WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1985 THROUGH SEPTEMBER 1986

Compiled by Robert S. Roberts

U.S. GEOLOGICAL SURVEY

Open-File Report 86-421W

Prepared in cooperation with the
State of Montana and other agencies

Helena, Montana

September 1986

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

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CONVERSION FACTORS

The following factors can be used to convert inch-pound units to the International System (SI) of units.

Multiply inch-pound unit	By	To obtain SI unit
acre	4047	square meter
foot	0.3048	meter
inch	25.40	millimeter
mile	1.609	kilometer

MESSAGE FROM THE DISTRICT CHIEF

The U.S. Geological Survey has collected and disseminated information on the quality and quantity of water in Montana's streams, lakes, and aquifers for nearly a century. Our first gaging station on the Missouri River at Fort Benton has provided streamflow records since 1890. Through cooperative and collaborative programs with local, State, and other Federal agencies, we have monitored streamflow at hundreds of sites throughout the State and have investigated the occurrence and availability of water in numerous study areas. Information obtained from our data-collection programs, investigative studies, and research efforts has been made available to water resource managers, regulators, and developers through annual data reports, formal published reports, and open-file releases to the public.

This report provides a brief summary of our current programs and activities. Major cooperating agencies and sources of funds that support our operations are acknowledged. Lists of surface-water gaging stations, crest-stage stations, surface-water-quality monitoring stations, and ground-water-level observation wells are included with maps showing distribution of data-collection sites. Current investigations are summarized with brief statements of problem, objective, approach, progress, future plans, period of project, and project chief. Additional information about specific projects can be obtained by contacting me or the project chief directly (phone 406-449-5263).

Montana experienced a number of hydrologic problems during the past year that strained the resources of several State and Federal agencies, including the U.S. Geological Survey. A drought of major proportions prompted numerous cooperating agencies to request increased streamflow monitoring at gaged and ungaged sites. Concerns about sediment loads in the Yellowstone River resulted in a multi-agency cooperative effort to collect suspended-sediment samples at several sites on the Yellowstone and its major tributaries. Concerns about potential water-quality degradation resulting from changes in waste-discharge practices resulted in massive sampling efforts on the Clark Fork (River) by many agencies and individuals. The controversy over planned development of a coal mine in Canada, in an area drained by a tributary of the North Fork Flathead River, resulted in the formation of an international committee to study potential changes to water quality in the Flathead drainage. U.S. Geological Survey data on streamflow and water quality have proven to be useful in the committee's deliberations.

The next few years will see significant changes in the field of water-resources investigations as public concerns about hazardous wastes and toxic substances in the environment become greater. We will be challenged to develop and use more sophisticated sampling and analytical techniques to measure exotic chemicals in minute quantities in both ground and surface water. Intrastate water allocation issues between private, State, and Federal users will require quantification of ground and surface water even in the absence of detailed studies or long-term records.

These issues and others will demand attention despite the severe budget constraints imposed by declining State revenues and Federal deficit. Clearly, increased cooperation between agencies will be essential if we are to meet our obligations. I look forward to the promise of technically challenging programs and stronger cooperative relationships.

Joe A. Moreland
District Chief
U.S. Geological Survey-WRD
Helena, Montana

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ABSTRACT

Water-resources programs and activities of the U.S. Geological Survey in Montana consist principally of hydrologic-data collection (6 projects); local, areal, or statewide hydrologic investigation (12 projects); and research (1 project). The work is supported by direct Federal funding, by transfer of funds from other Federal agencies, and by joint funding agreements with State or local agencies.

This report describes the projects funded for fiscal year 1986. In addition, it describes the operations of the Montana District, water conditions during the preceding year, activities in addition to regular programs, sources of publications and information, and lists reports published or released during the preceding 5 years.

BASIC MISSION AND PROGRAMS

U.S. Geological Survey

The U.S. Geological Survey 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 projects of 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 Geological Survey has grown and been modified to meet the changing needs of the Nation it serves. As part of the evolution, the Geological Survey 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's 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 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 Geological Survey 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."

Water Resources Division

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States.

This mission is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface and ground water.
- Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.
- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters.
- Providing scientific and technical assistance in hydrologic fields to other Federal, State and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.

DISTRICT OPERATIONS

The Montana District conducts its hydrologic work through a district office in Helena and field headquarters offices in Helena, Billings, Fort Peck, and Kalispell (fig. 1). The district employs 57 people (51 full-time and 6 less than full-time) to work on 19 funded projects. The principal functions of the district are to investigate the occurrence, quantity, quality, distribution, and movement of surface and ground waters in Montana.

Hydrologic data-collection programs and interpretive studies in Montana are conducted by three operating sections and one support unit (fig. 2). The three operating sections are responsible for the implementation and execution of District projects assigned to project chiefs.

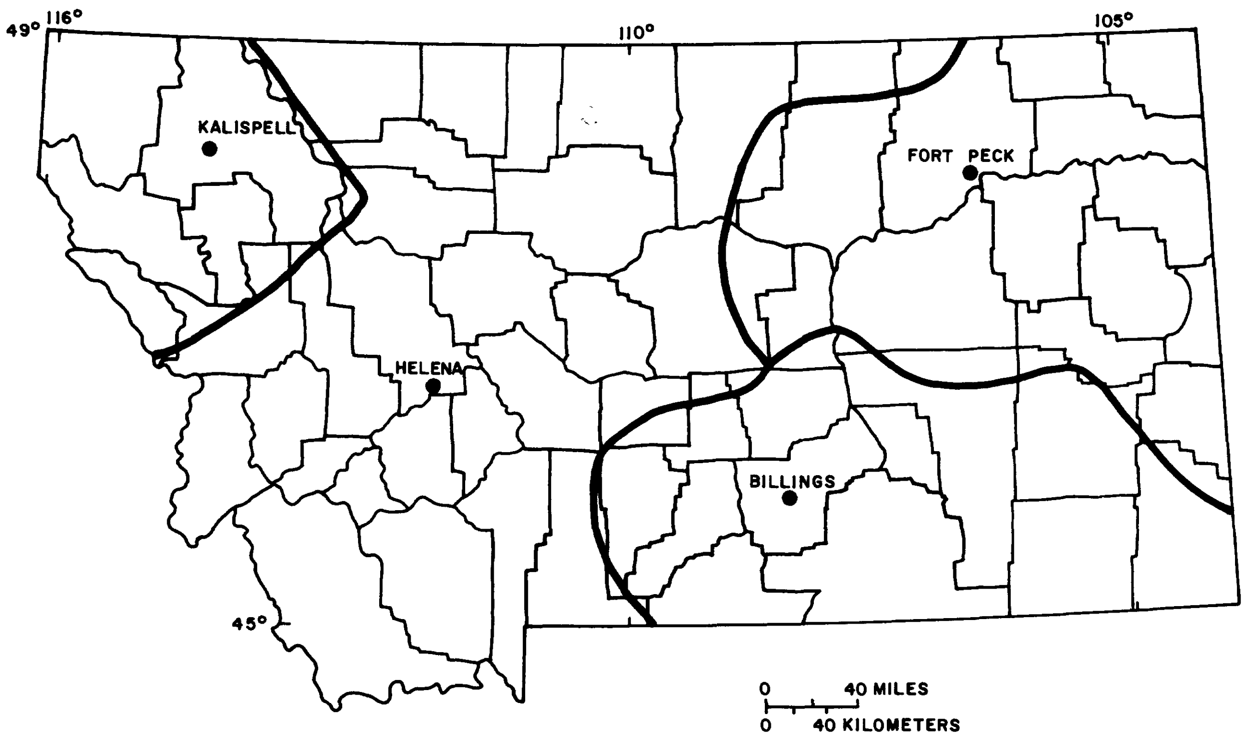

Figure 1.--Location and geographic division of responsibility of offices in the Montana District.

Operating Sections

The Hydrologic Surveillance and Analysis Section designs, constructs, operates, and maintains hydrologic-data networks in the State. It also manages the collection and analysis of hydrologic data for the State network, reviews and processes data for publication, prepares water-resources data for the annual water-data reports, and provides quality control of results for field and office methods.

The International Waters Section assists in the division of waters of the St. Mary and Milk Rivers between the United States and Canada, as directed by the

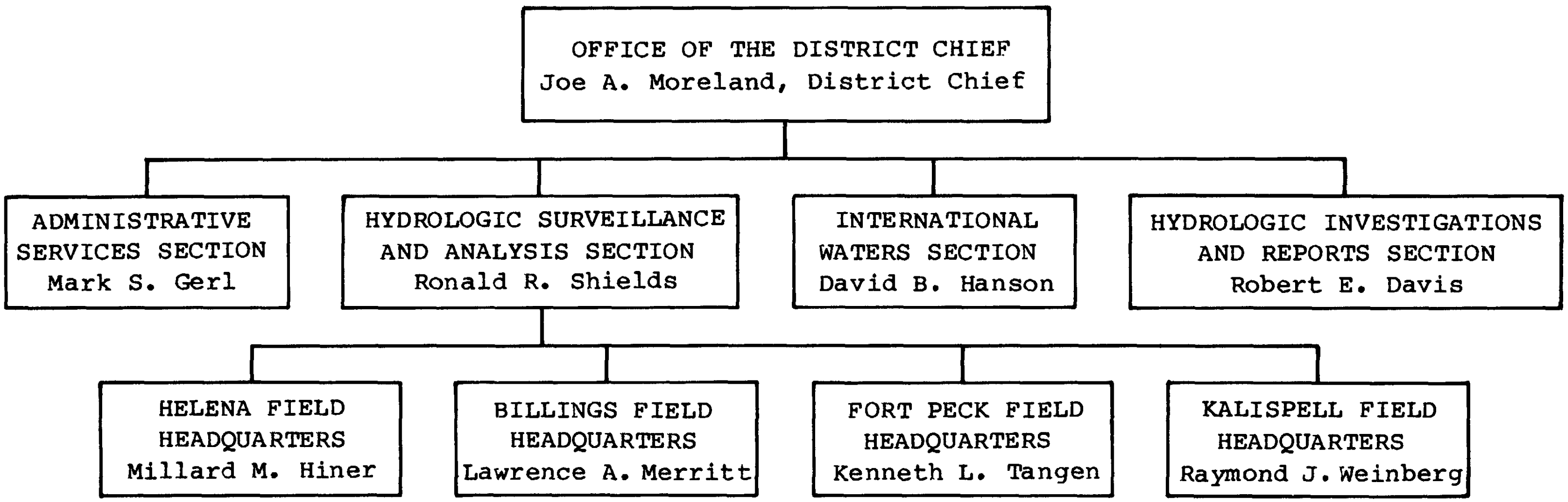

Figure 2.--Organization chart.

International Joint Commission Order of October 4, 1921. Duties required by the Order include streamflow measurement and record computation for 35 streamflow stations monitored jointly by the U.S. Geological Survey and the Water Survey of Canada. Allocation of the water is dependent on the streamflow record, records of several hundred minor diversions, computations of evaporation, and records of storage for 18 reservoirs.

The Hydrologic Investigations and Reports Section plans, executes, and reports on water-resources projects, including multidiscipline appraisal studies, and conducts hydrologic and hydraulic investigations. These investigations involve ground-water hydraulics and mathematical modeling of aquifer systems; hydraulics affected by manmade structures; magnitude and frequency of floods and droughts; assessment of hazardous waste and historical and ongoing mineral mining on the hydrologic system; and time-of-travel and dispersion studies. The Section maintains progress records of technical and hydrologic-data reports, and types, edits, assembles, verifies, and prepares manuscripts and illustrations for publication. The Section also advises and updates District personnel on current report-writing procedures.

Support Unit

The Administrative Services Section provides administrative support for the District. Responsibilities include programming, budgeting, accounting, management of personnel, property inventory, travel records, vehicle management, and related services.

Office Addresses

Inquiries regarding projects and water quality may be directed to the district office. Requests for current streamflow may be directed to the subdistrict office or field headquarters nearest the area of concern, or to the district office.

District Office Chief: Joe A. Moreland	(406) 449-5263	U.S. Geological Survey Water Resources Division 428 Federal Building 301 South Park, Drawer 10076 Helena, MT 59626-0076
Helena Field Headquarters Technician-in-charge: Millard M. Hiner	(406) 449-5496	U.S. Geological Survey Water Resources Division 428 Federal Building 301 South Park, Drawer 10076 Helena, MT 59626-0076
Billings Field Headquarters Hydrologist-in-charge: Lawrence A. Merritt	(406) 657-6113	U.S. Geological Survey Water Resources Division 2525 Fourth Avenue North Billings, MT 59101

Fort Peck Field Headquarters (406) 526-3532
Technician-in-charge: Kenneth L. Tangen

U.S. Geological Survey
Water Resources Division
Administration Building
P.O. Box 124
Fort Peck, MT 59223

Kalispell Field Headquarters (406) 755-6686
Technician-in-charge: Raymond J. Weinberg

U.S. Geological Survey
Water Resources Division
1015 East Idaho Street
P.O. Box 1012
Kalispell, MT 59901

Types of Funding

The Montana District is supported by funds appropriated directly to the Geological Survey (Federal program); by funds transferred from other Federal agencies (OFA program); and by services and (or) funds provided by State or other agencies, matched on a 50-50 basis with Federal funds (cooperative program). In fiscal year 1986 (October 1, 1985 through September 30, 1986), total support for program operation in Montana was about $3,056,000. Sources of funding are illustrated in figure 3.

Cooperating Agencies

The following agencies participated in program operation of the Montana District in fiscal year 1986 by providing funds and (or) services:

Federal agencies
- U.S. Geological Survey
- U.S. Bureau of Indian Affairs
- U.S. Army Corps of Engineers
- U.S. Bureau of Land Management
- U.S. Department of State-International Joint Commission
- Federal Energy Regulatory Commission
- U.S. Environmental Protection Agency
- U.S. Bureau of Reclamation
- Federal Emergency Management Agency
- Bonneville Power Administration
- U.S. Forest Service
- U.S. Fish and Wildlife Service
- National Park Service

State and local agencies
- Montana Department of Natural Resources and Conservation
- Montana Bureau of Mines and Geology
- Confederated Salish and Kootenai Tribes of the Flathead Indian Reservation
- Montana Department of Fish, Wildlife and Parks
- Montana Department of Highways
- Montana Department of Health and Environmental Sciences
- Montana Governor's Office
- University of Montana
- Daniels County Conservation District
- Montana Department of State Lands
- Wyoming State Engineer
- City of Helena

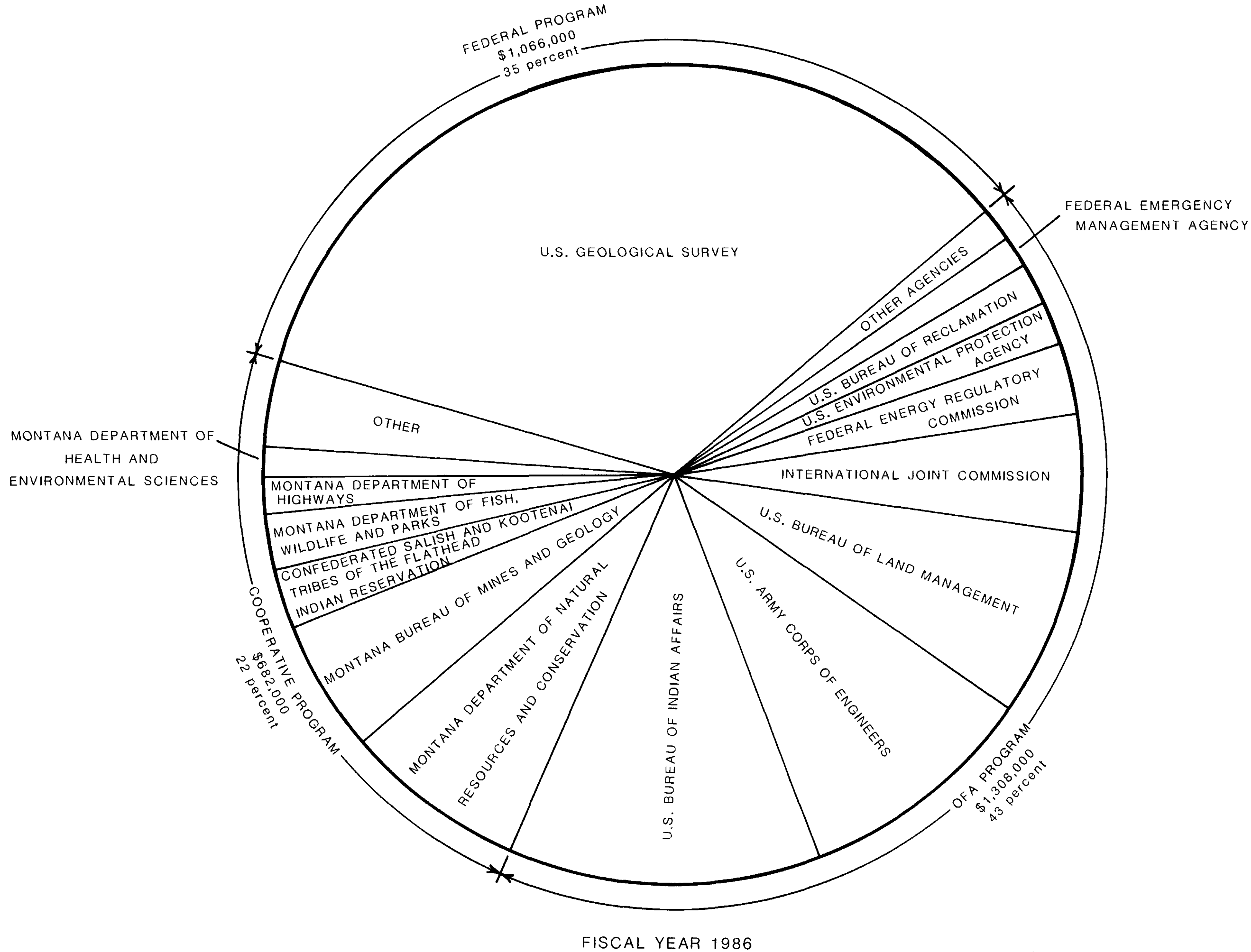

Figure 3.--Sources of funding for the water-resources program in Montana.

WATER CONDITIONS

Montana has two distinct hydrogeologic regimes: mountains and intermontane valleys in the west and south-central areas, and plains in the east and north-central areas. Precipitation and mountain snowpack provide abundant supplies of water in most of the larger rivers in the west and south (fig. 4), except for irrigation during the summer and fall of some years. Smaller streams, particularly in the eastern half of the State, do not provide dependable supplies except during spring runoff. The seasonal variation in quantity is the primary constraint on use.

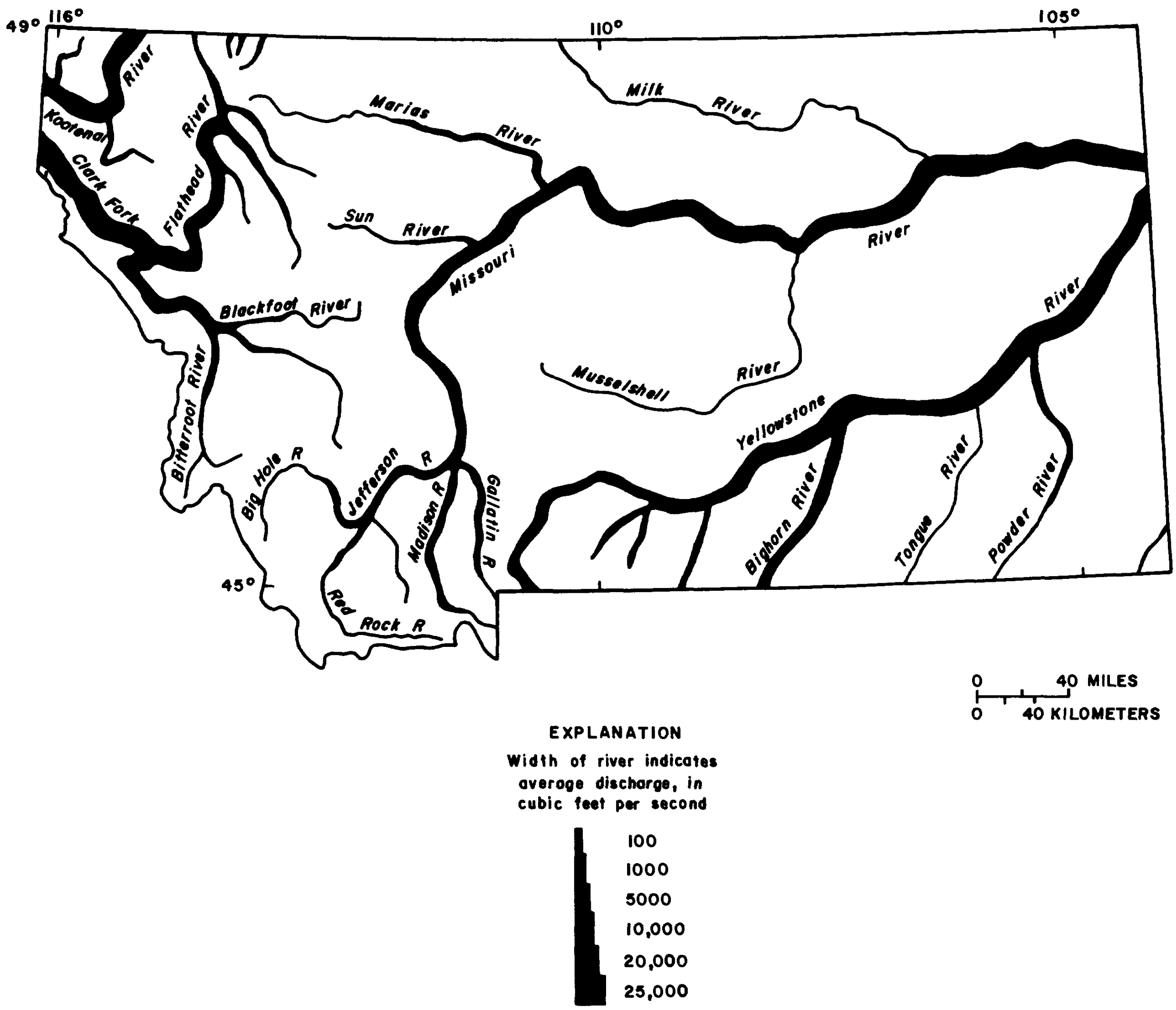

Figure 4.--Major river systems and long-term average discharge.

The 1985 water year was one of major drought conditions statewide. In the north and east, the 1985 water year was the third consecutive year of drought. Fishkills were reported on several major waterways, and 55 of 56 counties were declared as agricultural disaster areas.[1,2] In the west, precipitation reported by the National Weather Service for the first half of the water year (October 1984 through March 1985) averaged 7.81 inches, or 27 percent less than normal. Drought conditions continued from April through July. Then, in August and September, greater than normal precipitation amounts returned subsoil moisture conditions to normal in much of the State.

Surface water was the source for 98 percent of total offstream water use in 1980, and 98 percent of the surface-water withdrawal was used for irrigated agriculture.[3] The next largest use of surface water was for public supplies, where 0.8 percent of the withdrawal served a population of 358,000. Instream use is also important, especially for hydroelectric-power generation, recreation, and aquatic life.

Periodic flooding can occur almost anywhere in the State. Selected flood-prone areas have been delineated on maps (fig. 5) to show administrators, planners, and engineers concerned with future land developments those areas that are subject to flooding. More detailed maps, prepared as part of flood insurance studies, are available for the cities of Helena and East Helena and the heavily populated areas of Belt Creek, Cascade County, and Lewis and Clark County.

Streamflow quality generally is suitable for most uses statewide, except in parts of eastern Montana where large dissolved-solids concentrations render the water unsuitable for some domestic and agricultural uses. Current concerns focus on determining the source of large sediment loads in the upper part of the Yellowstone River after intense rains, and determining the potential for degradation as a result of waste-discharge practices in the Clark Fork and coal mining near the North Fork Flathead River.

Ground water is available in nearly every part of Montana. Water occurs principally in unconsolidated deposits along streams and in consolidated rocks underlying most of the State. Water also occurs in basin-fill deposits beneath intermontane valleys in the west.

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[1]U.S. Bureau of Reclamation, 1985, 1985 summary of actual operations and 1986 annual operating plans: 121 p.

[2]The 56th county was given the same designation in January 1986 (Jan Henry, Disaster and Emergency Services Division, Montana Department of Military Affairs, oral commun., 1986).

[3]Parrett, Charles, and Omang, R. J., in press, Montana surface-water resources *in* National water summary 1985--Hydrologic events, selected water-quality trends, and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300.

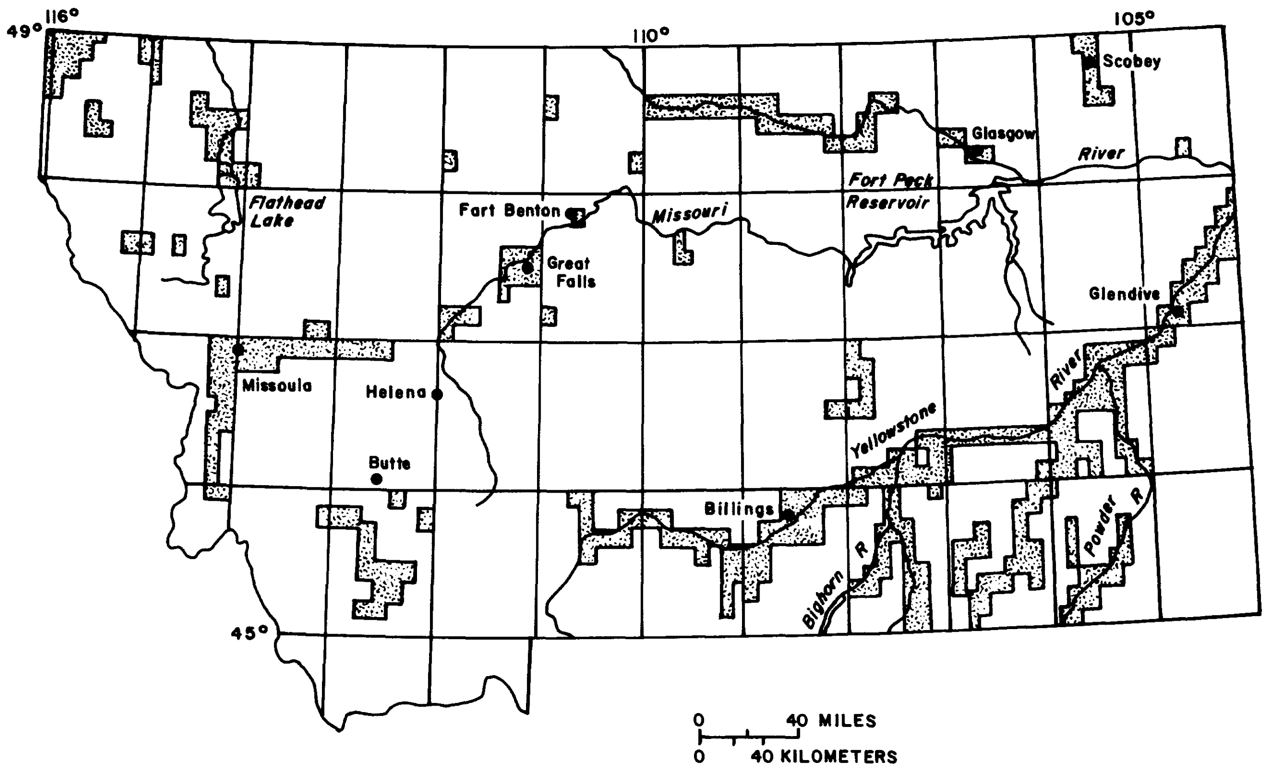


Figure 5.--Flood-prone areas (patterned) mapped in Montana.

Ground water constitutes less than 2 percent of total water withdrawals. However, about one-half of the State's population is supplied with water for domestic purposes from ground-water sources--230,000 people through public water-supply systems and 194,000 people through rural water-supply systems. About one-half of the fresh ground-water withdrawals in the State is used for irrigation.[4]

Hydrologic information is being collected to address several issues concerning ground water in Montana. In some areas, ground-water levels have declined or may decline in response to past or projected water use. Declines have resulted from irrigation, mining, and public-supply use and from drought and low-streamflow conditions. In other areas, the effects of coal and metals mining on water resources are being evaluated by hydrologic study. The potential for degradation of water quality by surface coal mining is most important in the eastern and southeastern parts of the State.

These and other water-resources problems can be solved only by long-term comprehensive planning and management, which require reliable hydrologic information. The current activities of the Montana District address many of the State's hydrologic problems. These activities, described in the following pages, are designed to provide the information needed for the best utilization of Montana's water resources.

[4]Levings, J. F., Davis, R. E., and Parrett, Charles, 1985, Montana ground-water resources *in* National water summary 1984--Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, p. 285-290.

DATA-COLLECTION PROGRAMS

Hydrologic-data stations are maintained at selected sites throughout Montana to collect basic information concerning stream discharge and stage, reservoir and lake storage, ground-water levels, quality of surface and ground water, depth and water content of snowpack, and water use. The station networks are revised periodically to ensure collection of meaningful and worthwhile data. Much of the collected information is published annually in water-data reports. Most is stored in computer files for efficient processing and retrieval. The computer-stored data are maintained in the Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) and are available on request to managers, planners, investigators, and others involved in making decisions affecting the State's water resources. Assistance in the acquisition of data obtained from these station networks can be obtained from the District Chief at the address shown at the front of this report.

Surface-water-discharge (streamflow), stage (water-level), and reservoir-contents data currently are obtained at the following number of stations.

Station classification		Number of stations
Stream stations		391
Continuous record:		
Discharge and stage	230	
Stage only	5	
Partial record:		
Peak (maximum) flow only	156	
Lake and reservoir stations		55
Stage and contents	54	
Stage only	1	
Total		446

The location of active continuous-record stations on streams, reservoirs, and lakes is shown in figure 6 at the back of the report; corresponding information on financial support and gage equipment is given in table 1. The location of active crest-stage partial-record stations is shown in figure 7 at the back of the report; corresponding information on period of record is given in table 2. Data are also available for 170 partial-record stations discontinued in previous years.

Water-quality data are obtained at 75 surface-water stations. In addition to monitoring the quality of surface water in Montana, 19 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 nationwide trends in water quality. The types of data determined at the surface-water stations are given below. Inasmuch as several types of data may be determined at a particular site and not all types of data are determined at each site, the numbers given will not equal the total number of stations.

Data classification	Number of sites
Physical data:	
Water temperature	72
Specific conductance.	62
pH.	47
Dissolved oxygen.	40
Sediment data	42
Chemical data (inorganic constituents).	61
Radiochemical data.	1
Biological data	21

The location of active surface-water-quality stations on streams and reservoirs is shown in figure 8 at the back of the report; corresponding information on financial support and sampling frequency is given in table 3.

Water levels in wells, discharges of 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 to have the fullest meaning and usefulness. In Montana, the U.S. Geological Survey regularly monitors water levels in selected wells (called observation wells). Other wells and springs are inventoried as part of ground-water projects throughout the State. Although the project wells and springs are not part of the observation-well program, the data obtained from these sources are available. The number of wells measured regularly and the number of project wells and springs at which water-level or discharge measurements were made during the past year are given below.

Site classification	Number of sites
Observation wells.	299
Project wells.	105
Project springs.	6

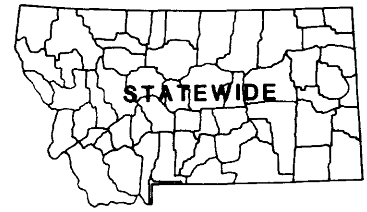
The basic observation-well network is shown in figure 9 at the back of the report; corresponding information on sampling is given in table 4. Project wells and springs are not identified.

Water-quality data are obtained at some of the observation wells and project wells and springs listed above. The types of data determined at these sites during the past year are given in the following table. The numbers will not equal the total number of sites inasmuch as several types of data may be determined at a single site and not all types of data are determined at each site.

Data classification	Wells	Springs
Physical data:		
Water temperature	134	6
Specific conductance.	135	6
pH.	134	6
Chemical data (inorganic constituents). .	59	6

Ground-water-quality sampling sites are not identified in figure 9.

The six projects described on following pages are concerned mainly with the collection of hydrologic data. The project number is given after each title.



Project title: Surface-Water Stations (MT001)

Location: Statewide

Period of project: Continuing

Project chief: Ronald R. Shields, Helena

Problem: Surface-water information is needed for 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.

Objective(s): (1) To collect surface-water data sufficient to satisfy needs for current-purpose uses, such as (a) assessment of water resources, (b) operation of reservoirs or industries, (c) forecasting, (d) disposal of wastes and pollution controls, (e) discharge data to accompany water-quality measurements, (f) compact and legal requirements, and (g) research or special studies. (2) 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, and other surface-water bodies for use in planning and design.

Approach: Use standard methods of data collection 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 last fiscal year: Data collection continued on schedule for all stations in the network. Four new streamflow stations were placed in operation and 12 were discontinued.

Plans this fiscal year: Continue to operate streamflow stations in the network and, if appropriate, make changes in the network based on financing or user needs.

Information product(s): Omang, R. J., 1984, Streamflow characteristics of the Yellowstone River basin, Montana, through 1982: U.S. Geological Survey Water-Resources Investigations 84-4063, 78 p.

Omang, R. J., Parrett, Charles, and Hull, J. A., 1983, Flood estimates for ungaged streams in Glacier and Yellowstone National Parks, Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4147, 10 p.

______Methods for estimating magnitude and frequency of floods in Montana based on data through 1983: U.S. Geological Survey Water-Resources Investigations Report (in review).

Parrett, Charles, Using the HEC-1 flood hydrograph program to simulate rain floods on Willow Creek, Valley County, Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

______Fire-related debris flows in the Beaver Creek drainage, Lewis and Clark County, Montana: U.S. Geological Survey Water-Supply Paper (in preparation).

Parrett, Charles, Carlson, D. D., Craig, G. S., Jr., and Chin, E. H., 1984, Floods of May 1978 in southeastern Montana and northeastern Wyoming: U.S. Geological Survey Professional Paper 1244, 74 p.

Parrett, Charles, Carlson, D. D., Craig, G. S., Jr., and Hull, J. A., 1978, Data for floods of May 1978 in northeastern Wyoming and southeastern Montana: U.S. Geological Survey Open-File Report 78-985, 16 p.

Parrett, Charles, and Hull, J. A., 1985, A method for estimating mean and low flows of streams in national forests of Montana: U.S. Geological Survey Water-Resources Investigations Report 85-4071, 13 p.

Parrett, Charles, Omang, R. J., and Hull, J. A., 1982, Floods of May 1981 in west-central Montana, *with a section on* Meteorological setting by John W. Fassler: U.S. Geological Survey Water-Resources Investigations 82-33, 20 p.

Shields, R. R., Knapton, J. R., White, M. K., Jacobson, M. A., and Kasman, M. L., 1985, Water resources data, Montana--Water year 1984, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-84-1, 589 p.

______1985, Water resources data, Montana--Water year 1984, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-84-2, 169 p.

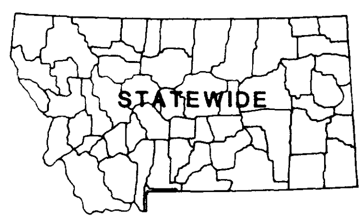
Shields, R. R., and White, M. K., 1981, Streamflow characteristics of the Hudson Bay and upper Missouri River basins, Montana, through 1979: U.S. Geological Survey Water-Resources Investigations 81-32, 144 p.

______1985, Uses, funding, and availability of continuous streamflow data in Montana: U.S. Geological Survey Open-File Report 84-862, 61 p.

Waltemeyer, S. D., and Shields, R. R., 1982, Streamflow characteristics of the upper Columbia River basin, Montana, through 1979: U.S. Geological Survey Water-Resources Investigations 81-82, 74 p.

Yellowstone River Compact Commission, Thirty-fourth annual report (in preparation).

Project title: Ground-Water Stations (MT002)



Location: Statewide

Period of project: Continuing

Project chief: Thomas E. Reed, Helena

Problem: Long-term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from 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(s): (1) 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. (2) To provide a data base against which the short-term records acquired in areal studies can be analyzed. This analysis must (a) provide an assessment of the ground-water resource, (b) allow prediction of future conditions, (c) detect and define pollution and supply problems, and (d) provide the data base necessary for management of the resource.

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 areal and temporal stress on the system and the hydrologic properties of the aquifers, a subjective decision can be made about the most advantageous locations 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 last fiscal year: Measured water levels in all observation wells as scheduled.

Plans this fiscal year: Continue operation of the statewide observation well network.

Information product(s): Cannon, M. R., Reconnaissance of the water resources and potential effects of mining of the Joliet-Fromberg coal tract, Carbon County, Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Coffin, D. L., Reed, T. E., and Ayers, S. D., 1977, Water-level changes in wells along the west side of the Cedar Creek anticline, southeastern Montana: U.S. Geological Survey Water-Resources Investigations 77-93, 11 p.

Johnston, M. F., and Dodge, K. A., Well records and water levels from the statewide observation-well network in Montana through mid-1985: U.S. Geological Survey Open-File Report (in preparation).

Levings, G. W., and White, M. K., 1983, Selective annotated bibliography of ground-water resources, records of wells and springs, and availability of streamflow data on Indian reservations in Montana: U.S. Geological Survey Open-File Report 83-129, 137 p.

Missouri River Basin Ground Water Resources Work Group, 1980, Inventory of ground-water resources, technical paper of Upper Missouri River Basin Level B Study: Missouri River Basin Commission, 54 p.

Roberts, R. S., 1980, Hydrogeologic data for selected coal areas, east-central Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-329, 63 p.

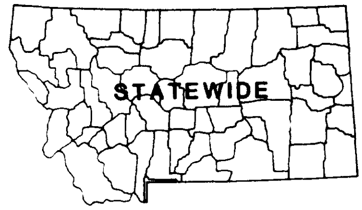
______Selected hydrogeologic data for the Southwest Glendive coal tract and adjacent areas, Dawson County, eastern Montana: U.S. Geological Survey Open-File Report (planned).

Shields, R. R., Knapton, J. R., White, M. K., Jacobson, M. A., and Kasman, M. L., 1985, Water resources data, Montana--Water year 1984, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-84-1, 589 p.

______1985, Water resources data, Montana--Water year 1984, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-84-2, 169 p.

Wood, W. A., 1984, Hydrogeologic data for selected test wells drilled in the Fort Union coal region, eastern Montana: U.S. Geological Survey Open-File Report 84-464, 63 p.

Project title: Water-Quality Stations (MT003)



Location: Statewide

Period of project: Continuing

Project chief: J. Roger Knapton, Helena

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 needs to be defined and monitored.

Objective(s): To provide a national bank of water-quality data for broad Federal and State planning and action programs and to provide data for Federal management of interstate and international waters.

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

Progress last fiscal year: Maintained data collection on schedule at all stations in the network. Analyzed the annual records and prepared for publication. Published the 1984 water year records.

Plans this fiscal year: Continue collection and analysis of samples from the network. Evaluate the network and make changes where appropriate.

Information product(s): Brosten, T. M., and Jacobson, M. A., 1985, Historical water-quality data for the Clark Fork (River) and the mouths of selected tributaries, western Montana: U.S. Geological Survey Open-File Report 85-168, 89 p.

Knapton, J. R., 1978, Evaluation and correlation of water-quality data for the North Fork Flathead River, northwestern Montana: U.S. Geological Survey Water-Resources Investigations 78-111, 95 p.

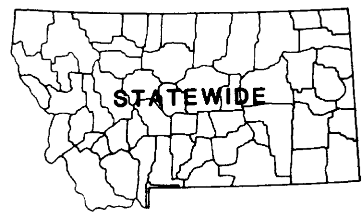
______1985, Field guidelines for collection, treatment, and analysis of water samples, Montana District: U.S. Geological Survey Open-File Report 85-409, 86 p.

Knapton, J. R., and Jacobson, M. A., 1980, Simulation of water-quality data at selected stream sites in the Missouri River basin, Montana: U.S. Geological Survey Water-Resources Investigations 80-76, 30 p.

Shields, R. R., Knapton, J. R., White, M. K., Jacobson, M. A., and Kasman, M. L., 1985, Water resources data, Montana--Water year 1984, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-84-1, 589 p.

______1985, Water resources data, Montana--Water year 1984, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-84-2, 169 p.

Project title: <u>Sediment stations (MT004)</u>



Location: Statewide

Period of project: Continuing

Project chief: J. Roger Knapton, Helena

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

Objective(s): To provide a national bank of sediment data for use in broad Federal and State planning and action programs and to provide data for Federal management of interstate and international waters.

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.

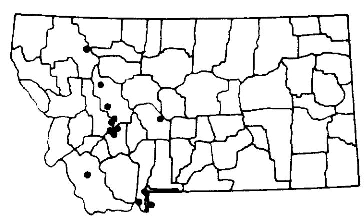
Progress last fiscal year: Maintained data collection on schedule at all stations in the network. Analyzed the annual records and prepared for publication. Published the 1984 water year records.

Plans this fiscal year: Continue collection and analysis of samples from the network. Evaluate the network and make changes where appropriate.

Information product(s): Shields, R. R., Knapton, J. R., White, M. K., Jacobson, M. A., and Kasman, M. L., 1985, Water resources data, Montana--Water year 1984, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-84-1, 589 p.

______1985, Water resources data, Montana--Water year 1984, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-84-2, 169 p.

Project title: <u>Precipitation Stations (MT005)</u>



Location: West-central Montana

Period of project: Continuing

Project chief: Ronald R. Shields, Helena

Problem: Increasing use of streamflow for irrigation, municipal, industrial, and other purposes requires additional planning for distribution and greater utilization. More detailed planning requires better data on streamflow currently available and estimates of future availability, particularly for succeeding irrigation seasons. Forecasting streamflow requires a knowledge of snowpack characteristics.

Objective(s): To periodically obtain the depth and water content of snowpack at 13 designated snow courses.

Approach: Use standard methods to measure the depth and water content at 10 sites on each snow course.

Progress last fiscal year: Measured all snow courses according to schedule. Compiled and distributed data to cooperating agencies. Operated two continuous-recording precipitation gages under the National Trends Network (NTN) for monitoring acid rain.

Plans this fiscal year: Continue measurements on same schedule as last year.

Information product(s): Results of measurements are included in U.S. Soil Conservation Service report, "Water supply outlook for Montana."

Project title: Water Use (MT007)

Location: Statewide

Period of project: Continuing

Project chief: Charles Parrett, Helena

Problem: Water-use data are needed to administer various State laws governing water use, appropriation, and allocation. Water-development planning requires a firm data base of current water use to evaluate various alternatives for expanded or revised use patterns.

Objective(s): (1) To develop a water-use data base responsive to the needs of State and Federal agencies and private individuals. (2) To acquire hardware and personnel needed to implement the program and begin data collection and processing.

Approach: Develop a water-use data base that is compatible with the national water-use system, and coordinate the formulation and implementation with other agencies.

Progress last fiscal year: Collected irrigation water-use data in Gallatin County. Field surveyed the irrigated acreage in Gallatin County so acreage data from other sources could be compared. Also obtained Land Satellite (LANDSAT) imagery for Gallatin County.

Plans this fiscal year: Compile water-use data for 1985 for all use categories for forthcoming national report. Continue to measure irrigation diversions in selected basins or counties.

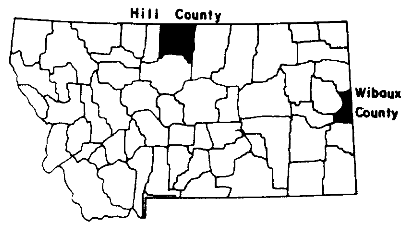
Information product(s): Water-use information will be supplied to requesters. Contributed water-use data for the report by Solley, W. B., Chase, E. B., and Mann, W. B., 1983, Estimated use of water in the United States in 1980: U.S. Geological Survey Circular 1001, 56 p.

Montana Department of Natural Resources and Conservation, Water use in Montana in 1980 (in preparation).

INVESTIGATIVE STUDIES

The Geological Survey is often asked by Federal, State, or local agencies to investigate hydrologic problems of limited areal extent. These problem-oriented studies range in scope from cursory examination of baseline conditions to detailed investigations of cause and effect. For problems of a recurring nature, continuing projects are established to provide an ongoing service to the funding agency. Other problems, such as evaluation of ground-water conditions beneath local areas, may or may not be of a recurring nature.

Project title: Flood Investigations (MT006)



Location: North-central, south-central, and eastern Montana

Period of project: March 1976 to September 1986

Project chief: Robert J. Omang, Helena

Problem: The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provide for the operation of a flood insurance program. The Federal Emergency Management Agency (FEMA) needs flood studies in selected areas to determine applicable flood insurance premium rates.

Objective(s): To conduct the necessary hydrologic and hydraulic evaluations and studies of areas assigned by FEMA and to present the results in an appropriate format.

Approach: Conduct the necessary evaluations or surveys by ground or photogrammetric methods. Determine flood-discharge frequency relationships using local historical information, gaging-station records, or other applicable information. Determine water-surface profiles using step-backwater models or by other acceptable methods and furnish the results in reports prepared to FEMA specifications.

Progress last fiscal year: Held time-and-cost meetings and determined areas to be studied (Wibaux-Wibaux County and Hill County). Surveyed cross sections, determined sea-level elevation of the cross sections, and completed other fieldwork for the Wibaux-Wibaux County study.

Plans this fiscal year: Perform the fieldwork for Hill County study. Conduct the hydrologic and hydraulic evaluations for Wibaux-Wibaux County and Hill County. Complete flood boundary maps and short reports for same areas.

Information product(s): Federal Emergency Management Agency, 1979, Flood insurance study, City of Belt, Montana: 16 p.

______1979, Flood insurance study, Cascade County, Montana: 88 p.

______1979, Flood insurance study, City of East Helena, Montana: 22 p.

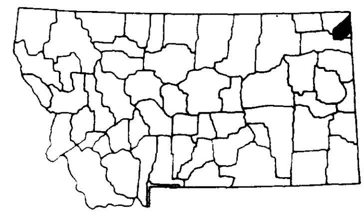
______1980, Flood insurance study, City of Helena, Montana: 29 p.

______1985, Flood insurance study, Lewis and Clark County, Montana: 87 p.

______Flood insurance study, Wibaux-Wibaux County, Montana (in preparation).

______Flood insurance study, Hill County, Montana (in preparation).

Project title: Buried Channel (MT086)



Location: Northeastern Montana

Period of project: April 1982 to September 1986

Project chief: Gary W. Levings, Helena[5]

Problem: An ancient valley of the Missouri River that has been filled and partly covered by glacial deposits extends from near Poplar, Montana, northeastward into Canada near the northwestern corner of North Dakota. In late 1980 and 1981, 15 irrigation wells completed in this buried-valley aquifer were drilled in Montana and 20 were drilled in North Dakota. The source, chemical quality, and yield of water from the aquifer are unknown. Also, the effects of large-scale withdrawals on water levels in the area were of major concern to some residents.

Objective(s): (1) To describe the ground-water resources of the area including occurrence, recharge, movement, discharge, well yields, water-level fluctuations, and water quality of the ancestral Missouri River valley aquifer. (2) To select sites that could be monitored after the study to determine the potential effects of continued or changed ground-water withdrawals on water levels and water quality of the aquifers.

Approach: Inventory wells to obtain water-level, water-quality, and water-use data. Drill, log, and sample test holes and observation wells. Establish a monitoring program to determine seasonal and long-term fluctuations in water levels and water quality.

Progress last fiscal year: Completed the writing phase of report preparation.

Plans this fiscal year: Respond to technical review comments, obtain Director's approval, and publish report.

Information product(s): Levings, G. W., 1985, Selected hydrogeologic data for the Big Muddy Creek valley near Plentywood, northeastern Montana: U.S. Geological Survey Open-File Report 85-406, 22 p.

______Preliminary appraisal of ground water in the vicinity of the ancestral Missouri River valley, northeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (in review).

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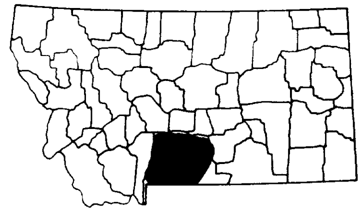
[5] Transferred to District Office, Albuquerque, N. Mex., August 1985.

Project title: Upper Yellowstone Streamflow (MT095)



Location: South-central Montana

Period of project: November 1982 to September 1986

Project chief: James A. Hull, Helena

Problem: Montana is currently adjudicating water rights throughout the State. The most serious problem confronting the courts and the users or potential users is the lack of information on the areal and temporal availability of streamflow. Because time and funds are not available to monitor flow of every stream in the State, alternative methods are required to estimate streamflow characteristics.

Objective(s): To determine selected flow values on the monthly flow-duration curve (for example, the 90th-percentile flow for September) for selected streams in the upper Yellowstone River basin.

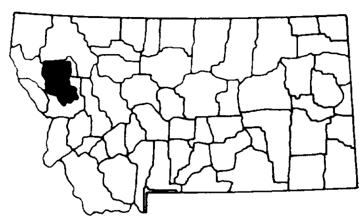
Approach: Measure monthly flow at approximately 19 sites. Correlate the monthly flow values with flow at long-term index stations to provide estimates of monthly means. Convert the mean values to flow rates to provide estimates of percentile flow. Use the regression equations relating mean monthly flows to various percentile flows at gaged sites to determine the required percentile flows at the ungaged sites.

Progress last fiscal year: Completed the 2-year measurement program originally planned and obtained estimates of monthly percentile discharge for 39 sites. Wrote report documenting results and submitted for colleague review. Selected nine new sites for measurement beginning in May 1985.

Plans this fiscal year: Measure nine new sites each month from October 1985 through April 1986. Estimate monthly percentile discharge for each measurement site plus several additional sites using old measurement data. Respond to technical reviewer comments, obtain Director's approval, and publish report.

Information product(s): Parrett, Charles, and Hull, J. A., Estimated monthly percentile discharges at ungaged sites in the upper Yellowstone River basin in Montana: U.S. Geological Survey Water-Resources Investigations Report (in review).

Project title: Ground Water, Flathead Indian Reservation (MT097)



Location: Northwestern Montana

Period of project: April 1983 to September 1986

Project chief: Steven E. Slagle, Helena

Problem: The ground-water system has a large potential as a source of water for irrigation throughout much of the area. As ground-water use increases, water levels may decline or water quality may degrade. Because ground water is the primary source of domestic water supply in the area, protection of the ground-water system is important. Well-planned development is necessary to protect existing uses and to maximize use. An in-depth knowledge of the resource is needed for the formulation of ground-water development plans.

Objective(s): (1) To acquire information on (a) aquifer properties, (b) ground-water withdrawals, (c) water-level fluctuations, and (d) water-quality variations. (2) To develop a conceptual understanding of the ground-water system including (a) recharge-discharge relationships, (b) areal and vertical distribution of aquifers, (c) patterns of ground-water flow, and (d) hydrogeochemical relationships.

Approach: The first phase of the study will consist of: (1) compilation of existing data, (2) inventory of wells including water-quality sampling with emphasis on areas not previously inventoried, (3) development of an observation-well network to monitor seasonal and long-term water-level and water-quality fluctuations, (4) inventory of ground-water withdrawals throughout the area, and (5) identification of wells suitable for aquifer testing.

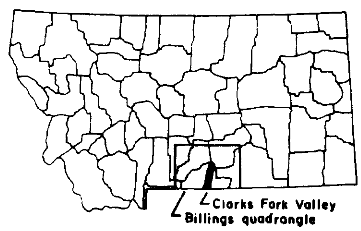
The second phase will consist of compilation and mapping of data to develop conceptual models of the ground-water system.

Progress last fiscal year: Completed the test drilling; 23 test holes were drilled and 19 were completed as wells. Conducted aquifer tests of test wells.

Plans this fiscal year: Complete the report, obtain technical review and Director's approval, and publish report.

Information product(s): Slagle, S. E., Ground-water resources of the Flathead Indian Reservation, northwestern Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Project title: Hydrology of Billings Quadrangle (MT101)



Location: South-central Montana

Period of project: October 1983 to September 1986

Project chief: Richard D. Feltis, Billings

Problem: Throughout the Billings quadrangle, relatively little information is readily available about the availability and occurrence of ground water. For the most part, ground water has been an underutilized resource because adequate quantities of surface water have been available to supply most irrigation and industrial requirements. These circumstances are beginning to change in some areas. For example, in the Clarks Fork Yellowstone River valley, irrigation practices have substantially increased downstream sediment and dissolved-solids loads. A steady inflow of people to parts of the valley has also placed more stress on the finite shallow alluvial aquifer. As the demand for a good quality water supply continues to expand, water users will need to explore alternative sources of supply and mutually acceptable management plans. Information on the availability, occurrence, and quality of ground water will be crucial in the decision-making process.

Objective(s): (1) In the Billings quadrangle, to determine the configuration of potentiometric surfaces, the water quality, and the structural configuration of the tops of selected shallow and deep aquifers. (2) In the Clarks Fork Valley, (a) to characterize the general quality and availability of water in alluvial and bedrock aquifers, (b) to determine the areal and vertical extent and aquifer characteristics of the alluvium, (c) to document and assess variations in the water quality and sediment load of the Clarks Fork, (d) to determine flow directions between aquifers and the river, and (e) to develop a plan of study to quantitatively assess specific hydrologic problems discovered during the first year of data collection.

Approach: Compile existing hydrologic information. For the Billings quadrangle, inventory selected wells and springs, collect water samples at representative sites, and use available geophysical logs to interpret the structural configuration of the tops of selected aquifer units. In the Clarks Fork valley, auger test holes through the alluvium and run geophysical logs to form the basis of an observation-well network. Monitor water quality and sediment load at two locations on the Clarks Fork from April to September and conduct a seepage run after diversions cease. Formulate a plan of study from these data for later phases of the study.

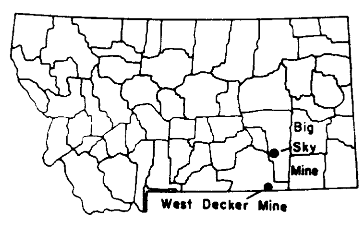
Progress last fiscal year: Completed the fieldwork, well and spring inventory, and water-sample collection. Wrote the Clarks Fork Yellowstone River valley report, obtained technical review and submitted report for approval. Drew all 1-degree by 2-degree maps of the Billings quadrangle.

Plans this fiscal year: Complete the text and explanations for the 1-degree by 2-degree quadrangle maps, obtain technical review and Director's approval, and submit copy to cooperating agency for publication.

Information products(s): Feltis, R. D., Several maps showing water quality, altitude and configuration of the potentiometric surface, and altitude and configuration of the stratigraphic top of selected aquifers: Montana Bureau of Mines and Geology Hydrogeologic Map (in preparation).

Levings, J. F., Water resources of the Clarks Fork Yellowstone River valley, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map (in review).

Project title: Mine Spoils (MT103)



Location: Decker and Big Sky Mines, Montana;
West-central United States

Period of project: October 1983 to September 1986

Project chief: Robert E. Davis, Helena

Problem: Potential hydrologic effects of surface mining of coal include changes in hydraulic characteristics of the mined area and changes in the quality of ground water associated with the mine spoils. Recent site studies have addressed these effects. Additional studies will expand the techniques of investigation to areas throughout the west-central United States. A comprehensive study is needed to combine all the scientific knowledge and methodology developed by the earlier work.

Objective(s): This project has two sets of separate but related objectives. (1) To expand previous knowledge by determining which geochemical processes are responsible for water-quality changes observed in Montana and to assist other districts in similar studies. (2) To (a) document the current state of knowledge related to mine spoils in the west-central United States, (b) illustrate the transferability of that knowledge, and (c) explain the techniques of investigation applicable to mine-spoils studies.

Approach: To achieve the first set of objectives, conduct batch-mixing experiments, including bulk-chemistry, cation-exchange-capacity, and water-quality analyses and geochemical modeling. Also, provide assistance to other districts with sample collection and performance of batch-mixing experiments. To achieve the second set of objectives, utilize the results of each district study to explain and support the scientific knowledge and methodology related to mine spoils and the transferability of that knowledge.

Progress last fiscal year: Received data for all mine sites. Montana part of report had received technical review. Completed about two-thirds of first draft of comprehensive report.

Plans this fiscal year: Obtain Regional and Headquarters review and approval for Montana report. Complete data analysis and draft of report for review of comprehensive part of project. Obtain technical, Regional, and Headquarters review of comprehensive report.

Information product(s): Davis, R. E., Geochemical and geohydrologic processes related to surface mining of coal in the west-central United States: U.S. Geological Survey Professional Paper (in preparation).

Davis, R. E., and Dodge, K. A., Results of experiments related to contact of mine-spoils water with coal, West Decker and Big Sky Mines, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (in review).

Project title: <u>National Water Information System (MT106)</u>

Location: Nationwide

Period of project: October 1985 to September 1986

Project Chief: Lawrence E. Cary, Billings

Problem: Meteorological data stored by the U.S. Geological Survey and other organizations is indexed in the Master Water Data Index of the National Water Data Exchange (NAWDEX). Meteorological data stored by the U.S. Geological Survey in the National Water Data Storage and Retrieval System (WATSTORE) is indexed in the Station Header File and the Ground-Water Site-Inventory File. These indexes are to be integrated into a single Site Index of the new National Water Information System (NWIS). The integration will require conversion to NWIS specifications, computation and validation of frequency codes, computation of frequency of collection, and validation of the period of record.

Objective(s): To have complete, efficient, tested, and documented software available by September 1986 for the conversion and validation of the Master Water Data Index meteorological data base for storage in the NWIS.

Approach: Develop and test computer code in FORTRAN to accomplish the integration into the Master Water Data Index. Prepare a program maintenance manual, a user's manual, and an operations manual to document the program that is developed; initial program development will be done on the district's computer. Make final testing on the AMDAHL V7 computer.

Progress last fiscal year: Project initiated October 1985.

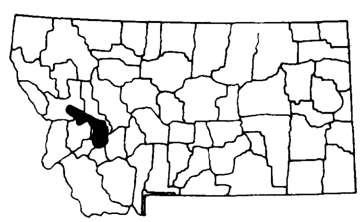
Plans this fiscal year: Write, check, and test the computer code and obtain code review. Prepare first and final drafts of documentation, including program maintenance manual, user's manual, and operations manual.

Information product(s): Cary, L. E., Program maintenance manual for NWIS meteorological site index data: U.S. Geological Survey Open-File Report (planned).

______User's manual for NWIS meteorological site index data: U.S. Geological Survey Open-File Report (planned).

______Operations manual for NWIS meteorological site index data: U.S. Geological Survey Open-File Report (planned).

Project title: Upper Clark Fork Ground Water (MT107)



Location: Southwestern Montana

Period of project: October 1985 to September 1988

Project chief: Thomas D. Brooks, Helena

Problem: The Clark Fork (River) basin has experienced a multitude of water-quality problems since the advent of large-scale mining activities in the 1860's. Acid-mine drainage and transport of metal-laden tailings and ore-processing wastes along with stress from wood-processing activities, domestic sewage, electrical generation, and irrigation and livestock demands have resulted in severe degradation of water quality in the river. Steps are being taken to improve water quality. However, understanding and management of water quality in the river require a thorough knowledge of water systems in shallow aquifers along the river.

Objective(s): (1) To assess the occurrence of water in shallow aquifers along the Clark Fork from the headwaters to the confluence with the Blackfoot River near Missoula. (2) To assess the occurrence and magnitude of chemical constituents, including toxic metals, in water in those aquifers. Specifically, the project will determine (a) characteristics of ground-water flow systems, (b) seasonal changes in the systems, (c) quality of ground water in the systems, (d) basic mechanisms for evolution of ground-water quality, and (e) relationships between ground-water and surface-water flow and quality.

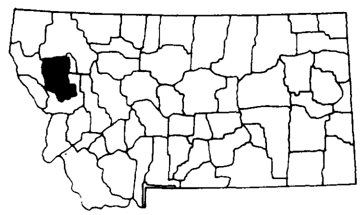
Approach: Obtain existing data from files of the U.S. Geological Survey and other Federal and State agencies. Supplement existing data by (a) selective field inventory of existing wells, (b) installation of test wells, (c) seepage runs along the upper Clark Fork, (d) establishment of a network of wells for periodic water-level measurement, and (e) establishment of a network of wells for annual water-quality sampling.

Progress last fiscal year: Project initiated October 1985.

Plans this fiscal year: Identify existing data, conduct field inventory, install test wells, and establish water-level and water-quality monitoring networks.

Information product(s): Water in shallow aquifers along the upper Clark Fork (River), southwestern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Project title: Canal Seepage (MT108)



Location: Flathead Indian Reservation

Period of project: October 1985 to March 1988

Project chief: Steven E. Slagle, Helena

Problem: Most of the canals in the Flathead Irrigation District are unlined and losses from seepage are large, especially along reaches underlain by coarse-grained sediments. Quantitative knowledge of canal losses would provide a base for development of management plans to decrease seepage losses and provide additional water for application to presently irrigated land or for expansion of irrigated acreage. However, losses from the canals recharge underlying aquifers, which supply water for domestic, stock, irrigation, and municipal supplies. Decreases in canal losses may affect ground-water users in some areas.

Objective(s): (1) To determine the magnitude and time distribution of canal leakage in representative geologic terraines within the reservation. (2) To determine the hydraulic, thermal, and geochemical effects, including introduction of pollutants, on the ground-water system near canals. (3) To assess the applicability of data transfer to the entire reservation.

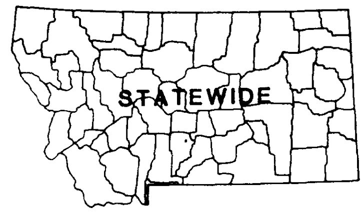
Approach: The initial phase of the study will consist of a review of the canal system and geology, and selection of sites representative of typical geologic terraines. The second phase will include installation of (a) shallow wells to monitor water-level changes and temperature gradients, (b) moisture-monitoring access tubes to monitor progression and regression of wetting fronts, (c) infiltrometers to monitor infiltration rates, and (d) continuous water-level recorders on monitoring wells and canals. The third phase will comprise data collection and interpretation including (a) monitoring of ground-water levels and canal stages, (b) monitoring of surface-water temperatures and ground-water temperature gradients, (c) monitoring of moisture profiles, (d) collection of water samples, (e) tracer tests to determine rate of subsurface flow, and (f) development of cross-section models to verify conceptual models developed from onsite observations.

Progress last fiscal year: Project initiated October 1985.

Plans this fiscal year: Select study sites (canal reaches), install monitoring wells, moisture-monitoring access tubes, infiltrometers, and water-level recorders, and begin collection of water-level, water-quality, and soil-moisture data.

Information product(s): Slagle, S. E., Water loss from irrigation canals on the Flathead Indian Reservation, northwestern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Project title: Geohydrologic Maps (MT109)



Location: Statewide

Period of project: Continuing

Project chief: Richard D. Feltis, Billings

Problem: The occurrence and availability of ground water are poorly known in large areas of Montana. The Montana Bureau of Mines and Geology, in an attempt to develop a systematic approach to assessing ground-water resources, initiated a statewide mapping effort based on 1-degree by 2-degree quadrangles. Their map series includes a delineation of bedrock geology, structure contours, potentiometric surfaces, and water-quality characteristics for selected units in selected quadrangles. The U.S. Geological Survey has contributed substantially to this effort through the Madison Aquifer structure maps by R. D. Feltis and the geohydrologic maps of the Northern Great Plains Regional Aquifer System Analysis (RASA) program. The Montana Bureau of Mines and Geology has requested that the Survey participate more fully in the long-range program and undertake full responsibility for selected quadrangles.

Objective(s): To prepare hydrogeologic maps of all 1-degree by 2-degree quadrangles in Montana for inclusion in the Montana Map Atlas portfolio.

Approach: Preparation of the maps will require compilation of existing hydrologic and geologic material, inventory of wells and springs, collection of water samples, and analysis of information. Data will be reviewed and entered into computer files and maps prepared. Each quadrangle will include bedrock geology, potentiometric surface, structure contours, and water-quality characteristics.

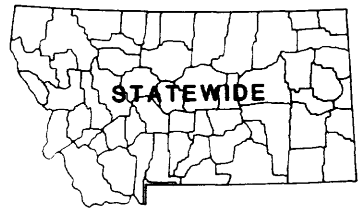
Progress last fiscal year: Project initiated October 1985.

Plans this fiscal year: Compile and review existing information. Select areas of sparse data for onsite inventories of wells and springs. Collect water samples from representative sites for chemical analyses. Begin compilation of geologic and hydrologic data on the Butte and Billings quadrangles.

Information product(s): Feltis, R. D., Ground-water resources map of the Billings 1-degree by 2-degree quadrangle, south-central Montana: Montana Bureau of Mines and Geology Hydrogeologic Map (planned).

______Ground-water resources map of the Butte 1-degree by 2-degree quadrangle, southwestern Montana: Montana Bureau of Mines and Geology Hydrogeologic Map (planned).

Project title: Channel Geometry (MT110)



Location: Statewide

Period of project: October 1985 to September 1986

Project chief: Charles Parrett, Helena

Problem: Reliable estimates of flood magnitude and frequency are essential for the economic design of bridges, culverts, and other structures located on streams. In addition, sound planning and land-use decision for lands bordering streams require information about the flood potential of the streams. Previous studies in Montana (Omang and others, 1983b; Parrett and others, 1983) found that measurements of channel width could be used to estimate flood peaks at ungaged stream sites with reasonably good accuracy. These studies were based on streamflow data through 1978 at more than 200 gages throughout Montana. Since then, more than 100 additional gages in Montana have accumulated 10 years of record and could be used to expand the data base. In addition, 5 additional years of record are available at all gage sites previously used, and updated flood-frequency curves have been determined. Thus, a new study relating channel-geometry measurements to flood frequency is warranted that would improve the reliability of the estimating equations.

Objective(s): To develop estimating (regression) equations relating peak discharges of various frequencies to channel width at all suitable, unregulated gages in Montana. The resulting equations then could be used to estimate flood magnitude at ungaged sites from measurements of channel width at the sites. The equations derived would be similar to those previously developed, but they would be based on revised flood-frequency information at gage sites previously used, as well as new information at more than 100 additional sites.

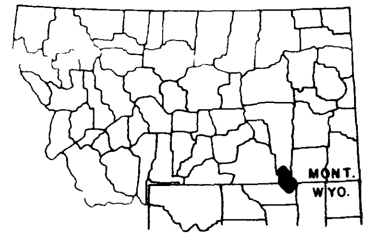
Approach: Measure channel geometry at the 100 gaged sites not previously used. Make multiple-regression analysis relating channel width to peak discharges of various frequencies (1-, 2-, 4-, 10-, 20-, and 50-percent exceedance probability) at about 280 gage sites (including the 100 new sites).

Progress last fiscal year: Project initiated October 1985.

Plans this fiscal year: Complete the project.

Information product(s): Parrett, Charles, Estimating magnitude and frequency of floods in Montana using channel geometry: U.S. Geological Survey Water-Resources Investigations Report (planned).

Project title: Hanging Woman Creek Salinity Model (MT111)



Location: Hanging Woman Creek, southeastern Montana and northeastern Wyoming

Period of project: October 1985 to April 1988

Project chief: Michael R. Cannon, Helena

Problem: Hanging Woman Creek is a small stream in the Powder River coal region of southeastern Montana and northeastern Wyoming. Water supplies in the basin are used primarily for agriculture and are obtained from Hanging Woman Creek and shallow aquifers of coal, sandstone, and alluvium. Other studies in the region indicate that coal mining would introduce large quantities of dissolved solids into local aquifers. Also, increased salinity would severely limit the the agricultural productivity of the basin. A need exists to determine the cumulative effects of surface coal mining on dissolved solids in Hanging Woman Creek and the valley alluvium.

Objectives: (1) To determine the pre-mining dissolved-solids load from the Hanging Woman Creek basin. (2) To determine the ground-water flow rates and salinity production potential of overburden for areas of the basin that contain strippable coal. (3) To determine the quantity of dissolved solids that coal mining might add to Hanging Woman Creek and the alluvial aquifer. (4) To determine the potential post-mining load of dissolved solids from the Hanging Woman Creek basin.

Approach: Determine pre-mining dissolved-solids loads from the basin using water discharge and quality data from Hanging Woman Creek and shallow aquifers. Perform extensive overburden sampling and analysis to evaluate the salinity production potential of the overburden; overburden analysis will involve batch-mixing experiments and saturated-paste extract tests. Combine the predicted dissolved-solids loads from mined lands with pre-mining loads to evaluate post-mining concentrations of dissolved solids in Hanging Woman Creek and the alluvial aquifer.

Progress last fiscal year: Project initiated October 1985.

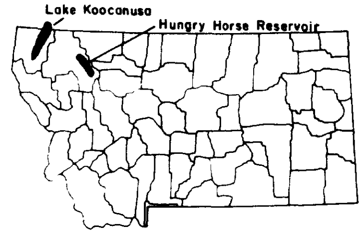
Plans this fiscal year: Install and operate surface-water stations; drill overburden holes, collect and test overburden samples; install observation wells; conduct aquifer tests; and collect ground-water samples for chemical analysis.

Information product(s): Cannon, M. R., Potential effects of coal mining on dissolved solids in Hanging Woman Creek basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

RESEARCH PROJECT

The Montana District program includes basic and applied research on various hydrologic principles. All projects directly or indirectly benefit from the results of research activities and contribute data needed in research programs. However, certain projects are primarily research-oriented and are designed to develop or apply new or unconventional hydrologic methods. One such project is currently underway.

Project title: <u>Reservoir Ecosystem Model (MT102)</u>



Location: Northwestern Montana

Period of project: October 1983 to September 1986

Project chief: Rodger F. Ferreira, Helena

Problem: The Montana Department of Fish, Wildlife and Parks has contracted with the Bonneville Power Administration (BPA) to quantify seasonal water levels needed to maintain or enhance principal gamefish species in Lake Koocanusa and Hungry Horse Reservoir. The Department plans to collect data on water quality, fish food organisms, critical life stages of gamefish, and gamefish population levels. Attempts will be made to relate these data to reservoir levels. Methods are needed to predict effects of reservoir drawdown on fish production. Simulation models are necessary to accomplish these predictions.

Objective(s): (1) To evaluate various model techniques and select potential models for application to Lake Koocanusa. (2) To construct and test a simulation model that could relate reservoir drawdown to trophic-dynamics of Lake Koocanusa. (3) To determine data requirements for various models and evaluate adequacy of data-collection programs for use in developing predictive models of Lake Koocanusa and Hungry Horse Reservoir.

Approach: Review various models for application to Lake Koocanusa. Relate data on gamefish productivity (water quality, fish-food organisms, life stages of gamefish, and gamefish population levels) to reservoir levels or drawdown to determine relationships between productivity and reservoir operation. Select applicable models for simulation of reservior conditions. Identify appropriate modifications that could be made in data-collection programs, if results indicate a need for change.

Progress last fiscal year: Analyzed fisheries data from Lake Koocanusa, which showed no correlation between annual reservoir drawdown and catch as an estimate of the reservoir's fish-carrying capacity. Developed a flow chart for a model that incorporates several input factors of energy flow to fish production. The project was suspended during fiscal year 1985, but was reactivated for fiscal year 1986.

Plans this fiscal year: Modify the reservoir circulation model (heat budget model) developed by D. Briane Adams of the Geological Survey's Florida District to accommodate a multiple-outlet release system. After modification, apply the model to Lake Koocanusa and Hungry Horse Reservoir to simulate the effects that different reservoir-drawdown schedules will have on temperature at various depths.

Information product(s): Ferreira, R. F., Heat budget for Lake Koocanusa and Hungry Horse Reservoir, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

OTHER HYDROLOGIC WORK BY THE DISTRICT

As part of its responsibility to provide information on water to all water users, the Geological Survey is involved in numerous other activities in addition to regular programs of data collection and hydrologic investigations. One of these functions is to serve as a Federal or Survey representative on advisory committees or ad hoc groups established for specific purposes. Some of the current special activities are described below:

Committee and task force memberships.--Members of the District staff are working members and advisors to several committees and task forces. Included are the International Joint Commission, the Flathead River International Study Board, and the Poplar River Bilateral Monitoring Committee, all involving the United States and Canada; the Yellowstone River Compact between Montana, Wyoming, and North Dakota; the Governor's Ground-Water Task Force; the City of Helena Ground-Water Task Force; the Helena-Lewis and Clark County Solid Waste Study Committee; the Governor's Clark Fork Task Force; the Montana Bureau of Mines and Geology Advisory Board; and the Water Resources Research Institute Advisory Board.

Review of Environmental Impact Statements and other agency reports.--The Water Resources Division reviews Environmental Impact Statements for Federal airport and highway projects to ensure that available hydrologic data are used, that they are used correctly, and that the effect of construction on water features and resources is accurately evaluated. From time to time, the District is also asked to review reports and projects of other Federal and State agencies, primarily because of the Survey's hydrologic expertise and impartiality.

Assistance to other agencies and individuals.--In addition to the Survey's formal programs and studies, water information and assistance are provided to other agencies having specific problems: for instance, to the National Park Service in locating water supplies in Yellowstone and Glacier National Parks. The District continually receives calls, visits, and mail requests for information on ground-water availability, streamflow data, and water quality from landowners, consultants, public officials, and business concerns. Federal regulations prohibit activity that encroaches on the work of professional consultants, but much information and assistance are provided to professional engineers, geologists, and other consultants.

Special activities.--The District is at times called on for certain work not covered under specific projects or data-collection programs. This work includes obtaining hydrologic data to document drought effects and direct or indirect measurement of floods, both in Montana and other States that have suffered flood disasters.

SOURCES OF GEOLOGICAL SURVEY PUBLICATIONS AND INFORMATION

Books

Current reports are listed in a pamphlet, "New Publications of the Geological Survey." Subscription to the pamphlet, which is issued monthly, is free upon request to the U.S. Geological Survey, 582 National Center, Reston, Virginia 22092.

Professional papers, bulletins, water-supply papers, techniques of water-resources investigations, circulars, and publications of general interest (such as leaflets, pamphlets, booklets) are available by mail from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Building 41, Box 25425, Denver, Colorado 80225.

Records of streamflow, ground-water levels, and quality of water have been published for many years as Geological Survey water-supply papers. Beginning with the 1971 water year, however, the data were released in a new publications series, U.S. Geological Survey Water-Data Reports. This new series combines for each State: streamflow data, water-quality data for surface and ground water, and ground-water-level data from the basic network of observation wells. For Montana, an example title is, "Water-Resources Data, Montana--Water Year 1984: U.S. Geological Survey Water-Data Report MT-84-1." Additional information on these publications can be obtained from the District Chief at the address shown at the front of this report.

Open-File Reports and Water-Resources Investigations Reports are available for inspection at the District office of the Geological Survey in Helena, Montana. Most reports in these series can be purchased in microfiche and paper-copy forms from:

U.S. Geological Survey
Books and Open-File Reports
Federal Center, Building 41
Box 25425
Denver, Colorado 80225.

Maps

Miscellaneous investigations maps, hydrologic investigations atlases, hydrologic unit maps, topographic maps, and other maps pertaining to Montana (as well as maps of other areas in the United States, Guam, Puerto Rico, Samoa, and The Virgin Islands) are available for sale from:

U.S. Geological Survey,
Map Distribution
Federal Center, Building 41
Box 25286
Denver, Colorado 80225.

Flood-prone-area maps of selected areas are available for inspection at the Montana District office in Helena, and are available for nominal cost from the Montana Bureau of Mines and Geology, Montana College of Mineral Science and Technology, Butte, Montana 59701. More detailed maps, prepared as part of flood insurance studies, are available on request to the Montana Department of Natural Resources and Conservation, 1520 East Sixth Avenue, Helena, Montana 59620.

General Information

The Public Inquiries Office (PIO) provides general information about the programs of the U.S. Geological Survey and its reports and maps. The PIO answers inquiries made in person, by mail, or by telephone and refers requests for specific technical information to the appropriate people. Direct inquiries for Montana to:

Public Inquiries Office
U.S. Geological Survey
678 U.S. Courthouse
West 920 Riverside Avenue
Spokane, Washington 99201
Phone: (509) 456-2524

Requests for miscellaneous water information and information on programs in other States may be referred to:

Water Resources Division
U.S. Geological Survey, Mail Stop 440
12201 Sunrise Valley Drive
Reston, Virginia 22092

The National Center of the Geological Survey maintains a library with an extensive earth-sciences collection. Local libraries may obtain books, periodicals, and maps through interlibrary loan by writing to:

U.S. Geological Survey Library
950 National Center
Room 4-A-100
12201 Sunrise Valley Drive
Reston, Virginia 22092

In addition to the data collected within the State, the Montana District has access to water data collected nationwide. The National Water Data Exchange (NAWDEX) of the Geological Survey provides information on location and type of data pertaining to water and related subjects from more than 400 organizations. The National Water Data Storage and Retrieval System (WATSTORE) serves as a central repository of water data collected by the Geological Survey, including large volumes of data on the quantity and quality of both surface and ground waters.

General information pertaining to Montana's water resources, water programs of the Geological Survey, availability of water data, and reports describing water resources can be obtained from the District Chief at the address shown at the front of this report. Additional information on other Geological Survey programs, both within and outside the State, can be obtained from the following sources:

Water: Regional Hydrologist, Central Region
U.S. Geological Survey
Mail stop 406, Box 25046
Federal Center
Denver, Colorado 80225
Phone: (303) 236-5920

Geology: Assistant Chief Geologist, Central Region
U.S. Geological Survey
Mail stop 911, Box 25046
Federal Center
Denver, Colorado 80225
Phone: (303) 236-5438

National maps: Chief, Rocky Mountain Mapping Center
U.S. Geological Survey
Mail Stop 510, Box 25046
Federal Center
Denver, Colorado 80225
Phone: (303) 236-5825

Finally, the reader interested in obtaining information on the varied material that the Geological Survey produces and distributes is referred to U.S. Geological Survey Circular 900, "Guide to obtaining USGS information." That guide covers a wide variety of specialties such as geology, hydrology, cartography, geography, and remote sensing, as well as information on land use and energy, mineral, and water resources.

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Boettcher, A. J., 1982, Ground-water resources in the central part of the Flathead Indian Reservation, northwestern Montana: Montana Bureau of Mines and Geology Memoir 48, 28 p.

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Cary, L. E., 1984, Application of the U.S. Geological Survey's precipitation-runoff modeling system to the Prairie Dog Creek basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4178, 95 p.

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______1982, Map showing total thickness of the Lakota Formation and equivalent rocks, Montana: U.S. Geological Survey Water-Resources Investigations 82-4026.

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______1984, Map showing configuration of the top of the Madison Group, Billings 1-degree by 2-degree quadrangle, southeastern Montana: Montana Bureau of Mines and Geology Geologic Map 36.

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______1985, Map showing configuration of the top of the Madison Group, Bozeman 1-degree by 2-degree quadrangle, southwestern Montana: Montana Bureau of Mines and Geology Geologic Map 38.

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Table 1.--*Surface-water gaging stations in operation, October 1985*

Station number

Stations are listed in downstream order by standard drainage basin number: Part 5 (Hudson Bay basin), Part 6 (Missouri River basin), and Part 12 (upper Columbia River basin). Each station number contains a 2-digit part number plus a 6-digit downstream order number. The location of streamflow and major-reservoir stations is shown in figure 6; the location of stations at some small reservoirs is not identified on the map.

Supported by

BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BPA	Bonneville Power Administration
CH	City of Helena
FERC	Federal Energy Regulatory Commission
MBMG	Montana Bureau of Mines and Geology
MDFWP	Montana Department of Fish, Wildlife and Parks
MDHES	Montana Department of Health and Environmental Sciences
MDNRC	Montana Department of Natural Resources and Conservation
MDSL	Montana Department of State Lands
MGO	Montana Governor's Office
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSE	Wyoming State Engineer
WWT	U.S. Department of State-International Joint Commission, Waterways Treaty

Gage equipment

A - Thermograph recorder
B - Minimonitor
C - DCP (Data-collection platform)
D - Digital recorder
G - Graphic recorder
M - Manometer (bubbler) gage
O - Observer record only
P - Electrical power
R - Rain gage
S - Selsyn unit
T - Telemark, BDT satellite
U - Other agency Telemark
W - Well gage

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Gage equipment
	Part 5		
05014500	Swiftcurrent Creek at Many Glacier	USGS	GPW
05015500	Lake Sherburne at Sherburne	WWT	GMP
05016000	Swiftcurrent Creek at Sherburne	WWT	DGPW
05017500	St. Mary River near Babb	WWT	GW
05018500	St. Mary Canal at St. Mary Crossing, near Babb	WWT	CGW
05020500	St. Mary River at international boundary	WWT	CGPUW
	Part 6		
06012000	Lima Reservoir near Monida	MDNRC	O
06012500	Red Rock River below Lima, near Monida	USBR	CDGW
06015300	Clark Canyon Reservoir near Grant	USGS	G
06016000	Beaverhead River at Barretts	USBR	DGPW
06018500	Beaverhead River near Twin Bridges	USGS	CDGPW
06019500	Ruby River above reservoir, near Alder	MDNRC	DGW
06020500	Ruby River Reservoir near Alder	MDNRC	O
06020600	Ruby River below reservoir, near Alder	MDNRC	DW
06024590	Wise River near Wise River	MDNRC	DGMW
06025500	Big Hole River near Melrose	MDNRC	ADGPW
06033000	Boulder River near Boulder	MDNRC	DGW
06035000	Willow Creek near Harrison	MDNRC	DGW
06036000	Willow Creek Reservoir near Harrison	MDNRC	O
06036650	Jefferson River near Three Forks	MDFWP	CDGMPR
06036905	Firehole River near West Yellowstone	NPS	BDGM
06037000	Gibbon River near West Yellowstone	NPS	BDGM
06037500	Madison River near West Yellowstone	NPS	BDGMW
06038000	Hebgen Lake near West Yellowstone	FERC	O
06038500	Madison River below Hebgen Lake, near Grayling	FERC	DGPW
06038800	Madison River at Kirby Ranch, near Cameron	MDFWP	O
06040300	Jack Creek near Ennis	MDNRC	DGPW
06040500	Ennis Lake near McAllister	FERC	O
06041000	Madison River below Ennis Lake, near McAllister	FERC	ACDGPSW
06043500	Gallatin River near Gallatin Gateway	MDFWP	DGTW
06049500	Middle Creek Reservoir near Bozeman	MDNRC	O
06050000	Hyalite Creek at Hyalite Ranger Station, near Bozeman	MDNRC	DGW
06052500	Gallatin River at Logan	USAE	CDGPTW
06054500	Missouri River at Toston	USGS	ACDGPRW
06058500	Canyon Ferry Lake near Helena	USGS	GPSW
06061500	Prickly Pear Creek near Clancy	MDNRC	DGW

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Gage equipment
	Part 6--Continued		
06062500	Tenmile Creek near Rimini	CH	DGPW
06064500	Lake Helena near Helena	FERC	O
06065000	Hauser Lake near Helena	FERC	O
06066000	Holter Lake near Wolf Creek	FERC	O
06066500	Missouri River below Holter Dam, near Wolf Creek	FERC	DGPSW
06075000	Smith River Reservoir near White Sulphur Springs	MDNRC	O
06076690	Smith River near Fort Logan	MDFWP	CDGMR
06078200	Missouri River near Ulm	USAE	CDGRW
06079500	Gibson Reservoir near Augusta	MDNRC	O
06080500	Pishkun Reservoir near Augusta	MDNRC	O
06082000	Willow Creek Reservoir near Augusta	MDNRC	O
06083000	Nilan Reservoir near Augusta	MDNRC	O
06088300	Muddy Creek near Vaughn	USGS	DGW
06088500	Muddy Creek at Vaughn	USGS	DGM
06089000	Sun River near Vaughn	FERC	CDGPRW
06090200	Morony Reservoir near Great Falls	FERC	O
06090300	Missouri River near Great Falls	FERC	DGMPS
06090800	Missouri River at Fort Benton	USGS	DGPTW
06090900	Lower Two Medicine Lake near East Glacier	MDNRC	O
06091700	Two Medicine River below South Fork, near Browning	BIA	DGM
06091800	Two Medicine Canal near Browning	BIA	DW
06092600	Four Horns Canal near Browning	BIA	GW
06093000	Four Horns Lake near Heart Butte	MDNRC	O
06093200	Badger Creek below Four Horns Canal, near Browning	BIA	DGPW
06094000	Swift Reservoir near Dupuyer	MDNRC	O
06095500	Lake Frances near Valier	MDNRC	O
06099000	Cut Bank Creek at Cut Bank	BIA	DGM
06099500	Marias River near Shelby	USGS	CDGMP
06101300	Lake Elwell near Chester	USGS	O
06101500	Marias River near Chester	USBR	CDW
06108000	Teton River near Dutton	USGS	DGMP
06109500	Missouri River at Virgelle	USAE	CDGPRW
06110500	Ackley Lake near Hobson	MDNRC	O
06115200	Missouri River near Landusky	USAE	CDGMPRW
06116500	Bair Reservoir near Delpine	MDNRC	O
06119000	Martinsdale Reservoir near Martinsdale	MDNRC	O
06120500	Musselshell River at Harlowton	MDNRC	DGTW
06122500	Deadmans Basin Reservoir near Shawmut	MDNRC	MO
06122800	Musselshell River near Shawmut	MDNRC	GW
06126470	Half Breed Creek near Klein	MDNRC	DGM

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Gage equipment
	Part 6--Continued		
06126500	Musselshell River near Roundup	MDNRC	CDGPRW
06127500	Musselshell River at Musselshell	MDNRC	DGW
06130500	Musselshell River at Mosby	MDNRC	DGM
06131000	Big Dry Creek near Van Norman	USAE, USGS	CDGMR
06131120	Timber Creek near Van Norman	MDSL	GM
06131200	Nelson Creek near Van Norman	BLM	DGM
06131500	Fort Peck Lake at Fort Peck	USAE	O
06131800	Missouri River stage station No. 1 near Fort Peck	USAE	DPW
06132000	Missouri River below Fort Peck Dam	USAE	DGM
06132200	South Fork Milk River near Babb	WWT	GPW
06133000	Milk River at western crossing of international boundary	WWT	CGW
06133500	North Fork Milk River above St. Mary Canal, near Browning	WWT	CGPW
06134000	North Milk River near international boundary	WWT	CGW
06134500	Milk River at Milk River, Alberta	WWT	CGPUW
06134700	Verdigris Coulee near mouth, near Milk River	WWT	GW
06135000	Milk River at eastern crossing of international boundary	WWT	CDGPTW
06136500	Fresno Reservoir near Havre	MDNRC	O
06137400	Big Sandy Creek at reservation boundary, near Rocky Boy	BIA	DGM
06137570	Boxelder Creek near Rocky Boy	BIA	DGPW
06137580	Sage Creek near Whitlash	MDNRC	DGM
06139500	Big Sandy Creek near Havre	BIA	CGW
06140500	Milk River at Havre	USAE	DGM
06141600	Little Boxelder Creek at mouth, near Havre	MDNRC	DW
06142400	Clear Creek near Chinook	BIA	CGW
06144260	Altawan Reservoir near Govenlock, Saskatchewan	WWT	GM
06144270	Spangler Ditch near Govenlock, Saskatchewan	WWT	GW
06144350	Middle Creek near Saskatchewan boundary	WWT	GW
06144360	Middle Creek Reservoir near Battle Creek, Saskatchewan	WWT	GM
06144395	Middle Creek below Middle Creek Reservoir, near Govenlock, Saskatchewan	WWT	GW
06145500	Lodge Creek below McRae Creek, at international boundary	WWT	GPUW
06147950	Gaff Ditch near Merryflat, Saskatchewan	WWT	GW
06148500	Cypress Lake west inflow canal near West Plains, Saskatchewan	WWT	GW
06148700	Cypress Lake west inflow canal drain near Oxarat, Saskatchewan	WWT	GW

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Gage equipment
	Part 6--Continued		
06149000	Cypress Lake west outflow canal near West Plains, Saskatchewan	WWT	GPW
06149100	Vidora Ditch near Consul, Saskatchewan	WWT	GW
06149200	Richardson Ditch near Consul, Saskatchewan	WWT	GW
06149300	McKinnon Ditch near Consul, Saskatchewan	WWT	GW
06149400	Nashlyn Canal near Consul, Saskatchewan	WWT	GW
06149500	Battle Creek at international boundary	WWT	DGW
06151000	Lyons Creek at international boundary	WWT	GW
06151500	Battle Creek near Chinook	BIA	CGM
06154100	Milk River near Harlem	MDNRC	DGM
06154140	Fifteenmile Creek tributary near Harlem	BIA	GW
06154400	Peoples Creek near Hays	BIA	GW
06154410	Little Peoples Creek near Hays	USGS	GM
06154490	Willow Coulee near Dodson	BIA	GW
06154500	Peoples Creek near Dodson	BIA	DGMW
06154510	Kuhr Coulee tributary near Dodson	BIA	GW
06155000	Nelson Reservoir near Saco	MDNRC	O
06155030	Milk River near Dodson	MDNRC	CDGM
06156500	Belanger Creek diversion canal near Vidora, Saskatchewan	WWT	GPW
06157000	Cypress Lake near Vidora, Saskatchewan	WWT	GM
06157500	Cypress Lake east outflow canal near Vidora, Saskatchewan	WWT	GPW
06158500	Eastend Canal at Eastend, Saskatchewan	WWT	GW
06159000	Eastend Reservoir at Eastend, Saskatchewan	WWT	GM
06159500	Frenchman River below Eastend Reservoir, near Eastend, Saskatchewan	WWT	GPW
06161300	Huff Lake pumping canal near Val Marie, Saskatchewan	WWT	GW
06161500	Huff Lake gravity canal near Val Marie, Saskatchewan	WWT	GW
06162000	Huff Lake Reservoir near Val Marie, Saskatchewan	WWT	GM
06162500	Newton Lake main canal near Val Marie, Saskatchewan	WWT	GW
06163000	Newton Lake near Val Marie, Saskatchewan	WWT	GM
06163050	Frenchman River below Newton Lake, near Val Marie, Saskatchewan	WWT	GW
06164000	Frenchman River at international boundary	WWT	GPTW
06164510	Milk River at Juneberg Bridge, near Saco	USGS	CDGMPR
06164590	Beaver Creek near Zortman	BIA	DGM
06164615	Little Warm Creek at reservation boundary, near Zortman	BIA	DGM
06164623	Little Warm Creek tributary near Lodge Pole	BIA	GW

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Sup-ported by	Gage equip-ment
	Part 6--Continued		
06164630	Big Warm Creek near Zortman	BIA	DGM
06166000	Beaver Creek below Guston Coulee, near Saco	USGS	GM
06169500	Rock Creek below Horse Creek, near international boundary	USGS	DGPW
06169600	South Fork Rock Creek tributary No. 1 near Opheim	BLM	GW
06169700	South Fork Rock Creek tributary No. 2 near Opheim	BLM	GW
06169800	South Fork Rock Creek tributary No. 3 near international boundary	BLM	GW
06170050	Rock Creek below McEachern Creek, near international boundary	BLM	GM
06170080	Starbuck Coulee near international boundary	BLM	GW
06172000	Milk River near Vandalia	MDNRC	CDGMW
06174000	Willow Creek near Glasgow	USGS	GM
06174500	Milk River at Nashua	USAE	CDGMPW
06175000	Porcupine Creek at Nashua	BIA	GM
06175100	Missouri River stage station No. 3 at West Frazer pumping plant, near Frazer	USAE	DPW
06175510	Missouri River stage station No. 4 at East Frazer pumping plant, near Frazer	USAE	DPW
06175520	Missouri River stage station No. 5 near Oswego	USAE	GM
06175540	Prairie Elk Creek near Oswego	BLM	DGM
06176500	Wolf Creek near Wolf Point	BIA	GMW
06177000	Missouri River near Wolf Point	USAE	ACDGMPW
06177500	Redwater River at Circle	BLM	DGPW
06178000	Poplar River at international boundary	USGS	CDGMPW
06178500	East Poplar River at international boundary	USGS	CDGPW
06181000	Poplar River near Poplar	BIA	GW
06181995	Beaver Creek at international boundary	WWT	GPW
06183450	Big Muddy Creek near Antelope	USGS	DGMP
06183700	Big Muddy Creek diversion canal near Medicine Lake	USGS	DGM
06183750	Lake Creek near Dagmar	USFWS	GW
06183800	Cottonwood Creek near Dagmar	USFWS	GW
06183850	Sand Creek near Dagmar	USFWS	GW
06185110	Big Muddy Creek near mouth, near Culbertson	BIA	GM
06185500	Missouri River near Culbertson	USAE	CDGMR
06186000	Yellowstone Lake at Bridge Bay, Yellowstone National Park	NPS	O
06186500	Yellowstone River at Yellowstone Lake outlet, Yellowstone National Park	NPS	DGW
06187550	Yellowstone River near Tower Junction, Yellowstone National Park	NPS	DGM

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Gage equipment
	Part 6--Continued		
06188000	Lamar River near Tower Falls Ranger Station, Yellowstone National Park	MDHES	0
06191000	Gardiner River near Mammoth	NPS	DGW
06191500	Yellowstone River at Corwin Springs	USAE	CDGPW
06191800	Big Creek near Emigrant	MDFWP	DW
06192500	Yellowstone River near Livingston	USAE	DGPTW
06195600	Shields River near Livingston	MDFWP	DGM
06200000	Boulder River at Big Timber	MDNRC	DGPTW
06202510	Stillwater River above Nye Creek, near Nye	MDFWP	0
06204000	Mystic Lake near Roscoe	FERC	0
06204050	West Rosebud Creek near Roscoe	FERC	DGPW
06205000	Stillwater River near Absarokee	USAE	DGMTW
06207500	Clarks Fork Yellowstone River near Belfry	MDNRC	DGMW
06208800	Clarks Fork Yellowstone River near Silesia	MDNRC, WSE	DGM
06209500	Rock Creek near Red Lodge	MDFWP	DGW
06211000	Red Lodge Creek above Cooney Reservoir, near Boyd	MDNRC	DGW
06211500	Willow Creek near Boyd	MDNRC	DGW
06212000	Cooney Reservoir near Boyd	MDNRC	0
06212500	Red Lodge Creek below Cooney Reservoir, near Boyd	MDNRC	DPW
06214000	Rock Creek at Rockvale	MDNRC	DGM
06214500	Yellowstone River at Billings	USAE	CDGPRTW
06216000	Pryor Creek at Pryor	USGS	DPW
06216900	Pryor Creek near Huntley	USGS	DGM
06286400	Bighorn Lake near St. Xavier	USGS	GW
06286490	Bighorn Canal near St. Xavier	USBR	GPW
06287000	Bighorn River near St. Xavier	USBR	DGPW
06289000	Little Bighorn River at State line, near Wyola	USGS	DGW
06290000	Pass Creek near Wyola	BIA	DGM
06290500	Little Bighorn River below Pass Creek, near Wyola	USGS	DGW
06291000	Owl Creek near Lodge Grass	BIA	DGM
06291500	Lodge Grass Creek above Willow Creek diversion, near Wyola	BIA	DGM
06294000	Little Bighorn River near Hardin	MDNRC, WSE	DW
06294500	Bighorn River above Tullock Creek, near Bighorn	MDNRC, WSE	CDGMR
06295000	Yellowstone River at Forsyth	USBR	DGMP
06295100	Rosebud Creek near Kirby	MDSL	GW
06295113	Rosebud Creek at reservation boundary, near Kirby	USGS	GM
06295250	Rosebud Creek near Colstrip	BIA	DGM
06296003	Rosebud Creek at mouth, near Rosebud	MDNRC	DGM

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Gage equipment
	Part 6--Continued		
06306100	Squirrel Creek near Decker	MDSL	DGM
06306300	Tongue River at State line, near Decker	MDNRC	DGPW
06307000	Tongue River Reservoir near Decker	MDNRC	O
06307500	Tongue River at Tongue River Dam, near Decker	MDNRC	DGW
06307600	Hanging Woman Creek near Birney	MDSL	DGW
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	DPW
06308500	Tongue River at Miles City	MDNRC, WSE	ACDGM
06309000	Yellowstone River at Miles City	USAE	CDGMPR
06324500	Powder River at Moorhead	MDNRC	DGPW
06324710	Powder River at Broadus	MDNRC	O
06326300	Mizpah Creek near Mizpah	MDNRC	DGM
06326500	Powder River near Locate	MDNRC, WSE	CDGMPR
06326600	O'Fallon Creek near Ismay	MDNRC	DGM
06329500	Yellowstone River near Sidney	USAE	CDGMP
06336447	Duck Creek near Wibaux	MDSL	GM
	Part 12		
12301300	Tobacco River near Eureka	USAE	AGW
12301920	Lake Koocanusa near Libby	USAE	GW
12301933	Kootenai River below Libby Dam, near Libby	USAE	DGMP
12302055	Fisher River near Libby	USAE	AGPW
12303000	Kootenai River at Libby	USAE	DGPTW
12303100	Flower Creek near Libby	BIA	GW
12303500	Lake Creek at Troy	FERC	DGMP
12304500	Yaak River near Troy	USAE	AGPW
12323170	Silver Bow Creek above Blacktail Creek, at Butte	MBMG	DGM
12323770	Warm Springs Creek at Warm Springs	MDFWP	DGM
12324200	Clark Fork at Deer Lodge	MDFWP	DGM
12324590	Little Blackfoot River near Garrison	MDNRC	DGM
12324680	Clark Fork at Goldcreek	MDFWP	DGM
12325000	Georgetown Lake near Southern Cross	FERC	O
12325500	Flint Creek near Southern Cross	FERC	DW
12329500	Flint Creek at Maxville	MDNRC	DGW
12330000	Boulder Creek at Maxville	MDNRC	DGW
12331900	Clark Fork near Clinton	MDFWP	O
12332000	Middle Fork Rock Creek near Philipsburg	MDNRC	DGW
12332500	East Fork Rock Creek Reservoir near Philipsburg	MDNRC	O
12334510	Rock Creek near Clinton	MDNRC	CDGPW
12334550	Clark Fork at Turah Bridge, near Bonner	MGO	GMO

Table 1.--*Surface-water gaging stations in operation, October 1985*--Continued

Station number	Station name	Sup-ported by	Gage equip-ment
	Part 12--Continued		
12370000	Swan River near Bigfork	BPA	DGPTW
12370900	Teepee Creek near Polson	BIA	GW
12371500	Flathead Lake at Somers	FERC	GW
12371550	Flathead Lake at Polson	FERC	GPTW
12372000	Flathead River near Polson	FERC	DGPSW
12372500	Camas Reservoir, group of four	BIA	0
12374250	Mill Creek above Bassoo Creek, near Niarada	BIA	GM
12374800	Cromwell Creek near Niarada	BIA	GM
12375900	South Fork Crow Creek near Ronan	BIA	DGM
12377150	Mission Creek above reservoir, near St. Ignatius	BIA	DGM
12377200	Mission Valley Reservoir, group of eight	BIA	0
12380500	Lower Jocko Lake near Arlee	BIA	0
12381400	South Fork Jocko River near Arlee	BIA	DGM
12383500	Big Knife Creek near Arlee	BIA	DGM
12387450	Valley Creek near Arlee	BIA	GW
12388400	Revais Creek below West Fork, near Dixon	BIA	DGM
12388650	Camas Creek near Hot Springs	BIA	GM
12388700	Flathead River at Perma	BIA	DGMP
12389000	Clark Fork near Plains	FERC	DGPTW
12389500	Thompson River near Thompson Falls	FERC	GPW
12390000	Thompson Falls Reservoir at Thompson Falls	FERC	0
12390700	Prospect Creek at Thompson Falls	FERC	GPW
12391300	Noxon Rapids Reservoir near Noxon	FERC	GW
12391400	Clark Fork below Noxon Rapids Dam, near Noxon	FERC	0

Table 2.--*Crest-stage partial-record stations in operation, October 1985*

[The stations are funded cooperatively with the Montana Department of Highways, the Federal Highway Administration of the U.S. Department of Transportation, and the Forest Service of the U.S. Department of Agriculture]

Station number

Stations are listed in downstream order by standard drainage basin number: Part 6 (Missouri River basin) and Part 12 (upper Columbia River basin). Each station number contains a 2-digit part number plus a 6-digit downstream order number. The location of the stations is shown in figure 7.

Records available

The date shown indicates the year of first record. The period of record extends to the current year. At a few stations, the period of record contains one or more years of no data.

Table 2.--*Crest-stage partial-record stations in operation, October 1985*--Continued

Station number	Station name	Records available
	Part 6	
06013500	Big Sheep Creek below Muddy Creek, near Dell	1946-
06015430	Clark Canyon near Dillon	1969-
06019400	Sweetwater Creek near Alder	1974-
06019800	Idaho Creek near Alder	1959-
06025100	Quartz Hill Gulch near Wise River	1974-
06027700	Fish Creek near Silver Star	1959-
06030300	Jefferson River tributary No. 2 near Whitehall	1957-
06031950	Cataract Creek near Basin	1973-
06038550	Cabin Creek near West Yellowstone	1974-
06043300	Logger Creek near Gallatin Gateway	1959-
06046500	Rocky Creek (head of East Gallatin River) near Bozeman	1951-
06053050	Lost Creek near Ringling	1974-
06056300	Cabin Creek near Townsend	1959-
06058700	Mitchell Gulch near East Helena	1959-
06071600	Wegner Creek at Craig	1959-
06073600	Black Rock Creek near Augusta	1974-
06076700	Sheep Creek near Neihart	1959-
06090550	Little Otter Creek near Raynesford	1974-
06090810	Ninemile Coulee near Fort Benton	1972-
06097100	Blacktail Creek near Heart Butte	1974-
06098700	Powell Coulee near Browning	1974-
06100300	Lone Man Coulee near Valier	1959-
06101520	Favot Coulee tributary near Ledger	1974-
06101700	Fey Coulee tributary near Chester	1963-
06105800	Bruce Coulee tributary near Choteau	1963-
06109530	Little Sandy Creek tributary near Virgelle	1972-
06109560	Alkali Coulee tributary near Virgelle	1974-
06111700	Mill Creek near Lewistown	1959-
06112800	Bull Creek tributary near Hilger	1974-
06114550	Wolf Creek tributary near Coffee Creek	1974-
06114900	Taffy Creek tributary near Winifred	1974-
06115300	Duval Creek near Landusky	1963-
06117800	Dirty Creek near Martinsdale	1972-
06120800	Antelope Creek tributary No. 2 near Harlowton	1955-
06123200	Spring Creek tributary near Harlowton	1971-

Table 2.--*Crest-stage partial-record stations in operation, October 1985*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06124600	East Fork Roberts Creek tributary near Judith Gap	1974-
06125520	Swimming Woman Creek tributary near Living Springs	1974-
06125680	Big Coulee Creek tributary near Cushman	1974-
06127505	Fish Creek near Musselshell	1974-
06127520	Home Creek near Sumatra	1973-
06127570	Butts Coulee near Melstone	1963-
06127585	Little Wall Creek tributary near Flatwillow	1974-
06128500	South Fork Bear Creek tributary near Roy	1962-
06129800	Gorman Coulee tributary near Cat Creek	1955-
06130610	Bair Coulee near Mosby	1974-
06130620	Blood Creek tributary near Valentine	1974-
06130850	Second Creek tributary No. 2 near Jordan	1958-
06130915	Russian Coulee near Jordan	1974-
06130925	Thompson Creek tributary near Cohagen	1974-
06130940	Spring Creek tributary near Van Norman	1974-
06131100	Terry Coulee near Van Norman	1974-
06131300	McGuire Creek tributary near Van Norman	1974-
06132400	Dry Fork Milk River near Babb	1961-
06134800	Van Cleeve Coulee tributary near Sunburst	1963-
06136400	Spring Coulee tributary near Simpson	1972-
06137600	Sage Creek tributary No. 2 near Joplin	1974-
06138700	South Fork Spring Coulee near Havre	1959-
06153400	Fifteenmile Creek tributary near Zurich	1974-
06154350	Peoples Creek tributary near Lloyd	1974-
06154410	Little Peoples Creek near Hays	1972-
06155300	Disjardin Coulee near Malta	1955-
06155600	Murray Coulee tributary near Hogeland	1974-
06156100	Lush Coulee near Whitewater	1972-
06164600	Beaver Creek tributary near Zortman	1974-
06165200	Beaver Creek tributary No. 2 near Malta	1974-
06172300	Unger Creek near Vandalia	1958-
06173300	Willow Creek tributary near Fort Peck	1972-
06174300	Milk River tributary No. 3 near Glasgow	1974-
06174600	Snow Coulee at Opheim	1972-
06175700	East Fork Wolf Creek near Lustre	1955-

Table 2.--*Crest-stage partial-record stations in operation, October 1985*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06176950	Missouri River tributary No. 6 near Wolf Point	1973-
06177020	Tule Creek tributary near Wolf Point	1974-
06177050	East Fork Duck Creek near Brockway	1955-
06177700	Cow Creek tributary near Vida	1963-
06177720	West Fork Sullivan Creek near Richey	1972-
06177800	Wolf Creek tributary near Vida	1962-
06177820	Horse Creek tributary near Richey	1974-
06179100	Butte Creek tributary near Four Buttes	1972-
06183300	Spring Creek near Plentywood	1955-
06184200	Lost Creek tributary near Homestead	1972-
06185400	Missouri River tributary No. 5 at Culbertson	1963-
06201700	Hump Creek near Reed Point	1959-
06205100	Allen Creek near Park City	1961-
06207600	Jack Creek tributary near Belfry	1974-
06214150	Mills Creek at Rapelje	1974-
06216200	West Wets Creek near Billings	1955-
06217300	Twelvemile Creek near Shepherd	1973-
06217700	Crooked Creek tributary near Shepherd	1962-
06290200	Little Bighorn River tributary near Wyola	1973-
06293300	Long Otter Creek near Lodgegrass	1973-
06294400	Andresen Coulee near Custer	1963-
06294600	East Cabin Creek tributary near Hardin	1973-
06294930	Sarpy Creek tributary near Colstrip	1972-
06294985	East Fork Armells Creek tributary near Colstrip	1973-
06295020	Short Creek near Forsyth	1962-
06296115	Reservation Creek near Miles City	1973-
06306900	Spring Creek near Decker	1958-
06306950	South Fork Leaf Rock Creek near Kirby	1959-
06307520	Canyon Creek near Birney	1972-
06307700	Cow Creek near Fort Howes ranger station, near Otter	1972-
06307720	Brian Creek near Ashland	1973-
06307780	Stebbins Creek at mouth, near Ashland	1963-
06307930	Jack Creek near Volborg	1973-
06308100	Sixmile Creek tributary near Epsie	1972-
06308200	Basin Creek tributary near Volborg	1955-

Table 2.--*Crest-stage partial-record stations in operation, October 1985*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06308330	Deer Creek tributary near Volborg	1973-
06308340	La Grange Creek near Volborg	1973-
06309060	North Sunday Creek tributary No. 2 near Angela	1962-
06309078	Tree Coulee near Kinsey	1972-
06309080	Deep Creek near Kinsey	1962-
06324995	Badger Creek at Biddle	1972-
06325700	Powder River tributary near Powderville	1973-
06325950	Cut Coulee near Mizpah	1973-
06326510	Locate Creek tributary near Locate	1973-
06326550	Cherry Creek tributary near Terry	1973-
06326580	Lame Jones Creek tributary near Willard	1974-
06326800	Pennel Creek near Baker	1962-
06326940	Spring Creek tributary near Fallon	1972-
06326950	Yellowstone River tributary No. 5 near Marsh	1962-
06326960	Timber Fork Creek tributary near Lindsay	1974-
06327550	South Fork Horse Creek tributary near Wibaux	1973-
06327720	Griffith Creek tributary near Glendive	1965-
06327790	Krug Creek tributary No. 2 near Wibaux	1974-
06328100	Yellowstone River tributary No. 6 near Glendive	1974-
06328400	Thirteenmile Creek tributary near Bloomfield	1972-
06329350	Alkali Creek tributary near Sidney	1974-
06329510	Fox Creek tributary near Lambert	1972-
06329570	First Hay Creek near Sidney	1963-
06334100	Wolf Creek near Hammond	1955-
06334330	Little Missouri River tributary near Albion	1972-
06334610	Hawks Nest Creek tributary near Albion	1973-
06334625	Coal Creek near Mill Iron	1974-
06334720	Soda Creek tributary near Webster	1962-
	Part 12	
12300800	Deep Creek near Fortine	1959-
12301997	Richards Creek near Libby	1973-
12302400	Shaughnessy Creek near Libby	1959-
12303400	Ross Creek (head of Lake Creek) near Troy	1972-
12303440	Camp Creek near Troy	1972-

Table 2.--*Crest-stage partial-record stations in operation, October 1985*--Continued

Station number	Station name	Records available
	Part 12--Continued	
12304300	Cyclone Creek near Yaak	1960-
12323300	Smith Gulch near Silver Bow	1959-
12324250	Cottonwood Creek at Deer Lodge	1975-
12324700	Clark Fork tributary near Drummond	1958-
12331700	Edwards Gulch at Drummond	1959-
12338550	Dunham Creek at mouth, near Ovando	1978-
12338600	Monture Creek at Forest Service boundary, near Ovando	1964-
12339300	Deer Creek near Seeley Lake	1974-
12339900	West Twin Creek near Bonner	1959-
12342950	Trapper Creek near Conner	1974-
12345850	Sleeping Child Creek near Hamilton	1972-
12353400	Negro Gulch near Alberton	1959-
12355350	Big Creek at Big Creek ranger station, near Columbia Falls	1964-
12356500	Bear Creek near Essex	1946-
12369250	Holland Creek near Condon	1974-
12369650	North Fork Lost Creek near Swan Lake	1982-
12370500	Dayton Creek near Proctor	1959-
12391200	Canyon Creek near Trout Creek	1972-

Table 3.--*Surface-water-quality stations in operation, October 1985*

Station number

Stations are listed in downstream order by standard drainage basin number: art 5 (Hudson Bay basin), Part 6 (Missouri River basin) and Part 12 (upper Columbia iver basin). Each station number contains a 2-digit part number plus a 6-digit ownstream order number. The location of the stations is shown in figure 8.

Supported by

BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
DANC	Daniels County Conservation District
MBMG	Montana Bureau of Mines and Geology
MDFWP	Montana Department of Fish, Wildlife and Parks
MDHES	Montana Department of Health and Environmental Sciences
MGO	Montana Governor's Office
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WSE	Wyoming State Engineer
WWT	U.S. Department of State-International Joint Commission, Waterways Treaty

Sampling frequency

0	Once-daily, continuous
1	Once-daily, seasonal
3	Monthly
4	Bimonthly
5	Quarterly
6	Miscellaneous
7	Continuous record

Table 3.--*Surface-water-quality stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 5						
05020500	St. Mary River at international boundary	USGS	4	4	4	4	4
	Part 6						
06025500	Big Hole River near Melrose	MDFWP	-	-	7	-	-
06036905	Firehole River near West Yellowstone	NPS	-	-	7	-	7
06037000	Gibbon River near West Yellowstone	NPS	-	-	7	-	7
06037500	Madison River near West Yellowstone	NPS	-	-	7	-	7
06041000	Madison River below Ennis Lake, near McAllister	MDFWP	-	-	7	-	-
06054500	Missouri River at Toston	USGS	5	5	7	5	5
06058502	Missouri River below Canyon Ferry Dam, near Helena	USGS	3	-	0	-	0
06089000	Sun River near Vaughn	USGS	3	-	0	-	0
06090800	Missouri River at Fort Benton	USGS	4	4	4	4	4
06099000	Cut Bank Creek at Cut Bank	BIA	6	-	3	-	3
06101500	Marias River near Chester	USGS	4	4	4	4	4
06115200	Missouri River near Landusky	USGS, USAE	4	0	0	4	4
06130500	Musselshell River at Mosby	USGS, USAE	5	0	0	5	5
06132000	Missouri River below Fort Peck Dam	USGS, USAE	4	4	4	4	4
06133000	Milk River at western crossing of international boundary	WWT	6	-	6	-	6
06134000	North Milk River near international boundary	WWT	6	-	6	-	6
06135000	Milk River at eastern crossing of international boundary	WWT	6	-	6	-	6
06154410	Little Peoples Creek near Hays	USGS	5	5	5	5	5
06154500	Peoples Creek near Dodson	BIA	6	-	3	-	3
06164510	Milk River at Juneberg Bridge, near Saco	USGS	3	-	0	-	0
06164615	Little Warm Creek at reservation boundary, near Zortman	BIA	6	-	3	-	3

Table 3.--*Surface-water-quality stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 6--Continued						
06169500	Rock Creek below Horse Creek, near international boundary	USGS	5	5	5	5	5
06174500	Milk River at Nashua	USGS	4	4	4	4	4
06175000	Porcupine Creek at Nashua	BIA	6	-	3	-	3
06178000	Poplar River at international boundary	USGS	3	3	3	-	3
06178500	East Poplar River at international boundary	DANC	3	3	0	-	0
06179000	East Fork Poplar River near Scobey	DANC	3	3	3	-	3
06179200	Poplar River above West Fork, near Bredette	BIA	3	-	3	-	3
06180400	West Fork Poplar River near Bredette	BIA	5	-	5	-	5
06181995	Beaver Creek at international boundary	WWT	5	5	5	-	5
06183450	Big Muddy Creek near Antelope	USGS	3	3	3	-	3
06185110	Big Muddy Creek near mouth, near Culbertson	BIA	6	-	3	-	3
06185500	Missouri River near Culbertson	USGS	4	4	4	4	4
06188000	Lamar River near Tower Falls Ranger Station	MDHES	-	1	-	-	-
06191500	Yellowstone River at Corwin Springs	MDHES	-	1	-	-	-
06192500	Yellowstone River near Livingston	USGS, MDHES	4	1	4	4	4
06207500	Clarks Fork Yellowstone River near Belfry	WSE	5	-	5	-	5
06214500	Yellowstone River at Billings	USGS	5	5	5	5	5
06294700	Bighorn River at Bighorn	USGS	4	4	4	4	4
06294995	Armells Creek near Forsyth	BLM	6	6	6	-	6
06296003	Rosebud Creek at mouth, near Rosebud	BLM	4	4	4	-	4
06306300	Tongue River at State line, near Decker	BLM,	3	-	0	3	0
		WSE	5	-	5	-	5
06307500	Tongue River at Tongue River Dam, near Decker	BLM	3	3	0	-	0
06307570	Hanging Woman Creek below Horse Creek, near Birney	BLM	3	3	3	3	3
06307600	Hanging Woman Creek near Birney	BLM	5	5	5	-	5

Table 3.--*Surface-water-quality stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 6--Continued						
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	3	3	3	-	3
06308500	Tongue River at Miles City	USGS	5	0	0	5	5
06324500	Powder River at Moorhead	USGS	-	1	1	-	-
06324710	Powder River at Broadus	USGS	-	1	1	-	-
06326500	Powder River near Locate	USGS	4	4	4	4	4
06329200	Burns Creek near Savage	BLM	3	3	3	-	3
06329500	Yellowstone River near Sidney	USGS, USAE	4	0	0	4	4
	Part 12						
12300110	Lake Koocanusa at international boundary	USAE	3	-	3	-	3
12301830	Lake Koocanusa at Tenmile Creek, near Libby	USAE	3	-	3	3	3
12301919	Lake Koocanusa at Forebay, near Libby	USAE	3	-	3	-	3
12301933	Kootenai River below Libby Dam, near Libby	USAE	3	-	3	-	3
12324200	Clark Fork at Deer Lodge	MGO	3	0	0	-	3
12324590	Little Blackfoot River near Garrison	MGO	3	3	3	-	3
12331500	Flint Creek near Drummond	MGO	3	3	3	-	3
12334510	Rock Creek near Clinton	MGO	3	3	3	-	3
12334550	Clark Fork at Turah Bridge, near Bonner	MGO	3	0	0	-	3
12340000	Blackfoot River near Bonner	MGO	3	3	3	-	3
12353000	Clark Fork below Missoula	USGS	4	4	4	4	4
12353450	Fish Creek below West Fork, near Tarkio	MDFWP	-	-	7	-	-
12353650	Clark Fork near Superior	MDFWP	-	-	7	-	-
12354000	St. Regis River at St. Regis	MDFWP	-	-	7	-	-
12354700	Clark Fork near Paradise	MDFWP	-	-	7	-	-
12355000	Flathead River at Flathead, British Columbia	USGS, MDFWP, MBMG	5	0	7	5	5
12355500	North Fork Flathead River near Columbia Falls	MDFWP	-	-	7	-	-

Table 3.--*Surface-water-quality stations in operation, October 1985*--Continued

Station number	Station name	Supported by	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 12--Continued						
12362500	South Fork Flathead River near Columbia Falls	MDFWP	-	-	7	-	-
12363000	Flathead River at Columbia Falls	USGS, MDFWP	5	5	7	5	5
12377150	Mission Creek above reservoir, near St. Ignatius	BIA	4	4	4	-	4
12381400	South Fork Jocko River near Arlee	BIA	4	4	4	-	4
12388700	Flathead River at Perma	BIA	4	4	4	-	4

Table 4.--*Ground-water-level observation-well network, October 1985*

[The network is funded cooperatively with the U.S. Bureau of Land Management and the Montana Bureau of Mines and Geology]

Local number--based on Federal system of land subdivision. The first numeral and letter indicate the township; the second, the range; and the third, the section. The first letter following the section number denotes the 160-acre tract; the second, the 40-acre tract; the third, the 10-acre tract; and the fourth, the 2.5-acre tract. Letters are assigned in a counterclockwise direction, beginning with "A" in the northeast quadrant. The last two digits are a sequential number.

Site identification--15-digit identification number, based on latitude-longitude location.

Well depth--reported in feet below land surface.

Principal aquifer--the following codes were computer retrieved from the National Water Data Storage and Retrieval System (WATSTORE) and some may not follow current usage of the U.S. Geological Survey:

110ALVM - Alluvium, Quaternary
111ALVM - Alluvium, Holocene
111SPBK - Spoil banks
112ALVM - Alluvium, Pleistocene
112DRFT - Glacial drift
112GCLO - Glacial outwash
112GLCC - Glaciolacustrine deposits
112OTSH - Outwash
112TILL - Glacial till
112TRRC - Terrace deposits
120PLNC - Plutonic rocks
120SDMS - Sediments
120TRTR - Tertiary System
121FLXV - Flaxville Formation
125FRUN - Fort Union Formation
125LEBO - Lebo Shale Member of Fort Union Formation
125TGRV - Tongue River Member of Fort Union Formation
125TLCK - Tullock Member of Fort Union Formation
210CRCS - Cretaceous System
211EGLE - Eagle Sandstone
211FHHC - Fox Hills-lower Hell Creek aquifer
211FXHL - Fox Hills Sandstone
211HLCK - Hell Creek Formation
211JDRV - Judith River Formation of Montana Group
211PRKM - Parkman Sandstone of Montana Group
211TMDC - Two Medicine Formation of Montana Group
211VRGL - Virgelle Sandstone Member of Eagle Sandstone
217FCCK - First Cat Creek sandstone of Colorado Group
217FLOD - Flood Member of Blackleaf Formation
217KOTN - Kootenai Formation
217SCCK - Second Cat Creek sandstone of Kootenai Formation
217TCCK - Third Cat Creek sandstone of Kootenai Formation

221SWFT - Swift Formation of Ellis Group
331MDSN - Madison Group
331MSNC - Mission Canyon Limestone

Begin year water level--year water-level measurements began.

Measurement frequency--A, annual; C, continuous recorder; I, intermittent; M, monthly; Q, quarterly; S, semi-annual; Z, other.

Begin year chemical analysis--year well first sampled for chemical analysis.

Type of chemical analysis--B, common ions; C, trace elements.

Analyzing agency--DH, Montana Department of Health and Environmental Sciences, Helena, Montana; GS, U.S. Geological Survey, Denver, Colorado; MB, Montana Bureau of Mines and Geology, Butte, Montana; PL, Private laboratory.

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
37N27W21CBAB01	485721115073101	45	112GLCC	1973	A	--	-	--
37N27W24BABB01	485746115032601	230	112GCLO	1977	A	1976	B	MB
37N27W27ACCB01	485634115054401	320	112GLCC	1977	A	--	-	--
37N47E01ABBB01	485958105274901	53	112OTSH	1978	A	1978	B,C	GS
37N47E01ABBB02	485958105274801	83	125TGRV	1978	A	1978	B,C	GS
37N47E12BBBB01	485859105282801	147	125TGRV	1978	A	1978	B	MB
37N47E13AADD01	485754105271001	208	125TGRV	1978	A	1978	B	MB
37N47E13ADAA01	485753105271001	45	112OTSH	1978	A	--	-	--
37N47E17DABB02	485741105324202	266	125TGRV	1978	A	--	-	--
37N47E23AADD02	485704105282902	120	125TGRV	1978	A	1978	B	MB
37N48E05AAAA01	485956105243301	218	125FRUN	1976	A	--	-	--
37N48E05BABB01	485957105252901	43	112OTSH	1978	A	1978	B	MB
37N48E06AABA01	485959105255701	76.6	125TGRV	1982	-	1978	B	MB
37N48E23BBDC01	485703105214301	400	211FHHC	1978	A	1978	B	MB
36N28W01ADC 01	485448115090801	206	112TILL	1972	A	--	-	--
36N28W11AADB01	485411115101901	290	112GLCC	1971	A	--	-	--
36N27W05DCBC01	485428115065601	168	112GLCC	1966	A	--	-	--
36N09E05DBAD01	485420110345801	1015	211EGLE	1978	A	1978	B	GS
36N25E06CBCB01	485422108311001	75	121FLXV	1975	A	--	-	--
36N26E33DBD 01	485001108195501	67	121FLXV	1975	A	--	-	--
35N02E27AABD01	484603111270301	250	211EGLE	1979	A	--	-	--
35N24E09DBBC01	484825108354501	53	121FLXV	1976	A	--	-	--
35N33E19DBA 01	484600107271001	246	211JDRV	1978	A	1978	B	MB
34N24E06DCCC01	484342108382801	200	211FXHL	1975	A	--	-	--
33N06W12AAA 02	483812112191202	400	211VRGL	1965	A	--	-	--
33N06W12AAA 03	483812112191203	250	211TMDC	1965	A	--	-	--
33N48E18DCB 01	483633104290101	325	211HLCK	1979	A	--	-	--
32N11W03DAD 01	483345113004501	12.1	112DRFT	1968	A	--	-	--
32N15E17DDDC01	483138109481001	180	110ALVM	1947	A	1947	B	--
31N31W33CCBB01	482408115344701	40	110ALVM	1972	C	--	-	--
31N14E03CDDC01	482804109535301	215	211JDRV	1978	A	1978	B	MB
31N24E06BCC 01	482823108401101	69.7	111ALVM	1960	A	--	-	--
30N33W05ABAB01	482357115503801	187	112GLCC	1980	A	1980	B,C	MB
30N33W05ABAB02	482357115503802	17.5	110ALVM	1980	A	1980	B,C	MB
30N33W30DAAD01	481958115513601	42.7	112GLCC	1980	A	1980	B,C	MB

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
30N33W30DAAD02	481958115513602	22.7	112GLCC	1980	A	1980	B,C	MB
30N05W33DDB 01	481839112151501	122	211VRGL	1968	A	--	-	--
30N38E09CADB01	482211106473201	195	211JDRV	1969	A	1978	B	MB
29N22W14BBDD01	481652114220501	220	112GLCC	1964	A	--	-	--
29N22W28ACCC01	481458114240901	200	112GLCC	1965	A	--	-	--
29N22W36BCBD01	481407114205601	452	112GLCC	1976	A	--	-	--
29N21W20CCCC01	481519114182501	278	112GLCC	1963	A	--	-	--
29N13E21AABA02	481542110023501	210	112ALVM	1947	A	--	-	--
27N56E34AABC01	480315104275001	118	125TGRV	1980	A	--	-	--
26N20E36ADCC01	475758109051101	1470	211EGLE	1978	A	--	-	--
26N49E13ACAB01	480034105195401	180	211FHHC	1982	A	--	-	--
26N54E17DCAA01	480005104460401	240	125TGRV	1982	A	--	-	--
26N59E22DBDD01	475914104044501	212	125TGRV	1980	A	1980	B,C	MB,GS
25N47E04DAAB01	475652105385701	200	211FHHC	1982	A	--	-	--
25N50E24CBDA01	475408105123901	220	125LEBO	1982	A	--	-	--
24N23W21BCDA01	474940114332901	250	112TILL	1975	A	--	-	--
24N44E20CABD01	474929106061401	300	211FHHC	1982	A	--	-	--
24N47E35BBBA01	474815105393601	101	125LEBO	1980	A	1980	B	GS
24N47E35BBBC01	474812105393501	640	211FHHC	1984	A	1985	B	MB
24N54E29CACB01	474827104492100	190	125TGRV	1975	A	--	-	--
24N56E25DDAC01	474822104280301	60	125TGRV	1980	A	1980	B	MB
23N24W27CDDD01	474305114392801	184	112ALVM	1967	A	--	-	--
23N24W34ADAA01	474251114385201	377	110ALVM	1943	C	--	-	--
23N43E34BABC01	474258106112901	175	211FHHC	1978	A	--	-	--
23N51E20BBBD01	474448105124200	175	125FRUN	1975	A	--	-	--
22N46E17BCBB01	474011105511701	168	125TGRV	1978	A	--	-	--
22N52E28B 01	473829105032401	1151	125FRUN	1983	A	1975	B	--
22N58E10CCCC01	474027104160801	135	125FRUN	1976	A	--	-	--
22N59E14BABD01	474023104064501	1345	211FHHC	1977	A	1980	B	GS
21N20W24CAAA02	473355114061302	290	112TILL	1974	A	1975	B	MB
21N23E13CBBB01	473456108430601	1630	211EGLE	1980	A	1980	B	MB
21N51E10ABCD01	473602105090500	131	125TGRV	1975	A	--	-	--
21N53E08ADCC01	473542104562701	70	125TGRV	1975	A	1976	B	GS
21N56E28ADDC01	473306104315001	220	125TGRV	1978	A	--	-	--
20N22W30DADD01	472740114260901	155	110ALVM	1969	A	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
20N20W26CCBD01	472733114065601	200	112GLCC	1967	A	--	-	--
20N02E01AABA01	473124111244501	605	331MDSN	1979	A	1979	B	--
20N03E28CCCD01	472703111220201	85	217FLOD	1973	A	--	-	--
20N03E32ADDC01	472636111221801	215	217FLOD	1973	A	--	-	--
20N47E36ADDD01	472700105394501	220	125TGRV	1976	A	1976	B	GS
20N52E17BBBB01	472959105074601	180	125TGRV	1982	A	--	-	--
20N53E04DAAA01	473117104573601	280	125TGRV	1981	A	1981	B,C	MB
20N53E22BCCC01	472843104573201	240	125TGRV	1981	A	1981	B,C	MB
20N54E01DCDD01	473052104463001	220	125TGRV	1975	A	1976	B	GS
20N55E32AAAA01	472721104433401	200	125TGRV	1981	A	1981	B,C	MB
20N55E32AAAA02	472721104433402	112	125TGRV	1981	A	1981	B,C	MB
19N20W35AAA 01	472211114054801	54	112GLCC	1967	A	--	-	--
19N03E01AABA01	472606111171201	65	217KOTN	1979	A	--	-	--
19N06E23BADA01	472403110553701	75	221SWFT	1979	A	--	-	--
19N06E26ACAD01	472303110552101	435	331MDSN	1982	A	--	-	--
19N44E35DDDD01	472118106135001	140	125TGRV	1981	A	1981	B,C	MB
19N53E24CCDC01	472302104544801	220	125TGRV	1981	A	1981	B,C	MB
18N20W14DBDC01	471900114061001	30	112TILL	1974	A	--	-	--
18N30E19BBBA01	471850107562601	1003	211JDRV	1978	A	1978	B	MB
18N38E20BBAB01	471837106544001	518	211HLCK	1983	A	--	-	--
18N40E01DBBB01	472046106334601	159	125FRUN	1965	A	1965	-	--
18N44E13AAAC01	471925106023501	278	125FRUN	1976	A	1976	C	GS
18N50E16CBBB01	471906105214701	161	125LEBO	1982	A	--	-	--
18N56E25ADBA02	471734104310002	600	211FXHL	1977	A	1977	B	GS
17N47E16DDDD01	471329105432801	242	125TGRV	1981	A	--	-	--
17N53E01CBAD01	471536104544401	133	125FRUN	1977	A	--	-	--
16N17E25DCAD01	470659109302901	260	217FCCK	1980	A	1980	B	MB
16N22E05DDB 01	470230108570301	1431	217SCCK	1979	A	--	-	--
16N44E25BBAA01	470711106061401	263	125TGRV	1980	A	--	-	--
16N44E25BBAB01	470711106051501	1460	211FHHC	1980	A	--	-	--
16N44E25BBAC01	470709106061401	103	125TGRV	1983	A	--	-	--
16N50E06DDCD01	470958105260401	380	125TGRV	1981	A	--	-	--
16N51E36DCCC01	470535105122201	202	125TLCK	1981	A	--	-	--
15N12W36BCDD01	470049113035401	206	112DRFT	1975	A	--	-	--
15N07W28ABB 01	470146112291201	130	120PLNC	1970	A	1970	B	MB

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
15N12E02BBBA01	470552110102901	1165	221SWFT	1980	A	1980	B	MB
15N19E09BABC01	470459109193501	90	217TCCK	1980	A	1980	B,C	MB
15N46E04BBBC01	470531105545901	160	125TGRV	1982	A	--	-	--
15N55E12ABDC01	470432104414001	675	211FHHC	1977	A	--	-	--
14N21W25BCA 01	465642114121401	50	110ALVM	1971	A	--	-	--
14N49E21AAAA01	465745105305501	440	125TLCK	1981	A	--	-	--
13N19W29DADD01	465110114010601	84.4	110ALVM	1958	A	--	-	--
13N51E31BCDD01	465024105190701	565	211HLCK	1979	A	--	-	--
13N51E31BCDD02	465026105190701	340	125TLCK	1979	A	1979	B,C	MB
13N51E31BDCB01	465026105190401	860	211FHHC	1979	A	1979	B,C	MB
13N53E18ABAA01	465326105031701	62	125TGRV	1980	A	--	-	--
13N56E30CCBC01	465258104411701	100	211FHHC	1962	A	--	-	--
13N59E13BCBB01	465305104115501	960	211FHHC	1979	A	--	-	--
12N14E07CDDA01	464837110003001	468	217TCCK	1980	A	1980	B,C	MB
12N55E20DCCD01	464627104492801	1185	211FHHC	1962	A	1962	B	PL
12N55E25CDCC01	464535104444401	1275	211FHHC	1964	A	--	-	--
12N55E27BADD01	464605104470501	1000	211FHHC	1962	A	--	-	--
12N56E23CCDA01	464626104384301	1449	211FHHC	1981	A	--	-	--
12N56E23DCCA01	464624104380601	1195	211FHHC	1962	A	--	-	--
12N56E24CABD01	464639104370801	145	211FXHL	1962	A	--	-	--
12N56E25CBDB01	464547104372701	1480	211FHHC	1962	A	--	-	--
12N56E34DAAC01	464457104390001	1467	211FHHC	1962	A	--	-	--
11N03W22BBCB01	464208111583701	194	110ALVM	1979	A	--	-	--
11N03W30BBBC01	464118112022501	127	110ALVM	1979	A	--	-	--
11N03W30DADA01	464009112011601	44	110ALVM	1979	A	1978	B	MB
11N36E28BACD01	464055107121101	2745	217TCCK	1978	A	1978	B	MB
11N54E29CACD01	464025104572901	800	211FHHC	1976	A	--	-	--
11N57E21CDBB01	464127104334003	1230	211FHHC	1957	A	1957	B	PL
11N57E32BBBD01	464010104345601	980	211FHHC	1963	A	1970	B	PL
10N07W30BBC 01	463540112320301	69.6	120TRTR	1961	A	--	-	--
10N04W02CBAA01	463906112043901	110	210CRCS	1976	M	--	-	--
10N04W10DDDA01	463754112050601	22.8	110ALVM	1978	A	1979	B	MB
10N03W03BACB01	463931111581801	64.8	110ALVM	1978	A	1979	B	MB
10N03W08BBAA01	463844112005701	23	110ALVM	1978	A	1978	B	MB
10N03W09ACCC01	463823111591801	64.5	110ALVM	1978	A	1978	B	MB

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
10N03W11DDCC01	463754111562201	39.6	110ALVM	1978	A	1979	B	MB
10N03W17ACAD01	463735112001701	28.2	110ALVM	1978	A	1978	B	MB
10N03W22AAAA01	463700111572501	23.3	--	1978	A	1979	B	MB
10N02W18DDCD01	463707111534701	70	120SDMS	1981	A	1981	B,C	MB
10N36E06CACA01	463847107144001	195	211JDRV	1978	A	--	-	--
10N45E28BBBA01	463602106044601	951	211FHHC	1979	A	1980	B	MB
10N45E28BBBA02	463559106044501	362	125TLCK	1979	A	--	-	--
10N45E28BBBB01	463602106044801	762	211HLCK	1980	A	1980	B	MB
10N55E25CDCD01	464530104444001	1150	211FHHC	1962	A	--	-	--
10N58E19ABBA01	463650104280601	166	211FHHC	1962	A	--	-	--
08N20W19BAAD03	462631114084603	52	120TRTR	1957	A	--	-	--
08N19W07CBBD01	462748114014101	117	120SDMS	1956	A	--	-	--
08N31E36DDDD01	462343107465501	1175	211FHHC	1980	A	1981	B	MB
08N31E36DDDD02	462343107465502	850	211HLCK	1980	A	1981	B	MB
08N31E36DDDD03	462343107465503	486	--	1980	A	1981	B	MB
08N50E18BDBC01	462704105311801	280	125TLCK	1976	A	--	-	--
08N59E16BCAB01	462705104213601	250	211FHHC	1962	A	--	-	--
07N09W08ADD 01	462239112444401	12.7	112ALVM	1957	A	--	-	--
07N47E24AAD 01	462120105470001	50.1	125FRUN	1947	A	--	-	--
07N50E05CCBD01	462250105303001	700	211FHHC	1965	A	--	-	--
07N57E24BBCB01	462057104325501	362	125TGRV	1977	A	--	-	--
06N20W19CCCC02	461518114090802	40	110ALVM	1970	C	--	-	--
06N10W27CCCC01	461420112504501	88.7	120SDMS	1960	Z	--	-	--
06N09W21CDBC01	461515112441201	150	120SDMS	1980	A	--	-	--
06N44E36CACD01	461341106100301	902	211FXHL	1980	A	1981	B	MB
06N44E36CACD02	461341106100302	609	211HLCK	1980	A	1981	B	MB
06N44E36CACD03	461341106100303	316	211HLCK	1981	A	1981	B	MB
05N01E27CCBB01	460915111354501	215	120SDMS	1977	A	--	-	--
05N25E16CCCC01	461035108364401	1350	211FXHL	1980	A	1981	B	MB
05N25E16CCCC02	461035108364402	427	211HLCK	1980	A	1981	B	MB
05N33E32DABC01	460825107365801	102	211FHHC	1980	A	--	-	--
05N55E23AADB01	461041104470001	1080	211FHHC	1977	A	1977	B	GS
05N58E14BBBB01	461120104253501	360	125TGRV	1977	A	--	-	--
04N10W10DC 02	460632112493502	20	111ALVM	1960	Z	--	-	--
04N01E02BBCC01	460801111343601	191	120SDMS	1977	A	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
04N01E10BBCB01	460712111354901	447	120SDMS	1977	S	--	-	--
04N01E13BCAC01	460615111330901	209	120SDMS	1977	A	--	-	--
04N01E15BCBB01	460612111355001	348	120SDMS	1977	A	--	-	--
04N23E14ABBA01	460612108494201	80	211FHHC	1980	A	1980	B	GS
04N23E16BCCC01	460547108525901	1100	211EGLE	1980	A	1980	B	GS
04N40E31DCAA01	460311106475601	199	211HLCK	1976	A	1976	B	MB
02N26E21CDAD01	455407108301301	240	211JDRV	1978	A	1978	B	MB
02N27E35DBAB01	455209108193601	5070	331MSNC	1983	A	1978	B,C	GS
02N40E31DCCD01	455236106473901	165	125TGRV	1972	A	1972	B,C	MB,GS
02N43E24CCBC01	455424106200801	60.5	110ALVM	1979	A	1979	B,C	GS
02N43E24CDDA01	455419106193701	20.8	110ALVM	1979	A	--	-	--
01N04E25DCD 01	454809111095401	101	110ALVM	1951	A	--	-	--
01N25E36CBDA01	454721108335001	12.5	110ALVM	1966	A	--	-	--
01N25E36CDDD01	454705108333101	17.2	110ALVM	1978	A	--	-	--
01N26E10ABBA01	455122108280201	193	211EGLE	1978	A	1978	B	MB
01N41E21DBDB01	454921106380601	131	125TGRV	1981	A	1981	B,C	MB
01N41E22CCAD01	454914106372401	72	111SPBK	1981	A	1981	B,C	MB
01N41E26BCAB01	454848106361600	195	125TGRV	1973	A	1976	B	MB
01N41E36DCBA01	454732106342801	150	125TGRV	1980	A	--	-	--
01N54E18DDAC01	455001105024301	8422	331MSNC	1977	A	1977	B,C	GS
01N54E18DDBA01	455004105024302	400	211FHHC	1977	A	--	-	--
01S25E05CD 01	454611108400901	62	110ALVM	1968	A	--	-	--
01S25E17AAAA01	454518108393201	42	110ALVM	1968	A	--	-	--
01S26E08DABA01	454532108324301	24	110ALVM	1968	A	--	-	--
01S33E19DAA 01	454350107410001	25.1	112TRRC	1957	S	1935	B	DH
01S33E24BCBC02	454401107360302	26	110ALVM	1960	S	--	-	--
02S23E16DADD01	453923108530301	63	110ALVM	1968	A	--	-	--
02S41E19DABA01	453904106424400	43	110ALVM	1968	A	--	-	--
02S44E35DAAB01	453709106152101	84	110ALVM	1979	Q	1979	B,C	GS
02S49E22DCCA01	453832105393901	118	125TGRV	1976	I	--	-	--
02S49E22DCCA04	453832105393904	118	125TGRV	1977	A	--	-	--
03S15W16DCCD01	453404113272601	205	120SDMS	1982	A	--	-	--
03S33E09DCC 01	453441107385501	74	112TRRC	1966	Z	--	-	--
03S33E16BBBB01	453419107393701	19	110ALVM	1965	Z	--	-	--
03S33E16BBBB02	453419107393702	45.8	110ALVM	1965	Z	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
03S35E18DABD01	453413107260201	400	211PRKM	1977	A	1977	B	MB
03S44E09ADD 01	453527106174801	84	110ALVM	1968	A	1968	B	GS
03S45E05DBAA01	453608106114901	148	125TGRV	1979	Q	1979	B	MB
03S46E17ADBC01	453426106040401	145	125TGRV	1965	A	--	-	--
04S06W16AAAA02	452942112202002	57.5	120SDMS	1965	A	--	-	--
04S06W35BBBB01	452703112190301	170	120SDMS	1963	A	--	-	--
04S32E35AAAA01	452647107431501	38.9	110ALVM	1965	Z	--	-	--
04S45E04BDDB01	453107106110601	68	110ALVM	1979	C	1980	B,C	MB
04S45E28BDDD01	452738106110801	269	125TGRV	1977	I	1977	B,C	MB
05S07W23ABA 01	452334112254301	20	120SDMS	1964	A	--	-	--
05S06W10BCCA01	452459112201201	200	120SDMS	1965	A	--	-	--
05S45E04ABCC01	452606106110101	223	125TGRV	1977	A	1977	B,C	GS
05S45E16ADDD01	452409106102801	320	125TGRV	1983	A	--	-	--
05S45E23ABCB01	452333106083501	41.4	110ALVM	1979	A	1980	B,C	MB
05S45E23BBAA01	452341106085801	169	125TGRV	1979	A	1980	B,C	MB
05S45E23BBAA02	452341106085802	106	125TGRV	1979	A	1980	B,C	MB
05S45E23BBAA03	452341106085803	65.1	125TGRV	1979	A	1980	B,C	MB
05S51E10ABAB01	452501105243001	1010	211FHHC	1975	A	--	-	--
06S08W26CCCA02	451641112332802	51	120SDMS	1965	A	--	-	--
06S08W27DAA 01	451658112333601	23.9	110ALVM	1965	A	--	-	--
06S07W06AAA 01	452052112295801	107	120SDMS	1964	A	--	-	--
06S39E26AABB01	451752106550201	130	125TGRV	1977	A	--	-	--
06S41E08CCAC01	451930106443801	128	125TGRV	1976	A	1978	B	GS
06S41E17ADDD01	451857106433301	19.1	110ALVM	1979	A	1979	B	MB
06S41E25CDAC01	451653106392401	144	125TGRV	1978	A	1978	B,C	GS
06S41E26BBDD01	451728106405101	23.3	110ALVM	1978	A	1978	B	MB
06S41E29ADCA01	451717106434601	393	125TGRV	1978	A	1978	B,C	GS
06S41E29ADCA02	451717106434602	322	125TGRV	1978	A	1978	B,C	GS
06S41E34CDAA01	451604106414701	364	125TGRV	1978	A	1978	B,C	GS
06S41E34CDAA02	451604106414702	155	125TGRV	1979	A	1979	B,C	MB
06S42E31DBBA01	451617106375201	67.8	110ALVM	1979	A	1979	B	GS
07S08W03BDC 02	451521112341902	40.5	110ALVM	1965	Z	--	-	--
07S08W17DDC 02	451307112361001	50	120SDMS	1965	Z	--	-	--
07S44E34BAAD01	451137106194901	86	125TGRV	1975	A	1975	B	GS
07S44E34BAAD02	451137106194902	272	125TGRV	1975	A	1975	C	GS

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
07S44E35DCCA01	451051106182901	213	125TGRV	1981	A	1983	B	MB
07S44E35DCCA02	451051106182902	132	125TGRV	1981	A	1982	B	GS
07S45E32CADD01	451102106145801	207	125TGRV	1981	A	1982	B	GS
07S45E32CADD02	451102106145802	42.1	125TGRV	1981	A	1982	B	GS
07S45E32DCBA02	451058106145201	17.8	110ALVM	1980	A	1982	B	GS
07S49E13ABBB01	451602105394801	--	211FHHC	1975	A	--	-	--
07S49E28DAAC01	451143105425801	452	125TLCK	1979	A	--	-	--
071/2S40E32DBDA	451027106511801	120	125TGRV	1976	A	--	-	--
08S09W01CCCC01	450937112393701	47	120SDMS	1966	A	--	-	--
08S40E26ACBC01	450622106473801	172	125TGRV	1981	A	--	-	--
08S42E06ADBA01	451020106374201	398	125TGRV	1976	A	--	-	--
08S43E20DABA01	450714106285001	222	125TGRV	1974	A	1974	B	MB
08S43E21BBDD03	450752106283002	12.9	110ALVM	1980	A	1981	B	MB
08S43E21BDBB01	450747106282901	223	125TGRV	1981	A	1981	B	MB
08S43E21BDBB02	450747106282902	146	125TGRV	1981	A	1981	B	MB
08S43E23CACA03	450729106255302	28.9	110ALVM	1980	A	1980	B,C	MB
08S43E23CDAA01	450721106254401	78	125TGRV	1981	A	1981	B	MB
08S43E23CDAA02	450721106254402	329	125TGRV	1981	A	1981	B	MB
08S43E31BBDA01	450609106310001	131	125TGRV	1981	A	1981	B,C	MB
08S43E31BBDA02	450609106310002	257	125TGRV	1981	A	1981	B,C	MB
08S44E02BACD01	451016106174901	14.7	110ALVM	1980	A	1980	B,C	MB
08S44E03CBBD01	450947106191601	201	125TGRV	1975	A	1982	B	GS
08S44E03CBBD02	450947106191602	129	125TGRV	1975	A	1982	B	GS
08S44E09DABB01	450906106194501	27.9	110ALVM	1980	A	1980	B,C	MB
08S44E12ACDC01	450909106161301	351	125TGRV	1981	A	1983	B	MB
08S44E12ACDC02	450909106161302	252	125TGRV	1981	A	1982	B	GS
08S44E12ADBC02	450915106160202	13.9	110ALVM	1980	A	1982	B	MB
08S44E14ABAB02	450839106172802	250	125TGRV	1981	A	1982	B	GS
08S44E14ABAB03	450839106172803	161	125TGRV	1981	A	1982	B	GS
08S44E19CBBB01	450723106231301	190	125TGRV	1975	A	1982	B	MB
08S44E19CBBB02	450723106231302	130	125TGRV	1975	A	1982	B	MB
08S44E19CBCB02	450717106232801	35.9	110ALVM	1980	A	1982	B	MB
08S45E16DBCB01	450806106124401	188	125TGRV	1975	A	1975	B	GS
08S45E16DBCB02	450806106124402	66	125TGRV	1975	A	1975	B	GS
08S45E34BCBC01	450548106120301	253	125TGRV	1975	A	1975	B	GS

Table 4.--*Ground-water-level observation-well network, October 1985*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
09S39E01BCBA01	450439106542301	465	125TGRV	1981	A	1981	B,C	MB
09S42E01BCAD02	450507106321501	33.6	110ALVM	1980	A	1980	B	MB
09S42E11BDAA01	450417106330901	222	125TGRV	1975	A	1980	B,C	MB
09S43E04ABDD02	450512106275602	26.4	110ALVM	1980	A	1980	B,C	MB
09S43E04CBAB01	450458106283501	186	125TGRV	1980	A	1980	B,C	MB
09S43E07CADB01	450438106301301	165	125TGRV	1979	A	1980	B,C	MB
09S43E07CADB02	450359106304402	218	125TGRV	1981	A	1981	B,C	MB
09S43E21BADA01	450240106281101	229	125TGRV	1975	A	--	-	--
09S43E21BADA02	450240106281102	135	125TGRV	1975	A	--	-	--
09S44E07ADDC01	450357106220401	200	125TGRV	1977	A	1977	B,C	GS
09S44E07BBCC03	450411106231703	92	125TGRV	1977	A	--	-	--
09S44E08BBAA01	450415106214001	180	125TGRV	1976	A	--	-	--
09S44E08BBAA02	450415106214002	110	125TGRV	1976	A	1977	B,C	MB
09S45E03DABB03	450447106111103	62.6	125TGRV	1976	A	--	-	--
09S45E11ADDB01	450400106094801	307	125TGRV	1975	A	1976	B	MB
09S45E11CCAA01	450343106103701	218	125TGRV	1976	A	--	-	--
09S46E08BACB01	450413106065701	240	125TGRV	1983	A	1975	B	GS
09S46E09DABA01	450357106050201	110	125TGRV	1983	A	1975	B	GS
09S51E21DBBB01	450208105282601	175	125TGRV	1976	A	1976	B	MB

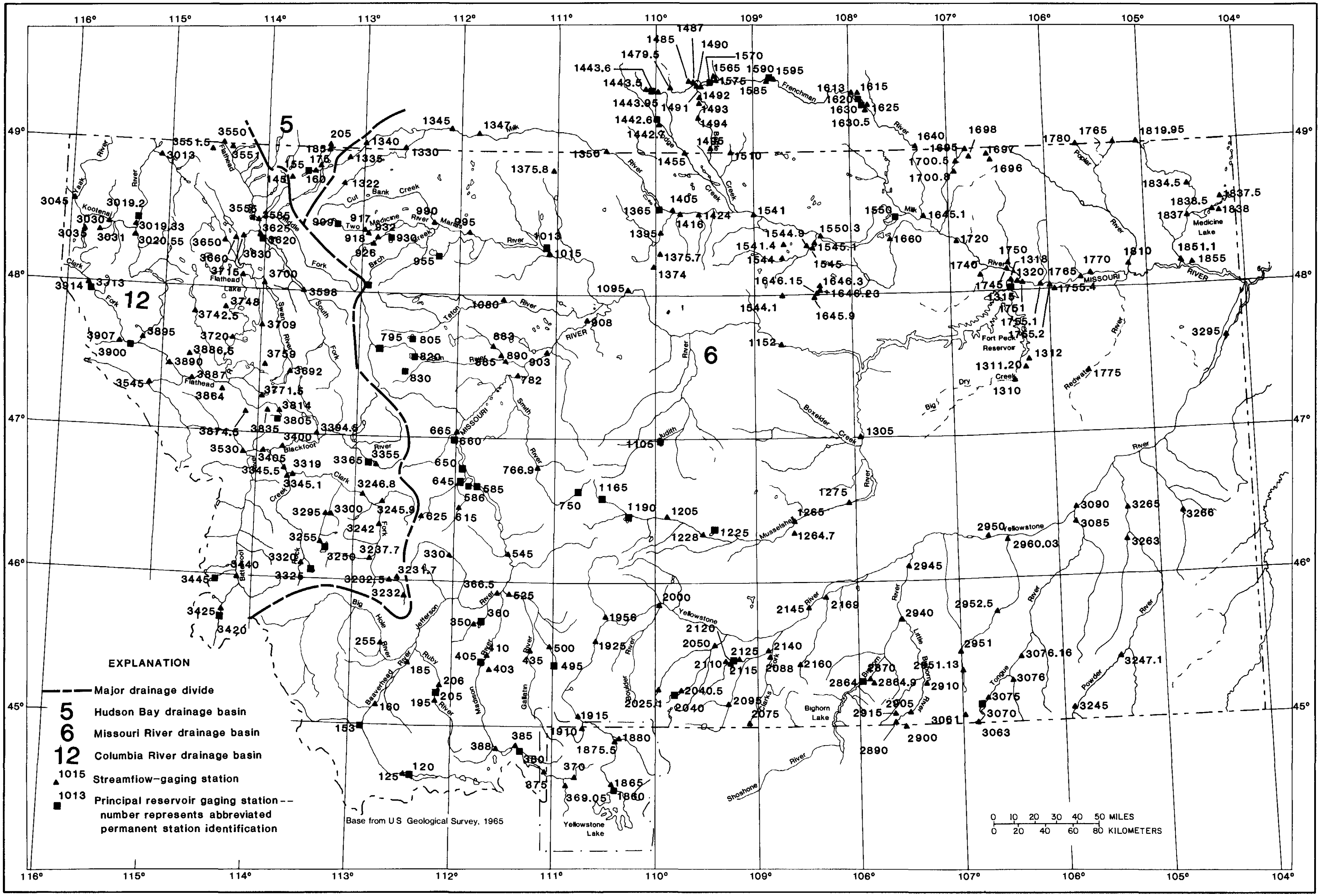

Figure 6.--Location of active surface-water gaging stations, October 1985.

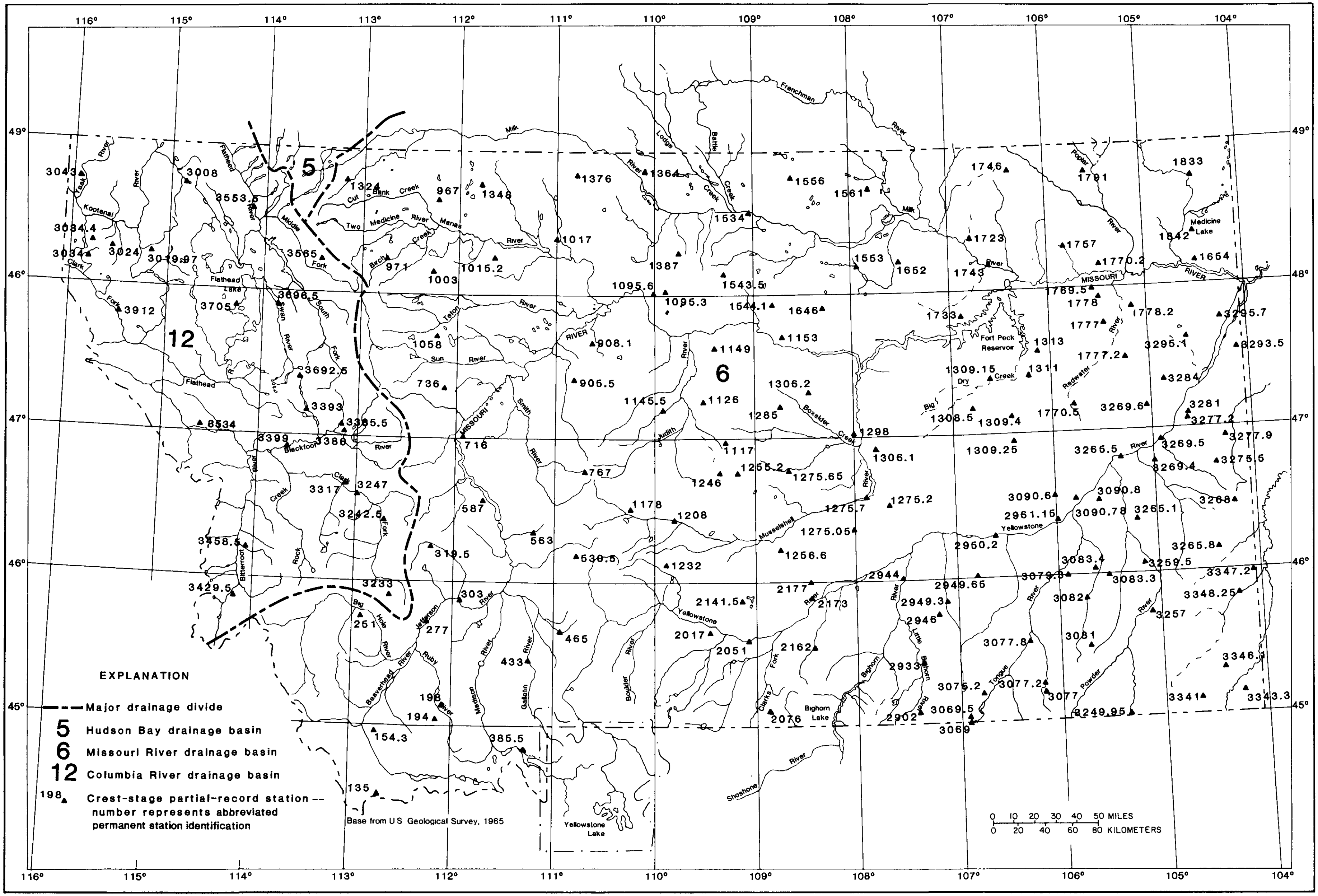

Figure 7.--Location of active crest-stage partial-record stations, October 1985.

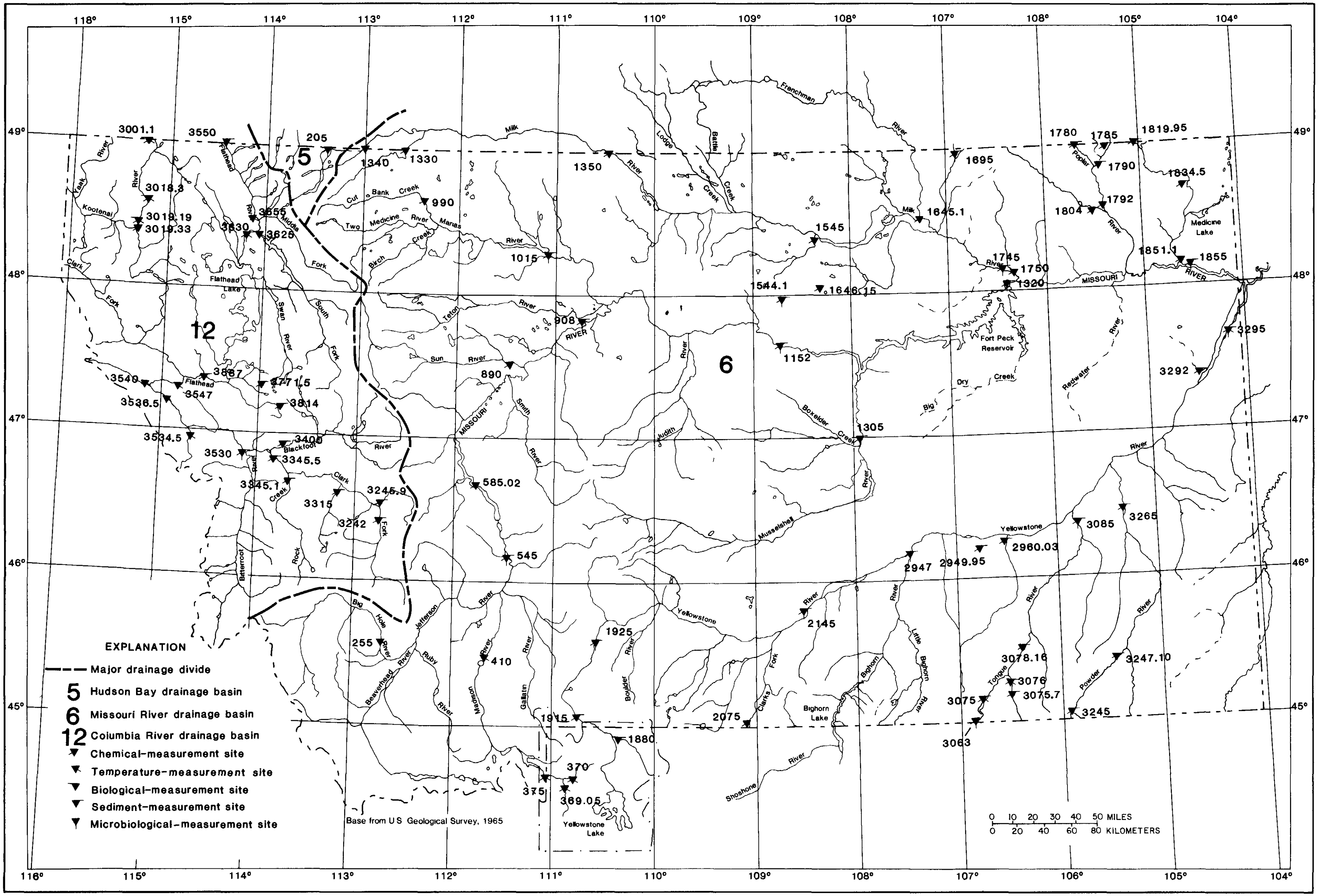

Figure 8.--Location of active surface-water-quality stations, October 1985.

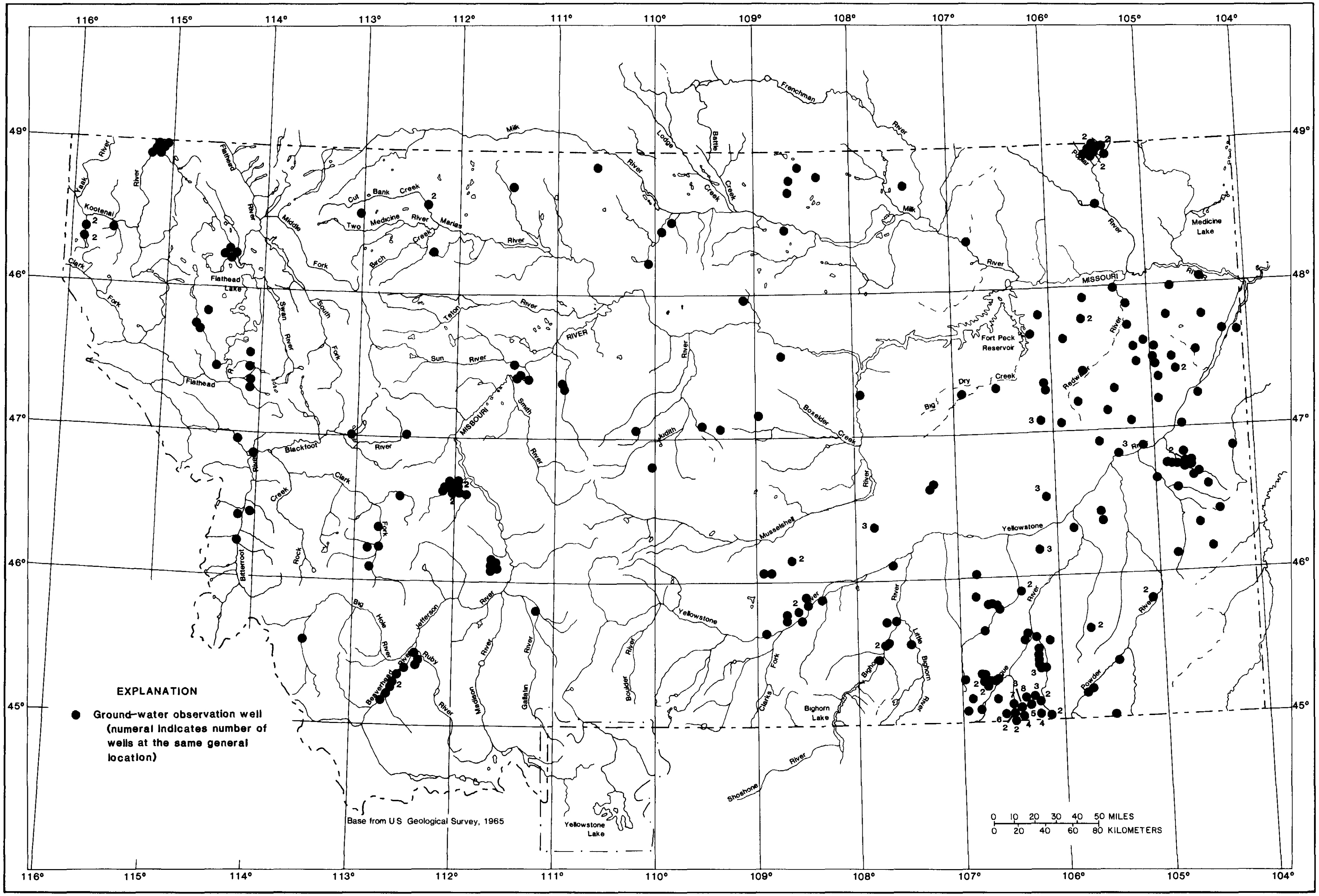

Figure 9.--Location of ground-water-level observation wells, October 1985.