperative Federal-State-county-water development district water-resources studies.



(Data From National Weather Service-NOAA)
(Contour interval 4 inches)

Figure 1.--Annual average precipitation, in inches.

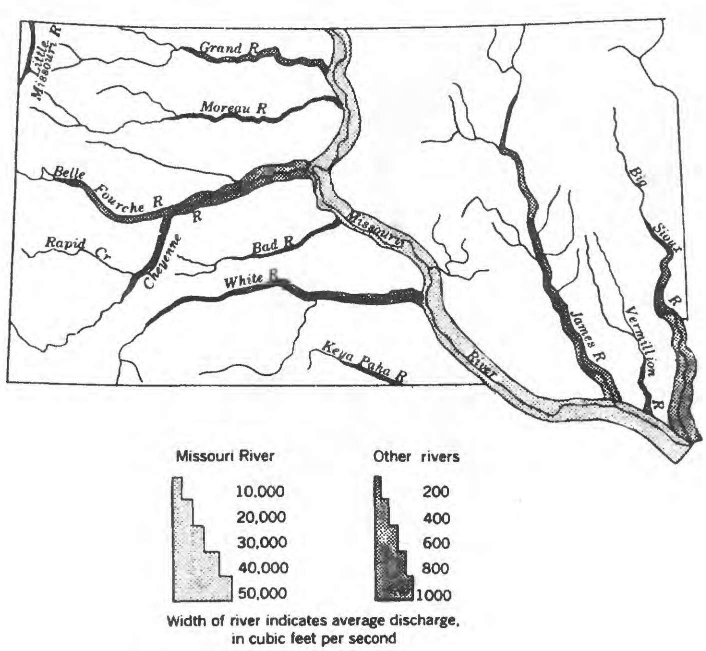


Figure 2.--Average discharge of the principal streams.

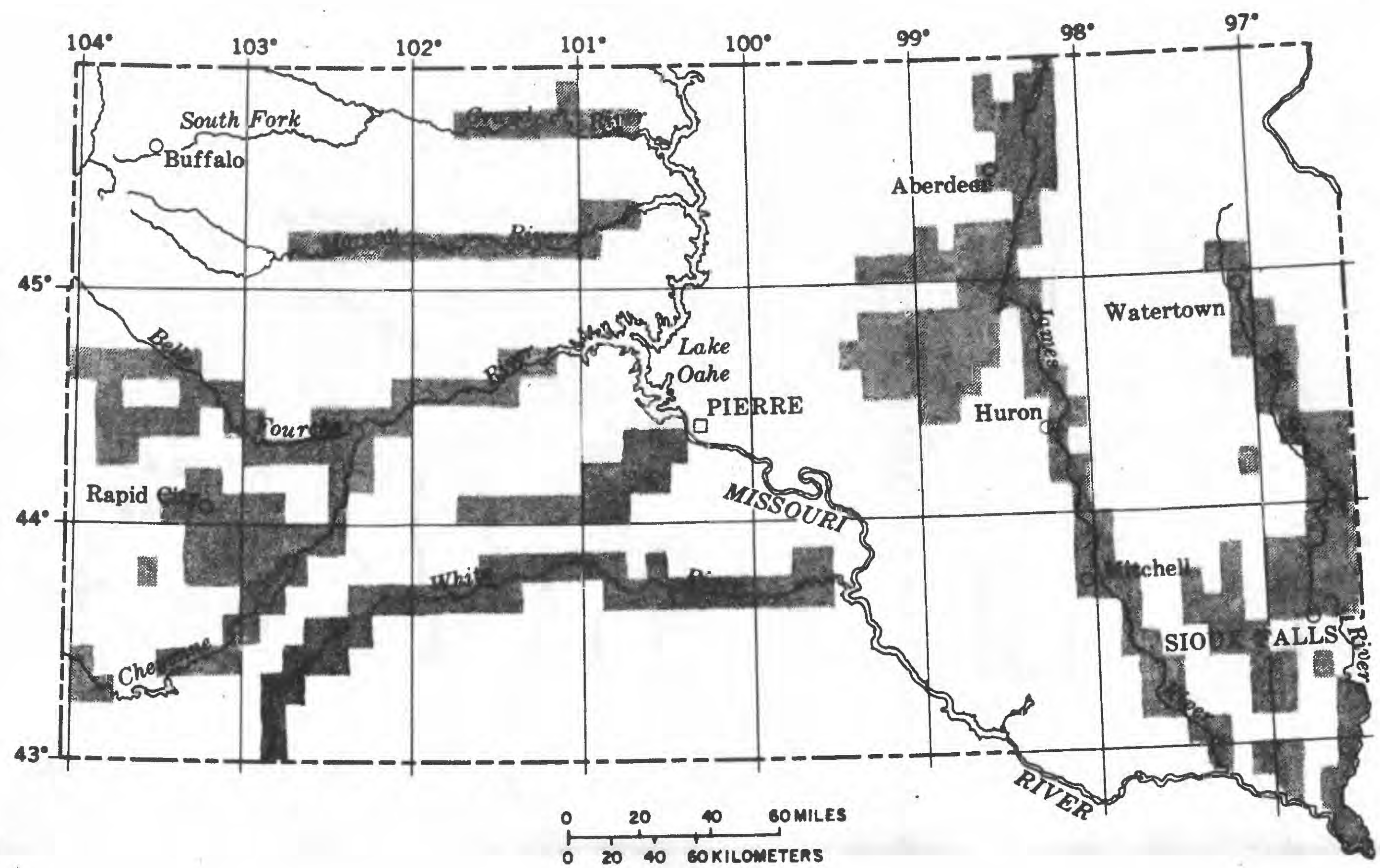


Figure 3.--Flood-prone area maps completed in South Dakota.

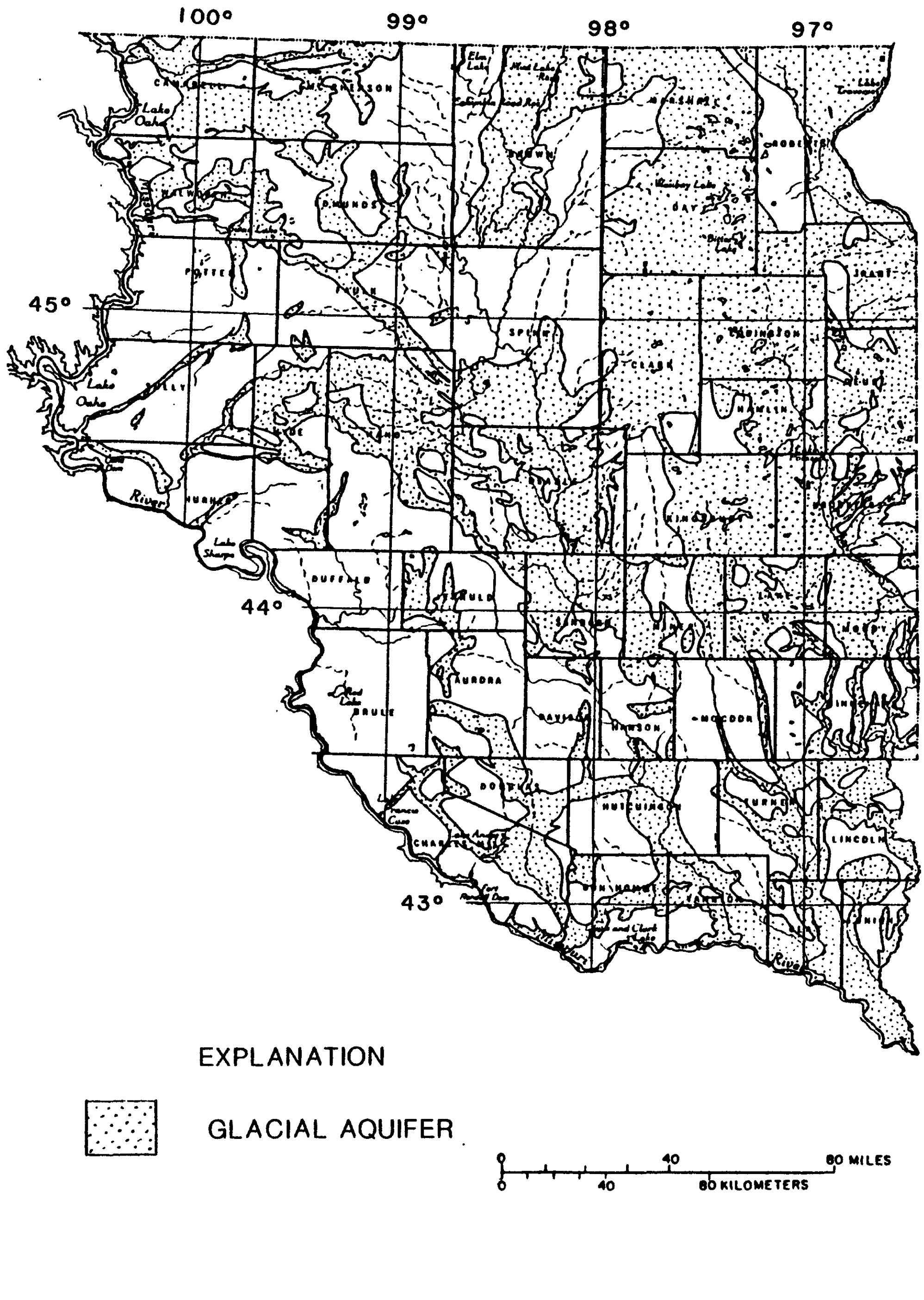


Figure 4.--Major glacial aquifers in eastern South Dakota. (Updated from Bardwell, 1984.)

HYDROLOGIC-DATA PROGRAM

Surface Water

Surface-water discharge (streamflow) and stage (water level) data (table 2, fig. 5) are collected for hydrologic purposes such as assessment of water resources, areal analyses, determination of long-term trends, research and special studies, or for management and operational purposes. Each year surface-water gaging stations are added and others are terminated as the needs and financial resources of the water-data users change. All data collected are stored in the Survey's National Water Data Storage and Retrieval System (WATSTORE) and are available on request to water planners and others involved in making decisions affecting the State's water resources. These data can be retrieved in machine-readable form or in the form of computer-printed tables or graphs, statistical analyses, and digital plots. Local assistance in the acquisition of services or products from WATSTORE can be obtained from the District Chief, U.S. Geological Survey, Water Resources Division in Huron.

Table 2.--Surface-water stations in operation in South Dakota, October 1, 1986

[Classification: B, bench-mark or long-term change station; C, current-purpose station; H, hydrologic station to meet objective of defining regional streamflow characteristics; P, principal stream station to meet objective of measuring principal unregulated streams; R, regulated stream station required to meet objective of defining regulated flow; S, stage. Equipment: D, digital water-stage recorder; M, servo-manometer unit; R, graphic water-stage recorder; T, telemark; P, data-collection platform. Supported by: COE, U.S. Army Corps of Engineers; BIA, Bureau of Indian Affairs; BR, Bureau of Reclamation; ED, East Dakota Water Development District; WD, West Dakota Water Development District; FED, Federal; MRB, Missouri River Basin Program; DWNR, Department of Water and Natural Resources; WAT, City of Watertown; RC, City of Rapid City; WY, State of Wyoming; BM, Federal bench-mark station; TVA, Tennessee Valley Authority.]

Station number	Station name	Classification	Gage equipment	Period of record (calender year)		Supported by
				Begin	End	
06334500	Little Missouri River at Camp Crook . . .	C,P	D,M	1903	1906	DWNR
				1956		
06355500	North Fork Grand River near White Butte .	C,R	D,M	1945		DWNR
06356000	South Fork Grand River at Buffalo	C,H	D,M	1955		DWNR
06356500	South Fork Grand River near Cash.	C,H	D,M	1945		COE
06357000	Shadehill Reservoir at Shadehill.	S	M,P	1950		MRB
06357500	Grand River at Shadehill.	C,R	D,R	1943		BR
06357800	Grand River at Little Eagle	C,R	D,M,P,T	1958		COE
06359500	Moreau River near Faith	C,H,P	D,M	1943		COE
06360500	Moreau River near Whitehorse.	C,H,P	D,M,P,T	1954		COE
06395000	Cheyenne River at Edgemont.	C,H,P	D,P,R	1903	1906	DWNR,TVA
				1928	1933	
				1946		
06400000	Hat Creek near Edgemont	C,H,P	D,M	1905	1906	DWNR
				1950		
06400497	Cascade Springs near Hot Springs.	C	D,M	1976		DWNR
06400875	Horsehead Creek at Oelrichs	C	D,M	1983		DWNR
06401000	Angostura Reservoir near Hot Springs. . .	S	P,R	1949		MRB
06401500	Cheyenne River below Angostura Dam. . . .	C,R	D,P	1945		BR

Table 2.--Surface-water stations in operation in South Dakota, October 1, 1986--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calender year) Begin	End	Supported by
06402000	Fall River at Hot Springs	C,R	D,M	1937		COE
06402500	Beaver Creek near Buffalo Gap	C,H	D,M	1937		DWNR
06403300	French Creek above Fairburn	C,H	D,M	1981		DWNR
06404000	Battle Creek near Keystone.	C	D,M	1945	1947	DWNR
				1961		
06406000	Battle Creek at Hermosa	C	D,M	1949		DWNR
06407900	Spring Creek near Rockerville	C,H	D,M	1985		WD
06408500	Spring Creek near Hermosa	C	D,M	1949		DWNR
06408700	Rhoads Fork near Rochford	C,H	D,M	1981		DWNR
06409000	Castle Creek above Deerfield Reservoir, near Hill City.	B,C	D,M	1948		BM
06409500	Deerfield Reservoir near Hill City. . . .	S	--	1947		MRB
06410000	Castle Creek below Deerfield Dam.	C,R	D,M,R	1946		BR
06410500	Rapid Creek above Pactola Reservoir, at Silver City.	C,R	D,M	1953		DWNR
06411000	Pactola Reservoir near Silver City. . . .	S	--	1956		MRB
06411500	Rapid Creek below Pactola Dam	C,R	D	1928	1932	BR
				1946		
06412500	Rapid Creek above Canyon Lake, near Rapid City	C,R	D,M,T	1946		DWNR
06414000	Rapid Creek at Rapid City	C,R	D,M,T	1903	1906	COE
				1942		
06418900	Rapid Creek below Sewage Treatment Plant, near Rapid City.	C	D,M	1981		DWNR
06421500	Rapid Creek near Farmingdale.	C,R	D,M	1946		RC,WD,DWNR
06422500	Boxelder Creek near Nemo.	C,H	D,M	1945	1947	DWNR
				1966		
06423010	Boxelder Creek near Rapid City.	C	D,M	1978		DWNR

Table 2.--Surface-water stations in operation in South Dakota, October 1, 1986--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calender year) Begin	End	Supported by
06423500	Cheyenne River near Wasta	C,R	D,M,P	1914	1915	COE
				1928	1932	
				1934		
06425100	Elk Creek near Rapid City	C	D,M	1979		DWNR
06425500	Elk Creek near Elm Springs.	C	D,M	1949		DWNR
06428500	Belle Fourche River at Wyoming-South Dakota State line	C,R	D	1946		FED
06430000	Murray Ditch at Wyoming-South Dakota State line	C,R	D,R	1954		WY,DWNR
06430500	Redwater Creek at Wyoming-South Dakota State line	C,R	D	1929	1931	WY,DWNR
				1936	1937	
				1954		
06431500	Spearfish Creek at Spearfish.	C	D,M	1946		DWNR
06433000	Redwater River above Belle Fourche. . . .	C,R	D,M	1945		DWNR
06433500	Hay Creek at Belle Fourche.	C,R	D	1953		COE,FED
06434500	Inlet Canal near Belle Fourche.	C,R	D	1945		BR
06435000	Belle Fourche Reservoir near Belle Fourche	S	M,R	1912		MRB
06436000	Belle Fourche River near Fruitdale. . . .	C,R	D,M	1945		DWNR
06436170	Whitewood Creek at Deadwood	C	D,M	1981		DWNR
06436180	Whitewood Creek above Whitewood	C	D,M,T	1983		FED
06436190	Whitewood Creek near Whitewood.	C	D,M	1981		DWNR
06436198	Whitewood Creek above Vale.	C	D,M,T	1983		FED
06436760	Horse Creek above Vale.	C,R	D,M	1962		MRB
06437000	Belle Fourche River near Sturgis.	C,R	D,M,P,T	1945		DWNR
06438000	Belle Fourche River near Elm Springs. . .	C,R	D,M	1928	1932	COE
				1934		
06439000	Cherry Creek near Plainview	C,H,P	D,M	1945		COE

Table 2.--Surface-water stations in operation in South Dakota, October 1, 1986--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calender year) Begin	End	Supported by
06439300	Cheyenne River at Cherry Creek.	C,R	D,M,P	1960		COE
06439430	Cottonwood Creek near Cherry Creek. . . .	H,P	D,M	1982		BIA
06439980	Lake Oahe near Pierre	S	--	1958		COE
06441000	Bad River near Midland.	C,P	D,M	1945		COE
06441500	Bad River near Fort Pierre.	C,H,P	M,P,R,T	1928		COE
06442000	Medicine Knoll Creek near Blunt	C,H	D,M	1950		DOE,FED
06442500	Medicine Creek at Kennebec.	C,H	D,M	1954		COE
06442700	Lake Sharpe near Fort Thompson.	S	--	1963		COE
06446000	White River near Oglala	C	D,M	1943		DWNR
06447000	White River near Kadoka	C,H,P	D,M,R	1942		COE
06447500	Little White River near Martin.	C	D	1938 1962	1940	DWNR
06449000	Lake Creek below refuge, near Tuthill . .	C,R	D,R	1938 1962	1940	DWNR
06449100	Little White River near Vetal	C	D,M	1959		MRB
06449300	Little White River above Rosebud.	C	D,M	1981		BIA
06449400	Rosebud Creek at Rosebud.	C,P	D,M	1974		MRB
06449500	Little White River near Rosebud	C,P	D,M	1943		DWNR
06450500	Little White River below White River. . .	C,H,P	D,M,R	1949		DWNR
06452000	White River near Oacoma	C,H	D,M,R	1928		COE
06452500	Lake Francis Case near Pickstown.	S	--	1952		COE
06453010	Missouri River at Greenwood	S	D,M,R	1981		COE
06453255	Choteau Creek near Avon	H,P	D,M	1982		BIA
06464100	Keya Paha River near Keyapaha	C	D,M	1981		DWNR
06464500	Keya Paha River at Wewela	C,H,P	D,M	1937 1947	1940	DWNR
06466700	Missouri River at Springfield	S	D,M,R	1981		COE
06467000	Lewis and Clark Lake near Yankton	S	--	1955		COE
06467500	Missouri River at Yankton	C,R	D,M,P,T	1930		COE,FED

Table 2.--Surface-water stations in operation in South Dakota, October 1, 1986--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calender year) Begin	End	Supported by
06471000	James River at Columbia	C,R	M,R,T	1945		DWNR
06471200	Maple River at North Dakota-South Dakota State line	C,H	D,M	1956		DWNR
06471500	Elm River at Westport	C,R	D,M	1945		DWNR
06473000	James River at Ashton	C,R	D,M	1945		MRB
06473700	Snake Creek near Ashton	H,P	D,M	1955	1969	BR
				1984		
06473750	Wolf Creek near Ree Heights	H,P	D,M	1959	1981	BR
				1984		
06474000	Turtle Creek near Tulare.	H,P	D,M	1953	1956	BR
				1965	1981	
				1984		
06474300	Medicine Creek near Zell.	H,P	D,M	1959	1981	BR
				1984		
06475000	James River near Redfield	C,R	D,M	1950		MRB
06476000	James River at Huron.	C,R	D	1928	1932	DWNR
				1943		
06476500	Sand Creek near Alpena.	C,H	D,M	1950		DWNR
06477000	James River near Forestburg	C,R	D,M,T	1950		DWNR
06477500	Firesteel Creek near Mount Vernon	C,H	D,M	1955		DWNR
06478052	Enemy Creek near Mitchell	C	D,M	1975		MRB
06478390	Wolf Creek near Clayton	C,H	D,M	1975		MRB
06478500	James River near Scotland	C,R	D,M,P,T	1928		COE
06478513	James River near Yankton.	C,R	D,M	1981		DWNR
06478515	Missouri River near Gayville.	S	D,M	1969		COE
06478533	Lake Thompson near Ramona	S	D,M	1986		DWNR
06478535	East Fork Vermillion River near Ramona. .	C,P	D,M	1986		DWNR
06478540	Little Vermillion River near Salem. . . .	B,C,H	R	1966		BM
06478690	West Fork Vermillion River near Parker. .	C,P	D,M	1961		DWNR

Table 2.--Surface-water stations in operation in South Dakota, October 1, 1986--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calender year) Begin	End	Supported by
06479010	Vermillion River near Vermillion.	C,P	D,M,P	1984		COE
06479215	Big Sioux River near Florence	C,H,P	D,M	1984		ED
06479438	Big Sioux River near Watertown.	C,H,P	D,M	1972		ED,WAT
06479525	Big Sioux River near Castlewood	C,H	D,M	1976		DWNR
06479980	Medary Creek near Brookings	H,P	D,M	1980		ED
06480000	Big Sioux River near Brookings.	C,P	D	1953		DWNR
06480400	Spring Creek near Flandreau	H,P	D,M	1982		DWNR
06480650	Flandreau Creek above Flandreau	H,P	D,M	1981		ED
06481000	Big Sioux River near Dell Rapids.	C,P	D,M,T	1948		COE
06481480	Skunk Creek near Chester.	H,P	D,M	1984		ED
06481500	Skunk Creek at Sioux Falls.	C,P	D,M,T	1948		COE
06482020	Big Sioux River at North Cliff Avenue, at Sioux Falls.	C,P	D,M,P,T	1972		COE
06482610	Split Rock Creek at Corson.	H,P	M,D	1970		MRB
06482848	Beaver Creek at Canton.	H,P	D,M	1982		DWNR
06485500	Big Sioux River at Akron, Iowa.	C,P	D,P	1928		COE
06485696	Brule Creek near Elk Point.	H,P	D,M	1982		DWNR

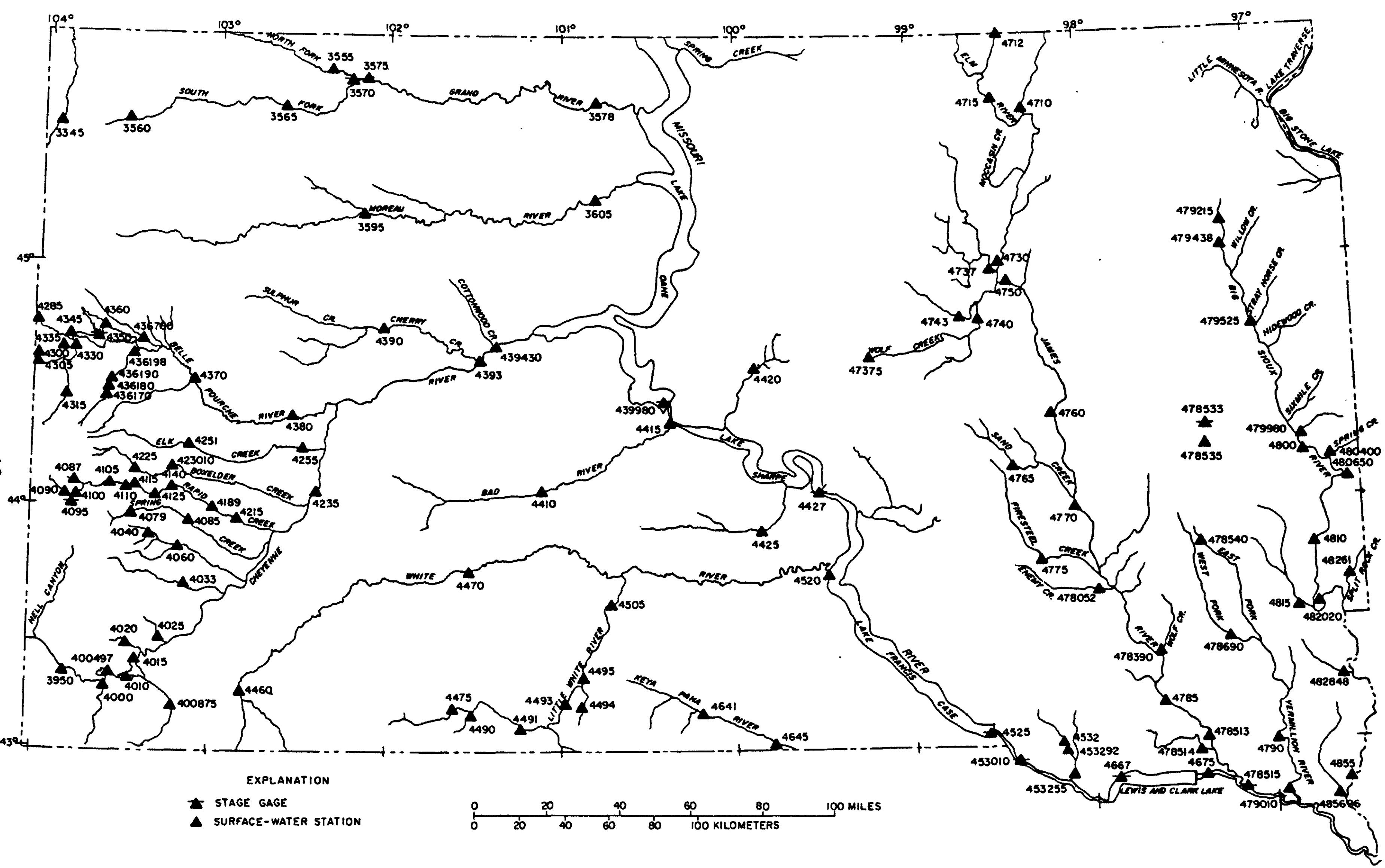


Figure 5.--Location of lake and stream-gaging stations, October 1, 1986.

Water-quality data are obtained at many of the surface-water stations (table 3, fig. 6) and occasionally at other surface-water sites where discharge and stage are not measured routinely. In addition to monitoring the quality of surface water in South Dakota, eight of these stations also are part of a U.S. Geological Survey nationwide network known as the National Stream Quality Accounting Network (NASQAN), which is used to detect trends in water quality.

Table 3.--Water-quality and sediment stations in operation in South Dakota, October 1, 1986

[Supported by: COE, U.S. Army Corps of Engineers; BIA, Bureau of Indian Affairs; BM, Federal bench-mark station; BR, Bureau of Reclamation; NASQAN, National stream-quality accounting netowrk; MRB, Missouri River Basin Program.]

Station number	Station name	Supported by: Water quality	Supported by: Sediment
06357800	Grand River at Little Eagle	NASQAN	NASQAN
06360500	Moreau River near Whitehorse.	NASQAN	NASQAN
06409000	Castle Creek above Deerfield Reservoir, near Hill City	BM	BM
06434500	Inlet Canal near Belle Fourche.	MRB	
06437000	Belle Fourche River near Sturgis. . . .	MRB	
06438000	Belle Fourche River near Elm Springs. .	NASQAN	NASQAN
06439300	Cheyenne River at Cherry Creek.	NASQAN	NASQAN
06441500	Bad River near Fort Pierre.		COE
06449100	Little White River near Vetal	MRB,BR	MRB,BR
06449300	Little White River above Rosebud. . . .	BIA,MRB,BR	BR
06452000	White River near Oacoma	NASQAN	NASQAN,COE
06452380	Andes Creek near Armour	MRB,BR	MRB,BR
06452383	Lake Andes tributary No. 3 near Armour.	MRB,BR	MRB,BR
06452386	Lake Andes tributary No. 2 near Lake Andes	MRB,BR	MRB,BR
06452389	Lake Andes tributary No. 1 near Lake Andes	MRB,BR	MRB,BR
06452392	Lake Andes near Lake Andes.	MRB,BR	
06452410	Lake Andes below Lake Andes	MRB,BR	
06453200	Choteau Creek near Wagner	MRB,BR	BR
06453252	Choteau Creek near Dante.	MRB,BR	BR
06470985	Mud Lake near Houghton.	BR	
06470992	Sand Lake near Columbia	BR	
06471000	James River at Columbia	NASQAN,BR	NASQAN
06473000	James River at Ashton	MRB,BR	BR
06473700	Snake Creek near Ashton	BR	
06473750	Wolf Creek near Ree Heights	BR	
06474000	Turtle Creek near Tulare.	BR	
06474300	Medicine Creek near Zell.	BR	
06476000	James River at Huron.	MRB,BR	BR
06478500	James River near Scotland	NASQAN,BR	NASQAN
06485500	Big Sioux River at Akron, Iowa.	NASQAN	NASQAN

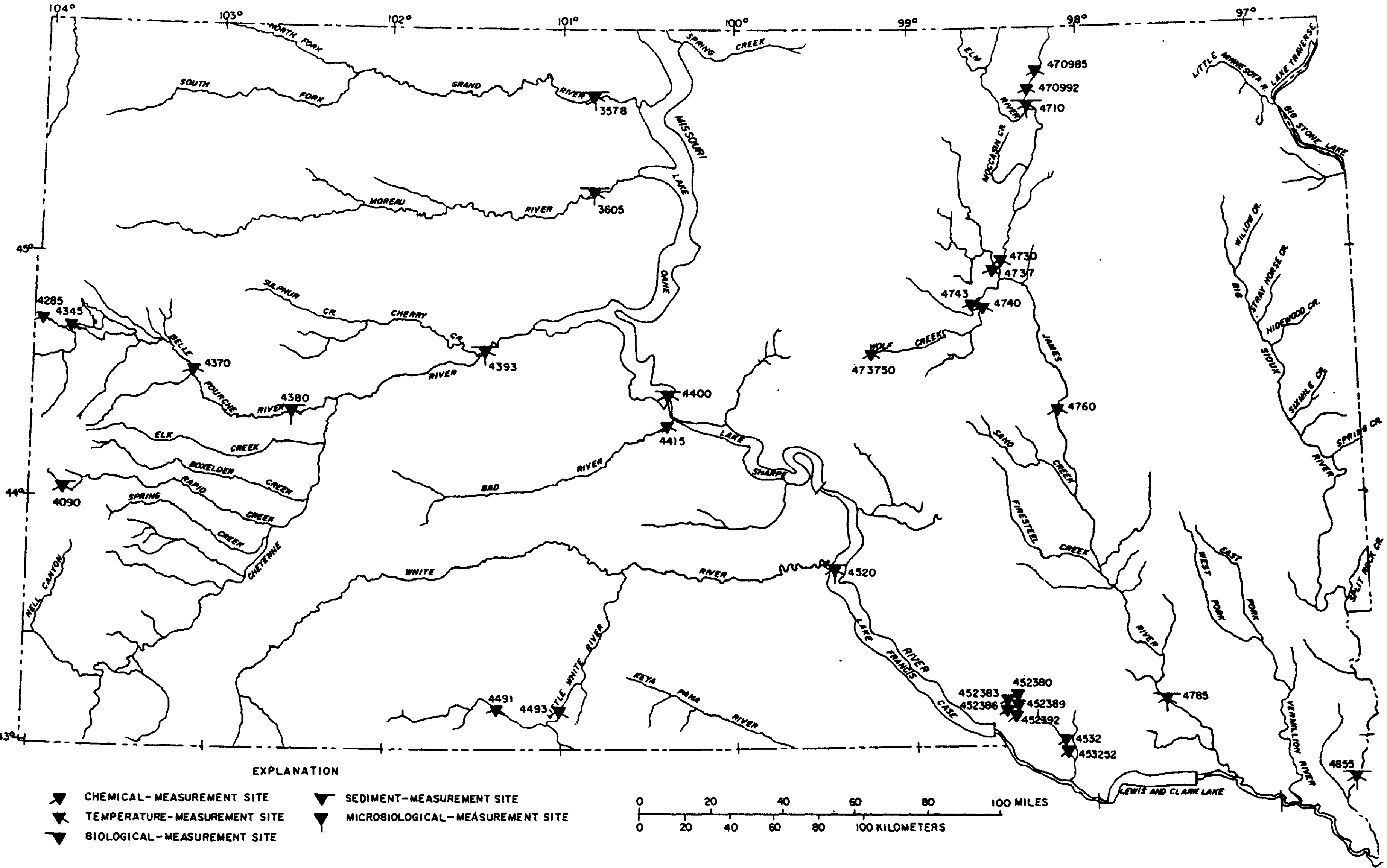


Figure 6.--Location of surface-water quality stations, October 1, 1986.

Ground Water

Water levels in wells, discharge from springs and wells, and water-quality data are key characteristics in monitoring ground-water trends; however, these hydrologic characteristics must be integrated with other observations and ground-water system studies in order to have the fullest meaning and usefulness. In South Dakota, the U.S. Geological Survey makes annual water-level measurements in a number of observation wells (table 4, fig. 7) in the bedrock artesian aquifers. Other wells, which are known as project wells, are used for specific (generally short-term) studies and, although they are not part of the observation-well program, data obtained from them also are available. In addition, the South Dakota Department of Water and Natural Resources maintains and measures more than 1,400 observation wells that are not listed in table 4.

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)

[Well number: The wells are numbered according to a system based on the Federal land surveys of South Dakota. The well number consists of the township number followed by "N," the range number followed by "W," and the section number, followed by a maximum of four uppercase letters that indicate, respectively, the 160-, 40-, 10-, and $2\frac{1}{2}$-acre tract in which the well is located. These letters are assigned in a counter-clockwise direction beginning with "A" in the northeast quarter. A serial number following the last letter is used to distinguish between wells in the same tract. Thus, well 103N65W21ADCC is the well in the SW$\frac{1}{4}$, SW$\frac{1}{4}$, SE$\frac{1}{4}$, NE$\frac{1}{4}$, sec. 21, T. 103 N., R. 65 W.]

County	Well number	Formation	Date of first measurement
Aurora	101N66W34BBBC	Dakota Formation	7-19-60
	103N65W21ADCC	do.	7-18-79
	103N65W21CAA	do.	8-20-76
	105N63W33CDBB	do.	7-21-77
	105N64W13DDA	do.	6- 9-61
Beadle	109N61W 6BAAC	do.	10-30-63
	109N64W33ACCD	do.	11- 2-60
	110N62W 9BBAD2	do.	10-16-67
	110N62W 9BBAD3	Greenhorn Limestone	7-16-68
	111N62W13DDDB	Dakota Formation	12-26-76
	113N65W16DDCD	do.	11- 4-63
Bon Homme	92N61W 5DDB	do.	4-12-60
	94N58W 1CCC	do.	10- 5-60
	94N59W 6DABA	do.	7- 7-67
Brookings	111N52W25DDCC	do.	10- 9-63

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)--Continued

County	Well number	Formation	Date of first measurement
Brown	122N60W 8CBBA2	Dakota Formation	6-21-60
	128N61W 5DCCC	do.	5-26-60
Brule	103N67W25CAD	do.	7-13-60
	104N70W26DCBC	Lakota Formation	3-23-59
	105N68W11CDB	Dakota Formation	7-14-60
Buffalo	107N73W 1BBBA	do.	10-13-71
	108N72W12BBCA	do.	9-26-61
	108N73W35DDA2	do.	11- 6-73
	108N73W35DDA3	Inyan Kara Group	7-19-79
Butte	8N 2E21CDBC	Lakota Formation	6- 4-80
	8N 2E23DCCA	Inyan Kara Group	6-10-80
	8N 3E12DBB	do.	10-22-70
	8N 3E33CCB	Minnelusa Formation	6- 4-80
	11N 1E17DCAC	Inyan Kara Group	7- 3-79
Campbell	127N78W209DCDD	Fall River Formation	8-14-62
Charles Mix	99N68W31DDDB	Dakota Formation	3-24-59
Clark	113N56W 5DDDD	do.	- -83
	115N59W15CAAB	do.	3-10-83
	116N59W23DDAA	do.	8-13-76
Clay	92N52W14DBBD	do.	12- 7-70
	93N52W28AAD	do.	6-21-61
	95N51W 7ADA	do.	6-21-61
Codington	116N52W 2CBBC	do.	2- 9-58
Corson	18N25E23DAD	Fox Hills Formation	7-15-80
	19N22E 1DB	do.	7-15-80
	20N29E25BBBC	Pierre Shale	7-14-80
	22N18E 4DBAC	Fort Union Formation	7-15-80
	22N19E32CBDA	Ludlow Member of the Lance Formation	7-15-80
	23N17E23ADCB	Fort Union Formation	7-15-80
Custer	2S 7E34ABBC	Minnelusa Formation	7-27-83
	2S 7E36CBCB	Lakota Formation	6-29-83
	3S 7E23DDAC	do.	6- 5-80
	3S 7E35DBB	do.	6- 5-80
	3S 8E17BACB	Graneros Shale	5-22-80
	3S 8E19BBBB	Morrison Formation	6-28-83

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)--Continued

County	Well number	Formation	Date of first measurement
Custer (Cont.)	3S 8E22ACDB	Inyan Kara Group	8-17-76
	3S 8E22ACDB2	do.	8- 1-77
	4S 7E 1DAAB	Dakota Formation	6-11-80
	4S 7E28DBBC	Fall River Formation	5-22-80
	5S 6E12DAAD	Sundance Formation	5-22-80
	6S 6E15ABDD	Madison Group	6-11-80
Davison	102N61W30CAC2	Dakota Formation	6- 2-83
	104N61W30DAA	do.	7-29-60
Dewey	12N22E 7ACC	Fox Hills Formation	7-16-80
	12N24E17CBBD	Madison Formation	7-15-81
	12N25E12BB	Fox Hills Formation	7- 6-80
	14N29E36DBDD	Sundance Group	5-19-81
	15N26E12CDB	Dakota Formation	6- 9-82
	15N30E26CCDA	Inyan Kara Group	9-25-75
Edmunds	121N68W 3AAAB	Dakota Formation	4-12-66
Fall River	7S 1E14BAAC	Sundance Formation	6-12-80
	7S 2E 3ACDD	do.	6-12-80
	7S 2E 3DAAB	do.	7-25-83
	7S 5E12CDBB	Minnelusa Formation	6-13-80
	7S 6E 1AAAD	Fall River Formation	5-22-80
	8S 2E 8AADD	do.	6-12-80
	8S 2E20DACC	Lakota Formation	6-12-80
	8S 2E36ADBB	Dakota Formation	6-12-80
	8S 2E36ADBC	Fall River Formation	4-11-81
	8S 3E32BDAB	Dakota Formation	6-12-80
Faulk	117N72W15CCCA	Inyan Kara Group	10-12-82
	118N67W16DBCC	Dakota Formation	6-22-60
	119N66W11ABAA	do.	6-23-60
	120N67W15AAAA	do.	11-28-61
Grant	120N48W 2ABBB	Cretaceous sandstone, undifferentiated	7-31-62
	121N47W36BBCB	do.	7-23-76
Gregory	96N68W29BDCB	Dakota Formation	7-10-63
Haakon	1N20E14DADB	Madison Group	7-23-80
	1N23E33CACC	Fall River Formation	- -83
	2N23E 4DA	do.	7- 6-80
	3N23E10BCAA	Newcastle Sandstone	7-15-80
	4N23E35AA	do.	- -83

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)--Continued

County	Well number	Formation	Date of first measurement
Haakon (Cont.)	6N18E31ABDC	Newcastle Sandstone	7- 4-80
	6N22E13BD	Lakota Formation	7-23-80
	6N23E31DB	Fall River Formation	7-16-80
	8N23E26ACDA	Madison Group	7-23-80
Hamlin	113N55W23BBAB	Dakota Formation	10-10-63
Hand	110N67W 7CBBB2	do.	5- 5-77
	116N67W31DDDB	do.	10-10-62
Hanson	104N58W13DCC	Codell Sandstone Member of the Carlile Shale	6-15-61
Harding	15N 1E13AADD	Fox Hills Formation	5-12-80
	19N 5E30DDA	Hell Creek Formation	7-16-80
Hughes	110N79W 4CAAA	Madison Group	5-13-81
	111N74W15BDAD	do.	7-20-76
Hutchinson	99N60W 1BBBC	do.	3-27-59
	99N61W 4AAD	do.	9-16-60
Hyde	109N72W32BAA	do.	5- 4-60
	109N73W12BDCB	Sundance Formation and Minnelusa Formation	6-24-70
	110N72W 1CDAA	Minnelusa Formation	6-24-70
	116N72W18DAAB	Inyan Kara Group	9-14-62
Jackson	1S22E10CCCC	do.	5-17-66
	1S22E19AADA	Fall River Formation	9-12-63
	1S22E28DAAA	Inyan Kara Group	7-22-80
	2S22E28BAD	Dakota Formation	8- -65
	2S22E32ABAD	do.	12-13-55
	2S24E11BDAC	Inyan Kara Group	7-22-80
	2S24E23DADD	Dakota Formation	8-17-76
	2S24E27CADA	do.	8-18-76
Jerauld	106N67W26CCDB	do.	11- 3-78
	108N63W20DCB	do.	4-27-61
Jones	1S28E36BBDB	Minnelusa Formation	7- 9-80
	2N26E31CBD	Dakota Formation	8-28-63
	2N27E17DDD	do.	8-28-63
	2S28E 8ADD	do.	5-17-78
	2S28E 8CBAC	do.	8-18-76
	3S28E 3AAA	Inyan Kara Group	9-13-63

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)--Continued

County	Well number	Formation	Date of first measurement
Kingsbury	110N53W10DAAA	Dakota Formation	8- 2-84
	110N58W32CCBC	do.	7-12-76
	111N58W13AAAA	do.	3-10-83
Lake	107N53W20BBC	do.	7-17-61
	108N53W32BDD2	do.	4-28-67
Lawrence	6N 2E 4BDD	Minnekahta Limestone	6- 4-80
	6N 2E23BBBA	Minnelusa Formation	6- 2-80
	6N 2E10BCBB	Spearfish Formation	6-10-80
	6N 4E21DBC	Minnelusa Formation	6-10-80
	6N 4E28BBA	Sundance Formation	5-28-80
	7N 1E14CCDD	Minnelusa Formation	6- 4-80
	7N 1E20AAD	do.	6- 2-80
	7N 1E21BBC	do.	6- 2-80
	7N 1E26ACD	do.	6-20-80
	7N 1E30BDA	Minnekahta Limestone	8-10-60
	7N 1E30BDA2	--	8-25-80
	7N 2E26BCDA	Minnelusa Formation	6- 3-80
	7N 2E32DD	Spearfish Formation	6- 4-80
	7N 3E 7AABA	Minnelusa Formation	8-27-62
	7N 4E 2BDBD	Fall River Formation	5-28-80
Lincoln	97N49W33AAAA	Dakota Formation	7- 6-61
	98N50W32AAAA2	do.	8-22-79
Lyman	101N72W35DADA	do.	7-10-63
	103N78W12BBAD	do.	10-21-75
	105N73W21CCBA2	do.	7-18-79
	105N73W27ADAC	do.	7- 9-62
	105N78W 9CABD	do.	8- 6-76
	105N78W14ADDA	do.	8-17-76
	107N75W17ABBC	Newcastle Formation	7-10-80
	108N77W21CCAB	Dakota Formation	7-18-63
McPherson	125N66W23ABAA	do.	8- 8-62
	127N66W 5BBBD	do.	8- 8-62
Marshall	127N58W19AABB	do.	4-22-65
	127N58W23DAD	do.	7- 1-70
	128N59W24CBBB	do.	6- 4-63
Meade	2N 9E 7CABC	Morrison Formation	1-13-83
	3N 6E15ABBB	Minnelusa Formation	7- 7-84
	3N 6E23DCB	Spearfish Formation	6-29-80
	4N 6E19AABA	Minnelusa Formation	7-10-84

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)--Continued

County	Well number	Formation	Date of first measurement
Meade (Cont.)	4N 9E 2DBDB	Sundance Formation	7-13-82
	6N 5E19ADCD	Fall River Formation	5-28-80
	6N 5E21DABA	Inyan Kara Group	5-28-80
	6N 5E22DDBC	do.	5-28-80
	7N14E25BDD	Newcastle Sandstone	6-23-80
	10N16E 3DB	Fox Hills Formation	6-11-80
Mellette	41N26W30DDC	do.	7- 7-80
	41N27W25DBDC	do.	6-27-78
	41N32W28CCD	Arikaree Formation	7- 8-80
	42N30W12CB	Dakota Formation	6-11-80
	43N27W 3BDA	do.	5-15-79
	43N27W14ACD	do.	7-25-63
	43N30W 8BBC	do.	7-30-63
	43N30W29A	Inyan Kara Group	7- 8-80
	44N31W20BBBB	Dakota Formation	7- 7-83
Miner	105N58W31BACC	do.	7-30-79
Moody	106N48W13BAAC	do.	7-13-61
	107N48W30DCCC	do.	7-13-61
Pennington	1N 7E14CBBD	Spearfish Formation	5-30-80
	1N 7E29DAC	Deadwood Formation	6-10-83
	1N 7E29CAD	Deadwood Formation	6-30-84
	1N 8E10DAAA	Inyan Kara Formation	8-30-82
	1N16E31CDA	Fall River Formation	8-19-70
	2N 7E17BAAD	Minnelusa Formation	7- 3-84
	2N 8E28BCB	Spearfish Formation	5-22-80
	1S 7E11ADB	Madison Group	11- 1-84
	1S 8E19BBBB	do.	3-13-84
	1S16E 6AAB	Fall River Formation	2- 2-61
	3S14E22DADA	Lakota Formation	6- 2-80
Perkins	13N14E 9DDA	Fox Hills Formation	6-17-80
	20N11E35BBA	Hell Creek Formation	6-18-80
	21N14E23C	Ludlow Member of the Lance Formation	6-18-80
	23N16E20ACAC	Fox Hills Formation	6-17-80
	23N17E31BBB	Ludlow Member of the Lance Formation	6-18-80
Potter	118N76W25AB	Dakota Formation	11-24-74
	120N76W33CDDB	Minnelusa Formation	7-24-76

Table 4.--Observation wells in bedrock aquifers in South Dakota, October 1, 1986 (statewide network)--Continued

County	Well number	Formation	Date of first measurement
Roberts	126N51W 9CCCA	Dakota Formation	6-20-62
	127N49W29BBBC	do.	6-20-62
Sanborn	106N62W30BCBA	do.	10-28-60
Spink	115N65W 4ADDC	do.	3-15-66
	116N62W 5DDCC	do.	3-15-66
Stanley	3N25E32BCDD	Inyan Kara Group	6-23-80
	5N27E22CDBB	Madison Group	5-20-81
	6N28E27ABBA	Newcastle Sandstone	6-24-80
	7N26E20B	Fall River Formation	6-25-80
Trip	99N79W33CC	Upper Cretaceous, undifferentiated	6- 9-80
	100N76W17ABB	Dakota Formation	6- 9-80
	101N74W 8DDCC	Graneros Shale	6- 9-80
	102N74W28CDAA	Dakota Formation	6-19-63
Turner	96N53W36DDDA	do.	7- 7-61
	97N54W 5AB	Niobrara Formation	3-31-66
Union	93N50W 4DAA	do.	6-30-61
	95N49W16ACD	do.	7- 7-61
Walworth	123N78W12BDCC	Dakota Formation	8-15-62
Yankton	93N54W 6CCD	do.	4-28-65
	93N55W 4BBC	do.	10- 6-60
Ziebach	13N18E29BBB	Fox Hills Formation	7-22-80
	13N19E36CC	do.	- -80
	13N21E31BDDA	do.	7-15-81

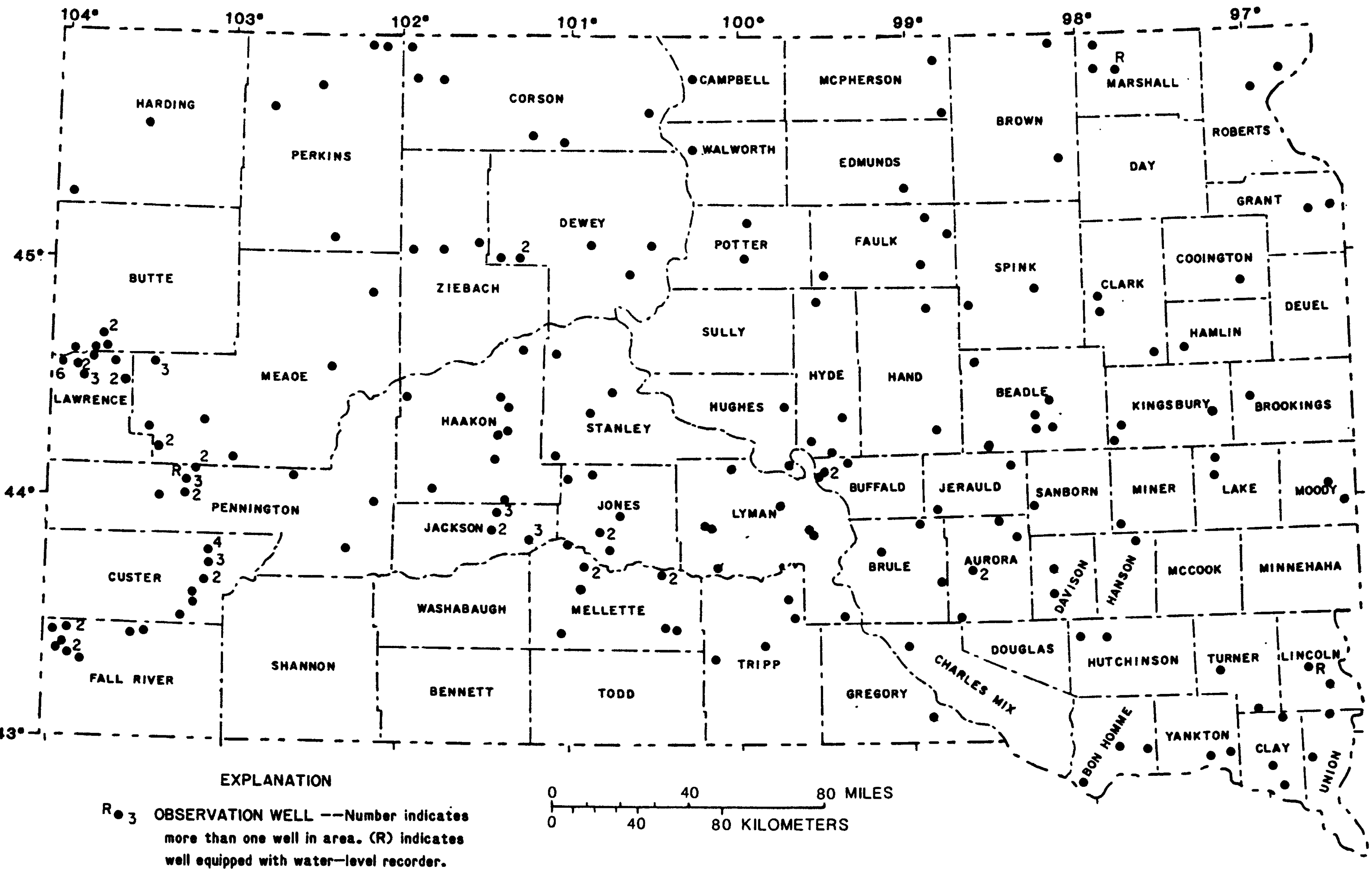
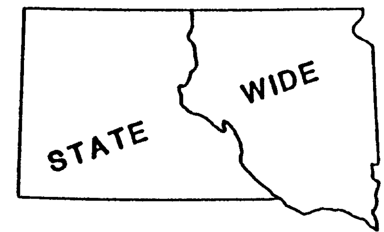


Figure 7.--Location of observation wells in bedrock aquifers, October 1, 1986.

CURRENT PROJECTS

The project descriptions in this section show the location, project number, title, period of the project, cooperating agencies, project leader, purpose of the project, progress, plans, and completed reports.

SURFACE-WATER STATIONS
(SD001)



Project leader: John R. Little

Project period: Continuous

Cooperators: South Dakota Department of Water and Natural Resources, East Dakota Water Development District, West Dakota Water Development District, City of Watertown, City of Rapid City, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Bureau of Indian Affairs, Tennessee Valley Authority, Missouri River Basin Program, U.S. Geological Survey (Federal Program).

Problem: Surface-water information is needed for purposes of surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. To provide this information, an appropriate data base is necessary.

Objective: A. To collect surface-water data sufficient to satisfy needs for current-purpose uses, such as 1) assessment of water resources, 2) operation of reservoirs or industries, 3) forecasting, 4) disposal of wastes and pollution controls, 5) discharge data to accompany water-quality measurements, 6) compact and legal requirements, and 7) research or special studies. B. To collect data necessary for analytical studies to define for any location the statistical properties of, and trends in, the occurrence of water in streams, lakes, estuaries, etc., for use in planning and design.

Approach: Standard methods of data collection will be used as described in the series, "Techniques of water resources investigations of the United States Geological Survey." Partial-record gaging will be used instead of complete-record gaging where it serves the required purpose.

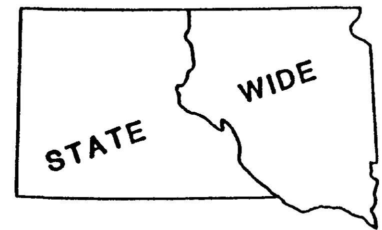
Progress and significant results during fiscal year 1986: Data were collected and published in U.S. Geological Survey Water-Data Report SD-85-1. No significant changes were made in the network. There are 119 active sites.

Plans for 1987: Review the network and consult with cooperators as to their needs. Expect to continue on about the same scale as last year. Data will be published in U.S. Geological Survey Water-Data Report SD-86-1. Requests for data will be answered.

Completed reports:

U.S. Geological Survey, 1986, Water resources data for South Dakota, water year 1985: U.S. Geological Survey Water-Data Report SD-85-1, 265 p.

GROUND-WATER RECORDS
(SD002)



Project leader: John R. Little

Project period: Continuous

Cooperators: South Dakota Department of Water and Natural Resources, City of Sioux Falls, West Dakota Water Development District, Missouri River Basin Program.

Problem: Long-term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from the ground-water systems, to provide a data base from which to measure the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resource.

Objective: A. To collect water-level data sufficient to provide a minimum long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known and potential problems can be defined early enough to allow proper planning and management. B. To provide a data base against which the short-term records acquired in areal studies can be analyzed.

Approach: Evaluation of regional geology allows broad, general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of the stress on the system in time and space and the hydrologic properties of the aquifers, a subjective decision can be made on the most advantageous location for observation of long-term system behavior. This subjective network can be refined as records become available and detailed areal studies of the ground-water system more closely define the aquifers, their properties, and the stresses to which they are subjected.

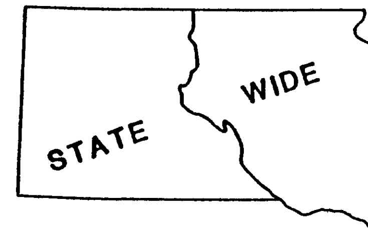
Progress and significant results during fiscal year 1986: Hydrologic data were collected for bedrock aquifers. All water levels for bedrock aquifers are either in the computer or ready for entry. Data for 30 observation wells were published in U.S. Geological Survey Water-Data Report SD-85-1. There are 219 active sites.

Plans for 1987: Continue collecting water-level data on existing observation wells and establish new observation wells in areas of poor coverage.

Completed reports:

U.S. Geological Survey, 1986, Water resources data for South Dakota, water year 1985: U.S. Geological Survey Water-Data Report SD-85-1, 265 p.

WATER-QUALITY STATIONS
(SD003)



Project leader: Stephen J. Lawrence

Project period: Continuous

Cooperator: U.S. Bureau of Reclamation, U.S. Bureau of Indian Affairs, Missouri River Basin Program, U.S. Geological Survey (Federal Program).

Problem: Water-resource planning and water-quality assessment require a nationwide base level of relatively standardized information. For intelligent planning and realistic assessment of the water resource, the chemical and physical quality of the rivers and streams must be defined and monitored.

Objective: To provide water-quality data for planning and action programs for Federal, State, and local water managers and users.

Approach: Operation of a network of water-quality stations to provide average chemical concentrations, loads, and time trends as required by planning and management agencies.

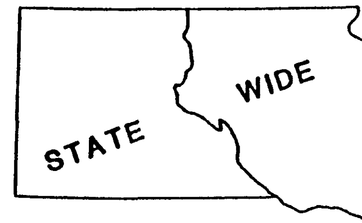
Progress and significant results during fiscal year 1986: There were no significant changes in the network. Water-quality data were published in U.S. Geological Survey Water-Data Report SD-85-1. There are 29 active sites.

Plans for 1987: Network will continue to be operated. Two sites will be discontinued in FY87.

Completed reports:

U.S. Geological Survey, 1986, Water resources data for South Dakota, water year 1985: U.S Geological Survey Water-Data Report SD-85-1, 265 p.

SEDIMENT STATIONS
(SD004)



Project leader: Eugene B. Hoffman

Project period: Continuous

Cooperators: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, Missouri River Basin Program, U.S. Geological Survey (Federal Program).

Problem: Water-resource planning and water-quality assessment require a nationwide base level of relatively standardized information. Sediment concentrations and discharges in rivers and streams must be defined and monitored.

Objective: To provide sediment data for use in planning and action programs for Federal, State, and local users.

Approach: Establish and operate a network of sediment stations to provide spatial and temporal averages and trends of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

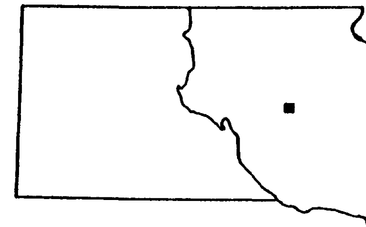
Progress and significant results during fiscal year 1986: Data collected as scheduled and published in U.S. Geological Survey Water-Data Report SD-85-1. Ten sites were added to the network. There are 20 active sites.

Plans for 1987: Continue network operation.

Completed reports:

U.S. Geological Survey, 1986, Water resources data for South Dakota, water year 1985: U.S. Geological Survey Water-Data Report SD-85-1, 265 p.

NATIONAL TRENDS NETWORK FOR MONITORING ATMOSPHERIC DEPOSITION (SD005)



Project leader: Stephen J. Lawrence

Project period: Continuous

Cooperator: Federal (USGS).

Problem: To establish and operate a nationwide long-term monitoring network to detect and measure levels of atmospheric deposition.

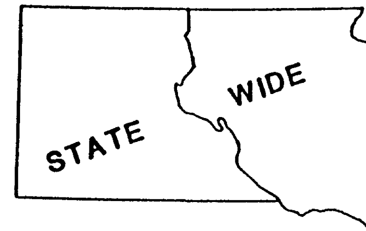
Objective: To determine variations in atmospheric deposition that occur on a week to week basis. To collect wet and dry deposition products for analysis of elements and compounds that can contribute to the chemical composition of surface waters.

Approach: Set up monitoring stations as part of the National Trends Network. Maintain station, make on-site measurements, process samples, and submit samples to an analytical laboratory. Verify data retrievals and report on results.

Progress and significant results during fiscal year 1986: Data were collected as scheduled.

Plans for 1987: Dry precipitation sampling will be discontinued. Water-quality data will be stored in the National Water Data Storage and Retrival System (WATSTORE) files and daily rainfall data will be stored in computer files. Data will be published in U.S. Geological Survey Water-Data Report SD-86-1.

SOUTH DAKOTA WATER-USE DATA PROGRAM
(SD007)



Project leader: Rick D. Benson

Project period: Continuous

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: Water requirements for various uses within South Dakota have increased considerably in recent years. A State Water Plan has been developed in order to implement a priority system for all State decisions affecting water-resource development. An important part of the State Water Plan is a comprehensive statewide water-use assessment program.

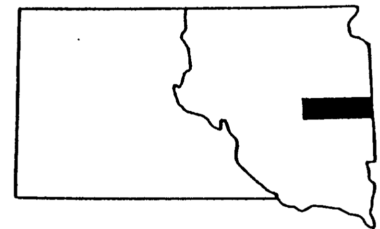
Objective: To develop and maintain a statewide water-use data program that will include field collection, computer storage, retrieval, manipulation, and dissemination of water-use data for 12 categories of water use.

Approach: The U.S. Geological Survey will provide direction, management, and standards development to meet the needs of the National Water-Use Program. The South Dakota Department of Water and Natural Resources will provide annual water-use data to the USGS for categories for which data are available.

Progress and significant results during fiscal year 1986: In excess of 8,000 water users were entered onto the State Water Use Data System (SWUDS). Data for the 1985 "Estimated Use of Water in the United States" report were entered onto SWUDS and then aggregated by county and by hydrologic unit. Irrigation questionnaire data for 1980, 1982, 1983, 1984, and 1985 were also entered onto SWUDS.

Plans for 1987: Irrigation questionnaire data for 1986 will be entered onto SWUDS. If time permits, a report summarizing 1985 water use by county and by hydrologic unit will be prepared.

WATER RESOURCES OF BROOKINGS AND KINGSBURY COUNTIES, SOUTH DAKOTA (SD060)



Project leader: Louis J. Hamilton

Project period: October 1981 to September 1987

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: The study will help complete the overall water resources picture in eastern South Dakota. A complete knowledge of the hydrology of the aquifers will be valuable in future land-use planning and in the development of irrigation and rural water systems in the area. Identification of significant new sources of ground water would undoubtedly encourage some changes from dryland to irrigation farming. Rural water systems may be developed in the heavily populated areas of the counties. Recent drought conditions have increased local interest in irrigation development from ground-water sources.

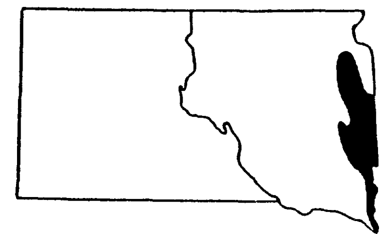
Objective: To provide reliable and up-to-date data and analyses needed for water-resources evaluation and for the efficient use of these resources by agriculture, rural water systems, and municipalities. Specifically, the study will concentrate on determining the availability of surface- and ground-water resources, the operation of the hydrologic system as it influences availability, the quality of surface and ground water, and the effects on the hydrologic system of developing the water resources. Areas of current or potential hydrologic problems as related to water use will be identified.

Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Glacial and bedrock aquifers will be delineated and hydrologic characteristics described. Pump tests, using existing wells, will be run whenever feasible. A geologic study will be made by the State Survey and there will be extensive test drilling by the State Survey. A preliminary report discussing the major aquifers will be prepared. A final report on the hydrology will be published by the U.S. Geological Survey and a report on the geology of the county will be prepared by a State Survey geologist.

Progress and significant results during fiscal year 1986: Test drilling was continued. Report illustrations and tables were prepared. Preliminary reports were written and submitted for review. The final interpretative report is being written.

Plans for 1987: Test drilling, mapping of hydrologic characteristics of the Big Sioux aquifer, and the study of lake flooding will be conducted. The reports will be completed.

WATER RESOURCES OF THE BIG SIOUX RIVER BASIN, SOUTH DAKOTA (SD065)



Project leader: Donald S. Hansen

Project period: October 1982 to September 1989

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: The Big Sioux River basin of eastern South Dakota represents a sizeable aquifer system of major importance to the economy of South Dakota. Management problems already exist and as development continues, the problems continue to increase in number and complexity. Although it is possible to roughly estimate the amount of water in the basin, management is extremely difficult. The aquifers are complex, consisting of many small aquifers that are hydrologically associated with several large aquifers and the Big Sioux River. A comprehensive model study is needed to aid in optimum development of water resources in the basin.

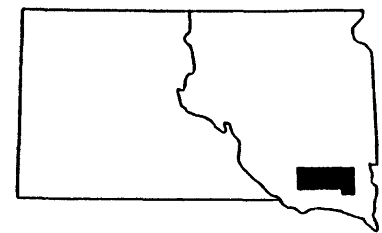
Objective: To provide a scientific basis for evaluation and efficient use of water resources and to explore the possibility of application of a solute transport model to describe rates and directions of movement. Information will be provided on the availability of surface- and ground-water resources, operation of the hydrologic system, and the effect of water-resources development on the hydrologic system. The study will complete the gathering of all necessary basic data within the basin. This data base will then be used to develop digital models of major aquifers.

Approach: The study will include hydrologic data collection and an extensive test drilling program by the State Survey. Two-dimensional models of the Big Sioux aquifer will be developed and the feasibility of the application of a solute transport model to describe rates and directions of movement, and concentrations of both naturally occurring and artificially introduced organic and inorganic constituents will be determined. Development alternatives will be tested and analyzed for possible impacts on the hydrologic system. Reports will be prepared summarizing the hydrology and recommending needs for further study and data collection.

Progress and significant results during fiscal year 1986: Test drilling continued in Codington and Grant Counties. A major aquifer confined within the glacial drift has been delineated. Measurement of observation well network in the Big Sioux aquifer in Lincoln, Union, and Minnehaha Counties continued. The Big Sioux aquifer model report for Moody County was completed. Ground-water samples were collected in Codington, Grant, Minnehaha, Lincoln, and Union Counties.

Plans for 1987: Continue test drilling in Codington and Grant Counties. Begin modeling of the Big Sioux aquifer in Codington, Grant, Lincoln, and Union Counties. Measure observation wells monthly and finish water-quality sampling.

WATER RESOURCES OF HUTCHINSON AND TURNER COUNTIES, SOUTH DAKOTA (SD066)



Project Chief: Richard J. Lindgren

Period of project: October 1982 to September 1987

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: Several productive aquifers mapped during U.S. Geological Survey studies in adjacent counties probably extend into Hutchinson and Turner Counties. A knowledge of the hydrology of these aquifers will be valuable in future land-use planning and in the development of irrigation and rural water systems. Identification of significant new sources of ground water would undoubtedly encourage some changes from dryland to irrigation farming. Also, the counties are quite heavily populated in rural areas which should favor the development of rural water systems which will benefit by the more detailed knowledge of the ground-water resources resulting from this study.

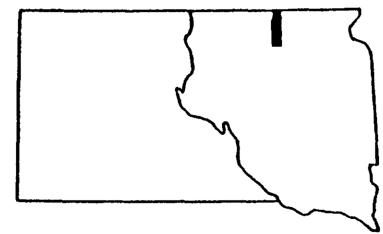
Objective: Provide the reliable and current basic data and analyses needed for water-resources evaluation for the efficient use of these resources by agriculture, rural water systems, and municipalities. The study will determine the availability of surface and ground-water, the operation of the hydrologic system as it influences availability, and the quality of surface and ground water. Current or potential problems related to development of the water resources will be identified. These problems may include declining water levels, decreased natural discharge, and changes in water quality due to induced recharge from materials adjacent to the aquifers.

Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Existing precipitation, streamflow, and well data will be collected. A well inventory will be conducted and a test-drilling program will be completed during the first two field seasons. An observation-well network will be established and water samples collected for chemical analyses. Glacial and bedrock aquifers will be delineated and hydrologic characteristics described. Pump tests, using existing wells, will be run whenever feasible.

Progress and significant results during fiscal year 1986: Test drilling to determine the location, extent, and thickness of aquifers in the study area was continued. Additional observation wells were installed at selected locations and measured periodically to provide water-level data. Analysis of data to determine the location, extent, and thickness of aquifers, as well as relationships between aquifers, was continued. Ground-water samples were collected and analyzed. The report "Major Aquifers of Hutchinson and Turner Counties, South Dakota" was written.

Plans for 1987: Test drilling will be completed and additional observation wells will be installed and measured periodically. Analysis of data to determine the location, extent, and thickness of aquifers, as well as relationships between aquifers will continue. Water-quality characteristics for major aquifers will be determined. The report "Water Resources of Hutchinson and Turner Counties, South Dakota" will be written.

HYDROLOGY OF THE GLACIAL AQUIFERS, ABERDEEN AREA, SOUTH DAKOTA (SD072)



Project leader: Patrick J. Emmons

Period of project: October 1983 to September 1987

Cooperators: South Dakota Department of Water and Natural Resources, City of Aberdeen.

Problem: Two glacial outwash aquifers in Brown County, the Elm and Middle James aquifers, can provide a major source of water in the area. Identification of aquifer properties and the prevailing flow regime will allow management decisions to be made from knowledge of storage, transmission, and recharge and discharge characteristics of the aquifers. With the anticipated large increases in water use from these aquifers, there is a need to better define the hydrologic system and to evaluate the effects of increased water demand on the water resources in this area.

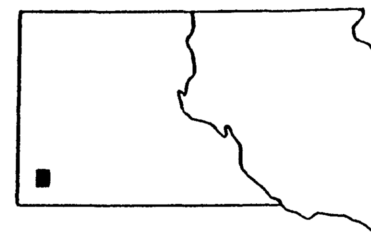
Objective: To define the ground-water system of the Elm and James River aquifers, develop a digital model of the aquifer system, and determine the hydrologic effects of the anticipated increase in water development in the aquifers.

Approach: Evaluate existing data and develop historical maps for aquifer simulation. Obtain current aquifer data and determine rates of recharge and discharge from existing hydrographs and precipitation records. Prepare maps of prepumping and current water tables, saturated aquifer thickness, and areal distribution of aquifer coefficients. Prepare a hydrologic budget and develop a digital model to simulate the aquifer system. The U.S. Geological Survey model will be used to estimate the long-term yield of the aquifer and to test selected pumping distribution plans. Prepare a Water-Resources Investigation Report.

Progress and significant results during fiscal year 1986: Continued to monitor 46 observation wells. Determined the elevation of approximately 60 observation wells to establish accurate altitudes of the measuring points. Continued to work on the three-dimensional ground-water flow model. Project complete except report.

Plans for 1987: Complete the three-dimensional ground-water flow model and prepare report.

SOUTH DAKOTA SIDE-LOOKING AIRBORNE RADAR STUDY (SD078)



Project leader: Mark T. Anderson

Period of project: May 1985 to September 1987

Cooperator: Federal (USGS).

Problem: Information on the relationship between the hydraulic conductivity of shale and fracturing of shale is needed for ongoing research and anticipated investigations in South Dakota. Investigation of the hydrology of the Upper Cretaceous shale has been hampered by the complexity of the hydrology, lack of data, and difficulty in applying standard methods. Lineaments, mapped using Landsat and Skylab imagery of South Dakota, may represent fractures, and ground-water movement may be related to these lineaments. If the permeability of the shale is fracture controlled, a relationship may be shown for the hydraulic conductivity and linear features in the shale.

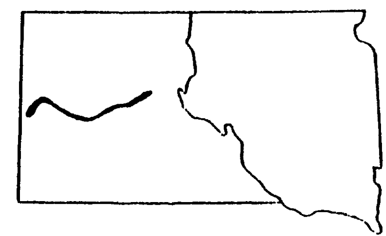
Objective: Test the hypothesis that the hydraulic conductivity of the Carlile Shale, of Upper Cretaceous age, in southwestern South Dakota is related to lineaments. The area of the investigation is in the Hot Springs, South Dakota, quadrangle. Measurements of hydraulic conductivity of the Carlile Shale within an area of about 10 square miles will be compared with lineaments throughout a 55-square mile area mapped from a variety of remote sensing techniques, including Landsat, side-looking airborne radar, and thematic imagery, aerial photographs, and digitized topographic data.

Approach: Compile existing data consisting of hydraulic conductivity measurements in the Carlile Shale, geophysical surveys by a consulting firm, and similar data collected for Department of Energy. In addition, Landsat, thematic mapping, and digital topographic imagery are available from the Earth Resources Observation Satellite (EROS) Data Center. To supplement existing imagery, the area will be mapped as part of the U.S. Geological Survey Side-Looking Airborne Radar (SLAR) program. The SLAR imagery and data will be combined with existing imagery and data and the linear features mapped, field checked, and compared with known geologic features. Hydraulic conductivities determined from existing data will be analyzed statistically to determine if a relationship exists between hydraulic conductivity and mapped lineaments.

Progress and significant results during fiscal year 1986: Project planning and literature review is complete. Side-looking imagery has not been flown.

Plans for 1987: Compile existing data on hydraulic conductivity of the Carlile Shale. Analyze Side-Looking Airborne Radar imagery and prepare report.

SEDIMENT CHEMISTRY - WHITEWOOD CREEK, WEST-CENTRAL SOUTH DAKOTA (SD079)



Project leader: Kimball E. Goddard

Period of project: April 1985 to September 1989

Cooperator: Federal (USGS).

Problem: Arsenic hydrogeochemistry in natural systems is largely undefined due to the complexity of the element's interrelationships with the environment. The transport of arsenic through a river system is dependent upon chemical transformations between ionic species, the sorption of arsenic species on solid materials, and the physical transport of sediment. The Cheyenne River basin, widely contaminated by arsenic-laden mill tailings discharged to a small tributary stream, provides an excellent field site to investigate the processes that control the distribution and movement of arsenic and other trace elements through the environment.

Objective: (1) Define the mechanisms responsible for the transport of arsenic and trace metals by the surface-water system, (2) describe the occurrence and distribution of arsenic and selected trace metals in water and sediment, and (3) develop and refine appropriate methods for field sampling, sample processing, and laboratory analysis. Other project objectives are being developed by Water Resources Division researchers and are to be accomplished separately.

Approach: A number of interrelated investigations will be conducted to define the distribution, transport, and fate of sediment and sediment-associated contaminants in the Cheyenne River basin. Laboratory experiments will be used to determine the sorption-desorption characteristics of tailings, alluvium, and suspended sediment. Geomorphologic and geometric measurements of flood-plain deposits will allow definition of sediment-source areas. In-stream sediment and chemistry data will be obtained at sites throughout the basin to determine the contaminants transport rates.

Progress and significant results during fiscal year 1986: Sediment and water chemistry sample collection was continued at four primary sites. Between five and ten large volume sediment chemistry samples were collected at each site during the spring snowmelt period. Additional sediment and water chemistry samples were collected at several background sites and at five intermediate sites within the contaminated reach. National Research Program projects were initiated to investigate ground-water geochemistry, biological interactions in Whitewood Creek, and sediment storage along the Belle Fourche River, and the Oahe Reservoir Sediment Geochemistry study was continued.

Plans for 1987: Continue field-data collection. Conduct laboratory and field experiments on the geochemical behavior of arsenic. Prepare for in-house use basic data tabulation that can be released at a future time as a basic data report. Develop organizational structure for Professional Paper.

WASTE DISPOSAL PLANNING STUDY
(SD080)

Project leader: Mark T. Anderson

Period of project: June 1985 to September 1987

Cooperator: Federal (USGS).

Problem: Reports on field studies of active or abandoned low-level waste disposal sites all point to a need for careful and comprehensive pre-siting studies of proposed sites. In addition, Nuclear Regulatory Commission regulations governing disposal of low-level radioactive waste list a number of disposal site suitability requirements and site characteristics which must be addressed before a site is accepted for licensing. A "generic" plan of study for proposed disposal sites could form the basis for the evaluation of many of the proposed sites.

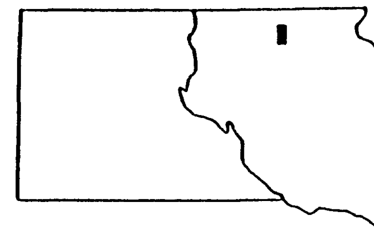
Objective: Develop a plan for evaluating the hydrogeologic suitability of potential sites for the shallow land disposal of low-level radioactive waste. The plan would specify the kinds and amounts of hydrogeologic information necessary for review and reasonable judgement by appropriate agencies as to the technical adequacy of a proposed disposal site.

Approach: The study will be in two phases. The first phase will begin with consultation with personnel associated with the Radioactive Waste Hydrology Program to establish firm guidelines and direction for the planning study. This will be followed by a review of the literature on the operating practices and hydrologic consequences thereof for a substantial number of low-level radioactive waste sites. The second phase of the project will be preparation of a report outline and a detailed plan for the study of the geohydrology and geochemistry of potential sites for the shallow land disposal of low-level radioactive waste. The plan for site evaluation will be published as a U.S. Geological Survey Circular.

Progess and significant results during fiscal year 1986: A literature search was completed--pertinent reports were obtained and reviewed. An annotated outline of the report was prepared and reviewed. The preparation of the report was begun.

Plans for 1987: Complete the draft report.

PRELIMINARY ASSESSMENT OF ARTIFICIAL RECHARGE POTENTIAL AND WELL YIELD CAPABILITIES OF THE ELM AND MIDDLE JAMES AQUIFERS IN THE ABERDEEN AREA, SOUTH DAKOTA (SD081)



Project leader: Patrick J. Emmons

Period of project: October 1985 to September 1986

Cooperator: U.S. Bureau of Reclamation.

Problem: Two glacial outwash aquifers in Brown County, the Elm and Middle James aquifers, have the potential of being major sources of water in the area. Identification of aquifer properties will allow management decisions to be made from knowledge of storage, transmission, recharge and discharge characteristics of the aquifers. The U.S. Bureau of Reclamation is in need of these data to evaluate the feasibility of using the Elm and Middle James aquifers for temporary storage of surplus water from the James River. Specifically, the U.S. Bureau of Reclamation needs a preliminary assessment of the aquifer's artificial recharge potential and the feasibility of retrieving the stored water via high-capacity wells. There is also a need to better define the hydrologic system of these aquifers in order to determine how the development of these aquifers will fit in with development of other water resources in the area.

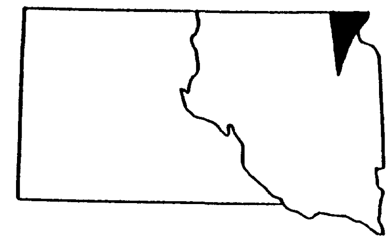
Objective: To define the ground-water system of the Elm and Middle James aquifers including a preliminary assessment of the aquifer's artificial recharge potential and well yield capabilities.

Approach: A large and detailed data base includes water-quality computer files, test-hole and well logs, aquifer test analyses, pumpage data, and water-level data. These data will be evaluated to define and prepare maps showing the areal extent of the Elm and Middle James aquifers, thickness, hydraulic conductivity, and quality of water. Also, to determine areas where artificial recharge using spreading ponds is feasible by mapping where the aquifer is within 5 feet of land surface or overlain by permeable material and to estimate well spacing, yield, and well depth based on an evaluation of existing high-capacity wells and extrapolating to other areas of the aquifer with similar hydrologic characteristics.

Progress and significant results during fiscal year 1986: Data analyses and a draft report was completed. The calculated theoretical composite well yield from the Elm and Middle James aquifers ranged from a conservative 64 cubic feet per second to a maximum 640 cubic feet per second. Based on available data, composite rates of 100 to 150 cubic feet per second probably are achievable from properly sited and constructed wells. Infiltration rates in the study area were estimated to range from 1.3 to 4.3 feet per day. Using an infiltration rate of 2 feet per day, 0.16 square miles of spreading pond would be required to artificially recharge at a rate of 100 cubic feet per second.

Plans for 1987: Approval and publication of report.

APPRAISAL OF THE WATER RESOURCES OF THE SISSETON INDIAN RESERVATION IN SOUTH DAKOTA (SD082)



Project leader: Stephen J. Lawrence

Period of project: April 1986 to September 1987

Cooperator: Federal (USGS).

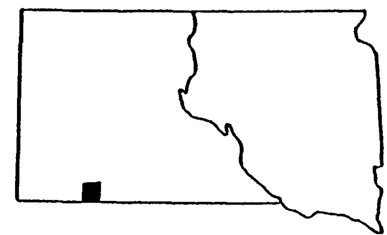
Problem: The Sisseton Indian Reservation Reservation is the last of the reservations in South Dakota awaiting an appraisal of its water resources. In 1977 the Sisseton-Wahpeton Tribal Council made a formal request to the U.S. Geological Survey for a hydrologic study. Officials from the Bureau of Indian Affairs support an appraisal study as a first step to help solve the reservation's need for water of good quality. It is generally felt that economic and social improvement of Indians living in the reservation is hampered by a lack of adequate and reliable information on the quantity and quality of water. The need for additional water supplies of good quality is critical because new housing development is proceeding.

Objective: The primary objective of the study is to provide current information on the extent, availability, and quality of both surface and ground water within the reservation. A secondary objective is to determine the beneficial uses of the water.

Approach: Geologic, ground-water, and surface-water resources will be evaluated using available data from records of the U.S. Geological Survey, South Dakota Department of Water and Natural Resources, Bureau of Indian Affairs, Environmental Protection Agency, and the Bureau of Reclamation. The available data will be used to determine quality and quantity of both surface water and ground water within the reservation. Meetings will be held with the Bureau of Indian Affairs, tribal officials, farmers, and local officials to determine water problems and needs. A detailed work plan will be prepared by the project chief during the first two months of the study. A final report will be published by the U.S. Geological Survey as a Water-Resources Investigations Report.

Plans for 1987: Project planning and field reconnaissance. Existing data will be analyzed. Prepare a report summarizing the results of the study.

AVAILABILITY OF WATER FOR IRRIGATION ON THE PINE RIDGE INDIAN RESERVATION NEAR PINE RIDGE, SOUTH DAKOTA (SD083)



Project leader: Mark T. Anderson

Period of project: April 1986 to September 1987

Cooperator: Oglala Sioux Tribe.

Problem: The Pine Ridge Indian Reservation is an economically depressed area and the lack of water-resources information greatly inhibits economic development. There is a great need to develop industry to decrease the unemployment on the reservation. The Tribe is looking at agriculture-related industries; however, an adequate water supply is a prerequisite to this development. The economic future of the Pine Ridge Indian Reservation is heavily dependent upon the capacity of underlying aquifers to sustain withdrawals. Irrigation systems have been established but have not operated because of a lack of a sufficient water supply. Knowledge of the high-yield capabilities of the aquifers is lacking. Previous studies dealt only with geologic mapping or an inventory of existing water development. Information is lacking on the aquifer-yield capabilities or the capacity of the aquifer to sustain withdrawals.

Objective: To provide reliable and up-to-date information and analyses needed for water-resources evaluation and for the efficient use of these resources by agriculture, rural water systems, and municipalities. Specifically, the study will concentrate on defining the aquifers, which can provide yields of 500 gallons per minute or more, and the capability of these aquifers to sustain withdrawals.

Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Test drilling will be conducted at selected sites to determine aquifer thickness and grain size. An aquifer test may be conducted where saturated thickness is estimated to be great enough to produce more than 200 gallons per minute.

Progress and significant results during fiscal year 1986: An exploratory well was drilled to a depth of 940 feet at a location two miles southeast of Pine Ridge without encountering the underlying Brule Formation. This is the greatest reported thickness of the Arikaree Formation in South Dakota. Two distinct water-bearing zones were found below the water level which was 44 feet: a shallow zone (44 to 180 feet) and a deep zone (500 to 540 feet). Based on the saturated thickness and grain size, a properly completed well at this site should yield 1,000 to 1,800 gallons per minute. Quality of water from the shallow aquifer is acceptable for irrigation. Four observation wells were drilled at various distances and depths from the proposed production well in preparation for an aquifer test.

Plans for 1987: Secure additional funds to complete one shallow and one deep production well. Conduct an aquifer test and analyze the data. Prepare a report summarizing the results of the study. Explore other areas on the Pine Ridge Indian Reservation to determine the yield potential of the aquifer.

JAMES RIVER DATA, GARRISON DIVERSION UNIT REFORMULATION (SD084)

Project leader: Rick D. Benson

Project period: October 1986 to September 1987

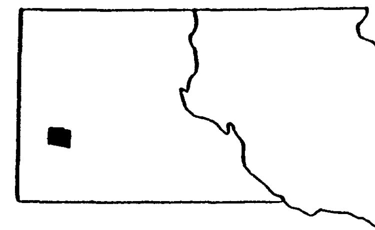
Cooperator: U.S. Bureau of Reclamation.

Problem: In 1984, the Garrison Diversion Unit Study Commission recommended major changes in the Garrison Diversion Unit (GDU) in North Dakota. On May 12, 1986, the Garrison Diversion Unit Reformulation Act of 1986 was signed into law. There are eight specific study areas identified within the Reformulation Act, seven of which are directly associated with impacts to the James River. The Reformulation Act directs the Secretary of Interior to submit a comprehensive report to the Congress as soon as practicable but not later than the end of FY 1988. The U.S. Bureau of Reclamation is the lead agency for evaluating the potential effects of GDU on the James River in South Dakota. As part of this evaluation, the Bureau requested that the U.S. Geological Survey conduct certain hydrologic studies on the James River in South Dakota.

Objective: The primary objective of this study is to provide flood-flow frequency data and flow duration data for the James River and certain tributaries in South Dakota. The study effort is devoted to the analysis of existing discharge records. Determination of the drainage area for the entire basin within South Dakota also will be accomplished.

Approach: The approach to be used to achieve the study objectives will be: A. Flood-flow frequency analyses will be conducted for the James River main-stem gages and for tributary gages using data stored in the WATSTORE Peak Flow File. Frequency data for gaged tributaries will be extended down to the confluence with the James River using drainage area data. Frequency data for ungaged tributaries will be computed using previously developed methods (Becker, 1974, 1980). Frequency data for ungaged tributaries will also be developed using frequency data from adjacent gaged basins with similar characteristics, adjusted for drainage area. Determination of frequency data for the main stem and for tributaries during the "summer" period will also be made. Frequency analyses of the maximum mean daily flow, which occurred during the summer each year, will be conducted. Extension of frequency data from tributary gages to the confluence with the river will be accomplished using drainage area data similar to the methods employed on the peak-flow data. B. Daily values duration hydrograph tables and plots will be prepared using Program K956 in conjunction with the WATSTORE Daily Values File. Additional daily values duration tables and statistics may be generated using Program A969. C. A section of the final report will discuss the channel-forming characteristics of the James River in South Dakota. D. Drainage boundaries will be delineated on 7.5-minute quadrangle sheets and electronically digitized for area determination. A separate report (Open File Map Report) will be prepared for the drainage-area study.

NITROGEN GAS IN GROUND WATER, EASTERN BLACK HILLS, SOUTH DAKOTA (SD085)



Project leader: Mark T. Anderson

Project period: October 1986 to September 1989

Cooperators: City of Rapid City and South Dakota Department of Game, Fish, and Parks.

Problem: The City of Rapid City, South Dakota, secures its municipal water supply primarily from three infiltration galleries along Rapid Creek. Because surface waters are fully appropriated, future water supplies are expected to tap the Madison Limestone aquifer which is known to be hydraulically connected to Rapid Creek. Since the terms of several long-term water agreements will be renegotiated within the next five years, the City would like a comprehensive hydrologic budget of Rapid Creek, which defines the ground water-surface water relationship. The mainstay of the City's water supply is Cleghorn Springs. Cleghorn Springs water is supersaturated with nitrogen gas, which is limiting fish production at the South Dakota Game, Fish and Parks Department fish hatchery. The origin and process of nitrogen gas supersaturation is unknown.

Objective: First, a hydrologic budget will be developed for the Rapid Creek drainage from Pactola Reservoir through Rapid City that includes ground-water contributions and losses. This will involve: (1) Tracing the sources and relative contributions of discharge from Cleghorn Springs; (2) identifying the source of water withdrawn from the City's infiltration galleries, whether spring water or surface water. Second, the occurrence of dissolved nitrogen gas and the process of gas supersaturation will be studied for ground water of the Black Hills area. Third, the study will test the use of nitrogen gas as a tracer of ground water.

Approach: The hydrologic budget between Pactola Reservoir and Rapid City will be estimated by use of existing streamflow records, new streamflow gages, and withdrawal records of water users. The source of water, whether ground water or streamflow, will be determined for each infiltration gallery by use of shallow observation wells, nitrogen gas concentrations, and stable isotopes. The origin and pathways of Cleghorn Springs water will be studied by determining the isotopic signatures at recharge and discharge points of Madison aquifer water. The process of nitrogen gas supersaturation in ground water will be studied by sampling gas concentrations and water temperatures at recharge points of the Madison and along known routes of water movement through the aquifer. Nitrogen gas as a tracer will be evaluated by comparing the results using gas with the results using stable isotopes.

Plans for 1987: A detailed plan of study will be completed in the first quarter of FY87. New streamflow gaging stations on Rapid Creek will be installed and the observation wells drilled near the infiltration galleries. A reconnaissance level assessment of nitrogen gas concentrations and stable isotope ratios will be conducted throughout the study area. Based on the findings of this initial survey, intensive gas and isotope sampling may be conducted.

PUBLICATIONS OF THE U.S. GEOLOGICAL SURVEY

General Information

The U.S. Geological Survey announces all its publications in a monthly report "New Publications of the Geological Survey." Subscriptions to this monthly listing are available upon request to the U.S. Geological Survey, 582 National Center, Reston, VA 22092. All publications are for sale unless specifically stated otherwise. Prices, which are subject to change, are not included here. Prepayment is required and information on price and availability should be obtained from listed sales offices before placing an order.

The "U.S. Geological Survey Yearbook" provides a comprehensive description of the Federal Government's largest earth-science agency; copies are available for fiscal years beginning with 1975 and may be purchased at the address where professional papers are sold (see below). Summaries of research in progress and results of completed investigations were formerly published each fiscal year in the professional paper series "Geological Survey Research" (see under heading "Professional Papers"). This series was discontinued in 1984. A pamphlet entitled "Geologic and Water-Supply Reports and Maps for South Dakota," which lists reports on the geology and water resources of South Dakota, is available upon request to the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225.

Water-Resources Information

A monthly summary of the national water situation presented in the "National Water Conditions" (formerly called "Water Resources Review") is available on request to the U.S. Geological Survey, 419 National Center, Reston, VA 22092. Water-resources activity reports (similar to this one) are available for each of the 50 States and Puerto Rico and the Virgin Islands.

Beginning with the 1971 water year, streamflow data, water-quality data for surface and ground water, and ground-water level data for each State are combined and published in the annual series "U.S. Geological Survey Water-Data Reports." See section "U.S. Geological Survey Water-Data Reports available only through NTIS" for listing of these reports.

Records of discharge of streams, and contents (or stage) of lakes and reservoirs were first published in a series of USGS water-supply papers entitled, "Surface Water Supply of the United States." Through September 30, 1960, these water-supply papers were in an annual series and then in a multiyear series for 1961-65 and 1966-70. Records of chemical quality, water temperatures, and suspended sediment were published from 1941 to 1970 in an annual series of water-supply papers entitled, "Quality of Surface Waters of the United States." Records of ground-water levels were published from 1935 to 1974 in a series of water-supply papers entitled, "Ground-water levels in the United States." Water-supply papers may be consulted in the libraries of the principal cities in the United States or may be purchased from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Pamphlets (mentioned under "General Information") listing the reports for each State by number and title may be obtained on request from that address also.

SELECTED LITERATURE ON WATER RESOURCES

Because the number of publications pertaining to water resources in South Dakota is large, the publications listed below were selected to show the types of information available to those interested in or in need of water facts. Many of these publications are available for inspection at the offices of the Geological Survey in Huron, Rapid City, and Pierre, and at large public and university libraries. The publications are grouped as follows: Publications of the U.S. Geological Survey (USGS); publications of State agencies prepared by or in cooperation with the U.S. Geological Survey; other publications, such as technical journals.

USGS Professional Papers

Professional Papers are sold by the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225.

P 600-D. Temperature variations of deep flowing wells in South Dakota, by D. G. Adolphson and E. F. LeRoux, in Geological Survey Research 1968, Chap. D, by U.S. Geological Survey, p. D60-D62. 1968.

P 650-B. Effects of reservoir filling on a buried aquifer in glacial origin in Campbell County, South Dakota, by N C. Koch, in Geological Survey Research 1969, Chap. B, by U.S. Geological Survey, p. B169-B173. 1969.

P 813-B. Summary appraisals of the Nation's ground-water resources--Upper Mississippi Region, by R. M. Bloyd, Jr. 1975.

P 813-K. Summary appraisals of the Nation's ground-water resources--Souris-Red-Rainy Region, by Harold O. Reeder. 1978.

P 813-Q. Summary appraisals of the Nation's ground-water resources--Missouri Basin Region, by O. James Taylor. 1978.

P 877. The Black Hills--Rapid City flood of June 9-10, 1972: A description of the storm and the flood, by F. K. Schwarz, M. S. Peterson, and others. 1975.

P 1015. Proceedings of the first annual William Pecora Memorial Symposium, October 1975, Sioux Falls, South Dakota, by P. W. Woll and W. A. Fischer, editors. 1977.

USGS Water-Supply Papers

Water-Supply Papers are sold at the above-listed Denver, Colo., address.

W 1137-A. Missouri River basin floods of April-May 1950 in North and South Dakota, by R. E. Oltman and others. 1951.

W 1260-B. Floods of April 1952 in the Missouri River basin. 1955.

W 1298. Reconnaissance of geology and ground water in the lower Grand River valley, South Dakota, by P. C. Tychsen and R. C. Vorhis, with a section on Chemical quality of the water, by R. A. Krieger. 1959.

W 1425. Ground water in the Crow Creek--Sand Lake area, Brown and Marshall Counties, South Dakota, by F. C. Koopman. 1957.

W 1460-G. Ground-water resources of the lower Niobrara River and Ponca Creek basins, Nebraska and South Dakota, by T. G. Newport, with a section on Chemical quality of the water, by R. A. Krieger. 1959.

W 1475-D. Geology and occurrence of ground water at Jewel Cave National Monument, South Dakota, by C. F. Dyer. 1961.

W 1531. Hydrology of the Upper Cheyenne River basin, by R. C. Culler, R. F. Hadley, and S. A. Schumm. 1961.

W 1534. Progress report on wells penetrating artesian aquifers in South Dakota, by R. W. Davis, C. F. Dyer, and J. E. Powell. 1961.

W 1539-T. Geology and ground-water resources of the Lake Dakota plain area, South Dakota, by W. B. Hopkins and L. R. Petri. 1963.

W 1769. Chemical quality of surface waters, and sedimentation in the Grand River drainage basin, North and South Dakota, by C. H. Hembree, R. A. Krieger, and P. R. Jordan, 1964.

W 1800. The role of ground water in the national water situation, by C. L. McGuinness. 1963.

W 1865. Water resources and geology of Mount Rushmore National Memorial, South Dakota, by J. E. Powell, J. J. Norton, and D. G. Adolphson. 1973.

W 2024. Water resources of the Big Sioux River valley near Sioux Falls, South Dakota, by D. G. Jorgensen and E. A. Ackroyd. 1973.

W 2090. Ground-water levels in the United States, 1967-71--north-central States. 1973.

W 2163. Ground-water levels in the United States, 1972-74, north-central States. 1977.

W 2250. National Water Summary 1983, includes State water-issue summaries - South Dakota, p. 209-211. 1984.

W 2275. National Water Summary 1984, includes State summaries of ground-water resources - South Dakota, p. 385-390. 1985.

W 2300. National Water Summary 1985, includes State summaries of surface-water resources - South Dakota, p. 419-424. 1986.

USGS Circulars

Single copies of circulars still in print are available free from the above-listed Denver, Colo., address.

C 54. Geology and ground-water hydrology of the Angostura irrigation project, South Dakota, by R. T. Littleton, with a section on Mineral quality of the waters, by H. A. Swenson. 1949.

C 201. Ground-water resources of the Rapid Valley unit, Cheyenne Division, South Dakota, by A. J. Rosier, with a section on Surface waters of Rapid Valley, by L. J. Snell. 1953.

C 270. Chemical quality of water and sedimentation in the Moreau River drainage basin, South Dakota, by B. R. Colby, C. H. Hembree, and E. R. Jochens. 1953.

C 676. Estimated use of water in the United States in 1970, by C. R. Murray and E. B. Reeves. 1972.

C 765. Estimated use of water in the United States in 1975, by C. R. Murray and E. B. Reeves. 1977.

C 1001. Estimated use of water in the United States in 1980, by W. B. Solley, E. B. Chase, and W. B. Mann IV. 1983.

Water-Resources Investigations Reports of the U.S. Geological Survey

Reports in this series are available for inspection at the South Dakota and Reston, Va., offices of the U.S. Geological Survey. Selected reports may be purchased either as microfilm or hard copy from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161; the NTIS ordering number is given in parenthesis at the end of the citation. Reports not listing a NTIS ordering number can be purchased from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Further information about these reports may be obtained from the District Chief, WRD, Huron, South Dakota.

WRIR 35-74. A method for estimating magnitude and frequency of floods in South Dakota, by L. D. Becker. 1974. (PB-239 831/AS)

WRIR 80-80. Techniques for estimating flood peaks, volumes, and hydrographs on small streams in South Dakota, by L. D. Becker. 1980. (PB-81 136 145)

WRIR 80-100. Appraisal of the water resources of the Big Sioux aquifer, Brookings, Deuel, and Hamlin Counties, South Dakota, by N. C. Koch. 1980. (PB-81 164 584)

WRIR 82-31. Magnitude and frequency of floods from selected drainage basins in South Dakota, by L. D. Becker. 1982 (PB 82-237470)

WRIR 82-4064. A digital-computer model of the Big Sioux aquifer in Minnehaha County, South Dakota, by N. C. Koch. 1983.

WRIR 83-4077. A preliminary assessment of the hydrologic characteristics of the James River in South Dakota, by R. D. Benson. 1983.

WRIR 83-4108. Water resources of Hanson and Davison Counties, South Dakota, by D. S. Hansen. 1983.

WRIR 83-4175. A two-dimensional, finite-difference model of the High Plains aquifer in southern South Dakota, by K. E. Kolm and H. L. Case III. 1983.

WRIR 83-4234. Evaluation of the response of the Big Sioux aquifer to extreme drought conditions in Minnehaha County, South Dakota, by N. C. Koch. 1983.

WRIR 84-4030. Water resources of Aurora and Jerauld Counties, Souoth Dakota, by L. J. Hamilton. 1984.

WRIR 84-4069. Water resources of Deuel and Hamlin Counties, South Dakota, by Jack Kume. 1986.

WRIR 84-4078. Appraisal of the water resources of the eastern part of the Tulare aquifer, Beadle, Hand, and Spink Counties, South Dakota, by L. K. Kuiper. 1984.

WRIR 84-4195. Water resources of Hughes County, South Dakota, by L. J. Hamilton. 1986.

WRIR 84-4209. Water resources of Lake and Moody Counties, South Dakota, by D. S. Hansen. 1986.

WRIR 84-4241. Water resources of Yankton County, South Dakota, by E. F. Bugliosi. 1986.

WRIR 84-4312. Effects of artificial recharge on the Big Sioux aquifer in Minnehaha County, South Dakota, by N. C. Koch. 1984.

WRIR 85-4015. Water resources of Walworth County, South Dakota, by Jack Kume and L. W. Howells. 1987.

WRIR 85-4021. Evaluation of techniques for mapping land and crops irrigated by center pivots from computer-enhanced Landsat imagery in part of the James River basin near Huron, South Dakota, by K. E. Kolm. 1985.

WRIR 85-4022. Availability and quality of water from the bedrock aquifers in Rapid City area, South Dakota, by K. D. Peter. 1985.

WRIR 85-4069. Geochemical survey to determine water-quality characteristics of the Big Sioux aquifer in eastern South Dakota, by N. F. Leibbrand. 1985.

WRIR 85-4217. Analysis of flood-flow frequency for selected gaging stations in South Dakota, by R. D. Benson, E. B. Hoffman, and V. J. Wipf. 1985.

WRIR 87-4017 Preliminary assessment of potential well yields and the potential for artificial recharge of the Elm and Middle James aquifers in the Aberdeen area, South Dakota, by P. J. Emmons. 1987.

USGS Water-Data Reports Available Only Through NTIS

The water-data reports listed below may be purchased as hard copy or microfiche only from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161. They are available for inspection only at the South Dakota and Reston, Va., offices of the U.S. Geological Survey. The PB number in parenthesis is the NTIS ordering number.

SD-75-1 Water resources data for South Dakota--water year 1975, by U.S. Geological Survey. 1976. (PB-251 861/AS)

SD-76-1 Water resources data for South Dakota--water year 1976, by U.S. Geological Survey. 1977. (PB-266 453/AS)

SD-77-1 Water resources data for South Dakota--water year 1977, by U.S. Geological Survey. 1978. (PB-281 757)

SD-78-1 Water resources data for South Dakota--water year 1978, by U.S. Geological Survey. 1979. (PB-296 426)

SD-79-1 Water resources data for South Dakota--water year 1979, by U.S. Geological Survey. 1980. (PB80- 195936)

SD-80-1 Water resources data for South Dakota--water year 1980, by U.S. Geological Survey. 1981. (PB82- 101338)

SD-81-1 Water resources data South Dakota--water year 1981, by U.S. Geological Survey. 1982. (PB83-102715)

SD-82-1 Water resources data South Dakota--water year 1982, by U.S. Geological Survey. 1983. (PB84-117175)

SD-83-1 Water resources data South Dakota--water year 1983, by U.S. Geological Survey. 1984. (PB85-127850)

SD-84-1 Water resources data South Dakota--water year 1984, by U.S. Geological Survey. 1985. (PB86-130507)

SD-85-1 Water resources data South Dakota--water year 1985, by U.S. Geological Survey. 1986. (PB87-152062).

USGS Hydrologic Investigations Atlases

Hydrologic Investigations Atlases (and other maps of areas west of the Mississippi River) are sold by the U.S. Geological Survey, Map Distribution, Federal Center, Bldg. 810, Box 25286, Denver, CO 80225.

HA-195. Hydrogeology of the glacial drift in the Skunk Creek--Lake Madison drainage basin, southeastern South Dakota, by M. J. Ellis and D. G. Adolphson. 1965.

HA-311. Hydrology of a part of the Big Sioux drainage basin, eastern South Dakota, by M. J. Ellis, D. G. Adolphson, and R. E. West. 1968.

HA-355. Hydrology of the Rosebud Indian Reservation, South Dakota, by M. J. Ellis, J. H. Ficken, and D. G. Adolphson. 1971.

HA-357. Hydrology of the Pine Ridge Indian Reservation, South Dakota, by M. J. Ellis and D. G. Adolphson. 1971.

HA-499. Geohydrology of Crow Creek and Lower Brule Indian Reservations, South Dakota, by L. W. Howells. 1974.

HA-511. Flood of June 9-10, 1972, at Rapid City, South Dakota, by O. J. Larimer. 1973.

HA-585. Geohydrology of the Cheyenne River Indian Reservation, South Dakota, by L. W. Howells. 1979.

HA-644. Geohydrology of the Standing Rock Indian Reservation, North and South Dakota, by L. W. Howells. 1982.

USGS Hydrologic Unit Maps

Hydrologic unit maps are sold at the above-listed Denver address.

U.S. Geological Survey, 1976, Hydrologic unit map--1974 State of South Dakota.

USGS Open-File Reports and Maps

Open-file reports, which may be in manuscript form, generally are not reproduced and distributed in quantity. These reports are available for inspection in the Huron, South Dakota, and Reston, Va., offices of the U.S. Geological Survey. Most numbered open-file reports may be purchased from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Information on the availability of the unnumbered reports may be obtained from the District Chief, USGS, Water Resources Division, Huron, South Dakota.

USGS Numbered Open-File Reports

OFR 70-194. A proposed streamflow-data program for South Dakota, by O. J. Larimer. 1970.

OFR 79-563. A geohydrologic overview for the Pecora Symposium field trip, June 1979, by N. C. Koch. 1979.

OFR 81-222. Water-level records for the Big Sioux aquifer, Minnehaha County, South Dakota, by W. L. Bradford. 1981.

OFR 81-627. Water levels in bedrock aquifers in South Dakota, by W. L. Bradford. 1981.

OFR 81-924. Records of water levels in unconsolidated deposits in eastern South Dakota, by W. L. Bradford. 1981.

OFR 82-1020. Records of water levels in the Big Sioux aquifer, Minnehaha County, South Dakota, by D. R. Winter. 1982.

OFR 83-207. Summary of water withdrawals in the United States, 1950-80, by W. B. Mann IV, W. B. Solley, and E. B. Chase. 1983.

OFR 83-754. Water resources investigations of the U.S. Geological Survey in South Dakota, project status summary, July 1, 1983, by E. F. LeRoux and E. M. Decker. 1983.

OFR 83-773. Streamflow and sediment data collected at seven stream-gaging stations in the James River basin downstream from Forestburg, S. Dak., from October 1, 1981, to September 30, 1983, by J. R. Little. 1983.

OFR 84-148. Geologic and hydrologic data from a test-drilling program in the High Plains area of South Dakota, 1979-80, by C. L. Loskot, H. L. Case, and D. G. Hern. 1984.

OFR 84-432. Flow-duration hydrographs for selected streamflow stations on South Dakota streams, by J. R. Little. 1984.

OFR 85-156. Streamflow and sediment data collected at seven stream-gaging stations in the James River basin downstream from Forestburg, South Dakota, from October 1, 1982, to September 30, 1983, by J. R. Little. 1985.

OFR 85-348. Drainage areas in the Big Sioux River basin in eastern South Dakota, by F. D. Amundson, W. L. Bradford, and N. C. Koch. 1985.

OFR 85-422. Water-resources activities of the U.S. Geological Survey in South Dakota - Fiscal year 1984, by E. F. LeRoux and E. M. Decker. 1985.

OFR 85-564. The stream-gaging program in South Dakota, by J. R. Little and D. K. Matthews. 1985.

OFR 86-147. Records of wells and chemical analyses of ground water in Brown County, South Dakota, by K. M. Neitzert and N. C. Koch. 1986.

OFR 86-419W. Post-Cretaceous uplift of the Sioux Quartzite ridge in southeastern South Dakota, by N. C. Koch. 1986.

OFR 86-496. Analyses of flood-flow frequency for selected gaging stations in South Dakota through September 1985, by E. B. Hoffman, M. E. Freese, and D. R. Winter. 1986

OFR 87-42. Records of wells and chemical analyses of ground water in Campbell County, South Dakota, by K. M. Neitzert and N. C. Koch. 1987.

USGS Unnumbered Open-File Reports

Adolphson, D. G., and LeRoux, E. F., 1971, Head fluctuations in artesian wells in the northern Black Hills, South Dakota.

----- 1974, Water resources of the proposed Rockyford area additions to the Badlands National Monument, Shannon County, South Dakota.

----- 1974, Water-supply sites for Wind Cave National Park, Custer County, South Dakota.

Dingman, R. J., 1952, Supplement to the geology and ground-water hydrology of the Angostura irrigation project, South Dakota, with special emphasis on the drainage problem of Harrison Flats.

Ellis, M. J., and Adolphson, D. G., 1965, Ground-water resources at three towns on the Standing Rock Indian Reservation in South Dakota.

McCabe, J. A., and Crosby, O. A., 1959, Floods in North and South Dakota, frequency and magnitude.

Maclay, R. W., 1952, Occurrence of ground water in the Cheyenne River and Standing Rock Indian Reservations, North and South Dakota.

Powell, J. E., and Jorgensen, D. G., 1971, Approximate optimum yield of ground water from glacial outwash between Sioux Falls and Dell Rapids, South Dakota.

Rosier, A. J., 1952, Reconnaissance of the geology and ground-water hydrology of the Belle Fourche irrigation project, South Dakota.

Publications of the South Dakota Geological Survey Prepared in Cooperation with the U.S. Geological Survey

Inquiries about these reports should be addressed to the South Dakota Geological Survey, Science Center, University of South Dakota, Vermillion, SD 57069.

Hamilton, L. J., 1982, Geology and water resources of McPherson, Edmunds, and Faulk Counties, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 26.

----- 1986, Geology and water resources of Clark County, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 29.

----- 1986, Major aquifers in Hughes County, South Dakota: South Dakota Geological Survey Information Pamphlet no. 29.

Hansen, D. S., 1986, Major aquifers in Lake and Moody Counties, South Dakota: South Dakota Geological Survey Information Pamphlet no. 31.

Howells, L. W., and Stephens, J. C., 1968, Water resources of Beadle County, South Dakota: South Dakota Geological Survey Bulletin 18.

Jorgensen, D. G., 1971, Geology and water resources of Bon Homme County, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 21.

Koch, N. C., 1970, Geology and water resources of Campbell County, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 20.

----- 1975, Geology and water resources of Marshall County, South Dakota: South Dakota Geological Survey Bulletin 23.

----- 1980, Geology and water resources of Hand and Hyde Counties, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 28.

Koch, N. C., and Bradford, Wendell, 1976, Geology and water resources of Brown County, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 25.

Kume, Jack, 1976, Geology and water resources of Charles Mix and Douglas Counties, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 22.

Lee, K. Y., and Powell, J. E., 1961, Geology and ground-water resources of the Flandreau area, Brookings, Moody, and Lake Counties, South Dakota: South Dakota Geological Survey Report of Investigations 87.

Rothrock, E. P., and Otten, E. G., 1947, Ground-water resources of the Sioux Falls area, South Dakota: South Dakota Geological Survey Report of Investigations 56, pts. 1 and 2.

Steece, F. V., and Howells, Lewis, 1965, Geology and ground-water supplies in Sanborn County, South Dakota: South Dakota Geological Survey Bulletin 17.

Stephens, J. C., 1967, Geology and water resources of Clay County, South Dakota--Pt. 2, Water resources: South Dakota Geological Survey Bulletin 19.

Other Publications

Address inquiries about the availability of these reports to the publishers.

Bugliosi, Edward F., 1980, Delineation of glaciofluvial aquifers using Landsat color composite imagery: Fifteenth International Symposium of Remote Sensing of Environment Proceedings.

Kerr, F. F., and others, 1968, How wells affect shallow ground-water supplies in South Dakota: Cooperative Extension Service Pamphlet EC667.

Koch, Neil C., 1970, A graphic presentation of stream gain or loss as an aid in understanding streamflow characteristics: Water Resources Research, v. 6, no. 1, p. 239-245.

----- 1983, Irrigation-water classification diagram for South Dakota: South Dakota Academy of Science Proceedings, v. 62, p. 107-114.

Kuiper, Logan K., 1981, Test of the incomplete Cholesky-conjugate gradient method applied to the solution of two-dimensional ground water flow equations: Water Resources Research, v. 17, no. 4.

Peter, Kathy D., 1982, Recharge to the Inyan Kara Group in central South Dakota by leakage from deeper aquifers [abs.]: South Dakota Academy of Science Proceedings, v. 61, p. 177.

Petri, L. R., and Larson, L. R., 1967, Quality of water in lakes in eastern South Dakota: South Dakota Water Resources Commission Bulletin (unnumbered).

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Reports Pending Publication

In addition to the published reports listed above, the following reports have been approved and are in various stages of the publication process. Information on the availability of these reports can be obtained by contacting the District Chief, USGS, Water Resources Division, Huron, South Dakota:

Water-Resources Investigations Reports of the U.S. Geological Survey

WRIR 85-4053. Map showing the geologic structure and the altitude of the top of the Minnelusa Formation in the northern Black Hills, South Dakota and Wyoming, and in the Bear Lodge Mountains, Wyoming, by K. D. Peter, D. P. Kyllonen, and K. R. Mills-Satter. 1985.

WRIR 85-4233. Map showing the geologic structure and the altitude of the top of the Minnelusa Formation of the northeastern Black Hills, South Dakota, by K. D. Peter, D. P. Kyllonen, and K. R. Mills. 1985.

WRIR 86-4035. Water resources of Miner County, South Dakota, by N. C. Koch and S. D. McGarvie.

WRIR 86-4158. Geohydrology and water quality of the Inyan Kara, Minnelusa, and Madison aquifers of the northern Black Hills, South Dakota and Wyoming, and Bear Lodge Mountains, Wyoming, by D. P. Kyllonen and K. D. Peter.

WRIR 86-4167. Map showing geologic structure and altitude of the top of the Minnelusa Formation and orientation of mapped cave passages in the Madison Limestone, southern Black Hills, South Dakota, by K. D. Peter, K. R. Mills, and C. L. Loskot.

WRIR 87-4082. A digital simulation of the glacial-aquifer system in Sanborn and parts of Beadle, Miner, Hanson, Davison, and Jerauld Counties, South Dakota, by P. J. Emmons. 1987.

USGS Numbered Open-File Reports

OFR ______. Summary of data pertaining to land use, rainfall, dryfall, stream discharge, and storm runoff collected as part of a study of the effects of urban runoff on Rapid Creek, Rapid City area, South Dakota, by K. E. Goddard, T. K. Lockner, L. L. Harms, and M. H. Smith.

Other publications

A possible relation between lineaments and leakage through confining layers in South Dakota, by K. E. Kolm and K. D. Peter.

Geochemistry of lower Cretaceous sandstone aquifers in the northern Great Plains, by K. D. Peter.

Hydrology of the Inyan Kara and Dakota-Newcastle aquifer systems in South Dakota, by H. L. Case, III.