WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1993 THROUGH SEPTEMBER 1995

Compiled by C.J. Harksen and Karen S. Midtlyng

U.S. GEOLOGICAL SURVEY
Open-File Report 95-194

Prepared in cooperation with
FEDERAL, STATE, AND LOCAL AGENCIES

Helena, Montana
April 1995

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

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CONVERSION FACTORS

Multiply	By	To obtain
acre	4,047	square meter
cubic foot per second	0.028317	cubic meter per second
foot	0.3048	meter
inch	25.4	millimeter
mile	1.609	kilometer
million gallons per day	3,785	cubic meter per day

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 more than 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 gaging 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, and information products; projects are identified by title, location, period of activity, project chief, and funding source. Additional information about specific projects can be obtained by contacting me or the project chief directly (phone 406-449-5263).

During the past few years, Montana has experienced an extreme drought that has greatly impacted the hydrologic programs of the U.S. Geological Survey. The need for real-time data from gaging stations for operational purposes by water-management agencies has been unprecedented. Numerous gaging stations have been equipped with instruments to transmit data to earth-orbiting satellites to allow data collection in near-real-time. The information from these stations has been invaluable to water users and water managers during the prolonged drought.

Interest in ground-water resources has emerged as a priority hydrologic issue in Montana. The severe drought has focused attention on ground water as an alternative source of water for municipal, industrial, domestic, and agricultural supplies. In many areas, the drought has caused water levels to decline in shallow aquifers. Ground-water-quality concerns have also received considerable attention. Leaky underground storage tanks, agricultural chemicals, municipal landfills, mining activities, oil and gas developments, and hazardous-waste sites all can contribute to ground-water contamination, and several studies have been or are being conducted by the U.S. Geological Survey and others to determine the extent of contamination at numerous sites.

The next few years will see substantial change in the field of water-resources investigations as the public becomes more concerned about the availability of water and about hazardous wastes and toxic substances in the environment. 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. We will be challenged to develop and use more sophisticated sampling and analytical techniques to measure chemicals in trace quantities in both ground and surface water.

These issues and others will demand attention despite the severe budget constraints imposed by declining State revenues and despite the 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 and investigative studies that address water-resource issues. 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.

The Montana District of the Geological Survey's Water Resources Division conducts its hydrologic work through a District Office in Helena and Field Headquarters in Helena, Billings, Fort Peck, and Kalispell. Thirty-two projects are currently being conducted. As outlined in this report, these projects are operated under the general categories of data-collection programs and investigative studies.

This report describes the projects funded for fiscal years 1994 and 1995. The report also describes the operations of the Montana District, general hydrology of the State, activities in addition to regular programs, and sources of publications and information. It also lists reports published or released during the preceding 5 years.

BASIC MISSION AND PROGRAMS OF THE 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 products of national domain." An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, plan the use of, and manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the U.S. 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 in the Nation. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of 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 land and offshore areas.
- Conducting topographic surveys 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.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the U.S. 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."

MISSION OF THE 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 water.
- Providing scientific and technical assistance in hydrologic fields to other Federal, State and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.

DISTRICT OPERATIONS

The Montana District conducts its hydrologic work through a District Office in Helena and Field Headquarters in Helena, Billings, Fort Peck, and Kalispell (fig. 1). The District currently employs 57 people (51 full-time, 3 part-time, 2 temporary, and 1 student) to work on 32 projects. The principal functions of the District are to investigate the occurrence, quantity, quality, distribution, and movement of surface and ground water in Montana.

Hydrologic data-collection programs and investigative studies in Montana are conducted by three operating sections (fig. 2) and four support units. The operating sections are responsible for the implementation and execution of District projects. The support units provide services and advice to the Office of the District Chief and the operating sections.

Operating Sections

The Hydrologic Surveillance and Analysis Section designs, constructs, operates, and maintains hydrologic-data networks in the State. It also manages the compilation and analysis of hydrologic data, reviews and processes data for publication, prepares water-resources data for the annual water-data report, and provides quality assurance in the collection and processing of hydrologic data.

The International Waters Section apportions the water of the St. Mary and Milk Rivers in cooperation with the Water Survey of Canada as directed by the Boundary Waters Treaty of 1909 and the International Joint Commission Order of 1921. This apportionment involves the operation of 36 streamflow-gaging stations and 7 reservoir-gaging stations; computation of streamflows, reservoir contents, and natural flows; and dissemination of information to ensure the delivery of water entitlements to the United States and Canada.

The Hydrologic Investigations Section plans, conducts, and reports on multidiscipline water-resources projects. These investigations involve general geohydrology, ground-water hydraulics, and mathematical modeling of aquifer systems; hydraulic effects of manmade structures; magnitude and frequency of floods and droughts; assessment of surface-water availability and water use; and assesment

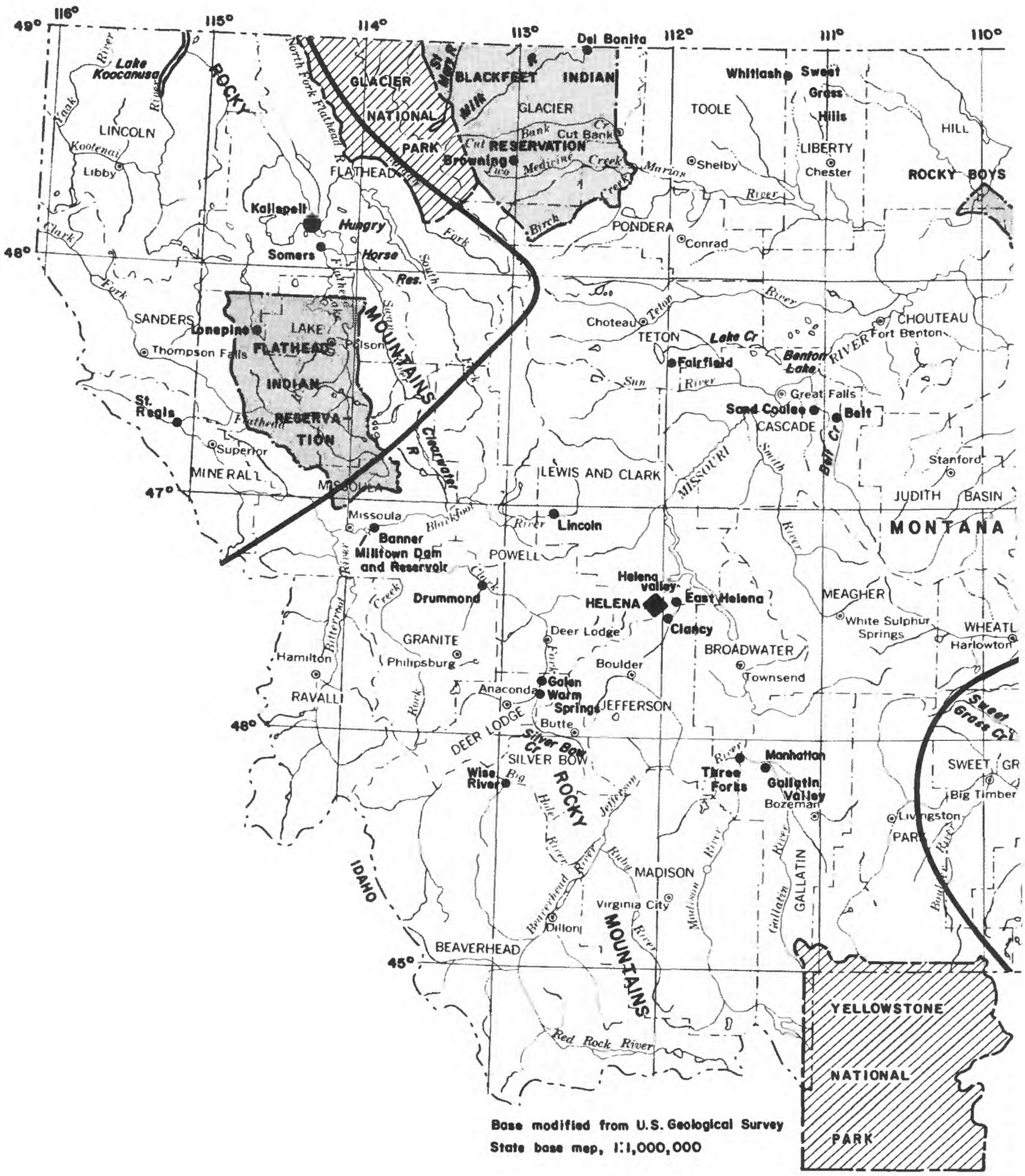
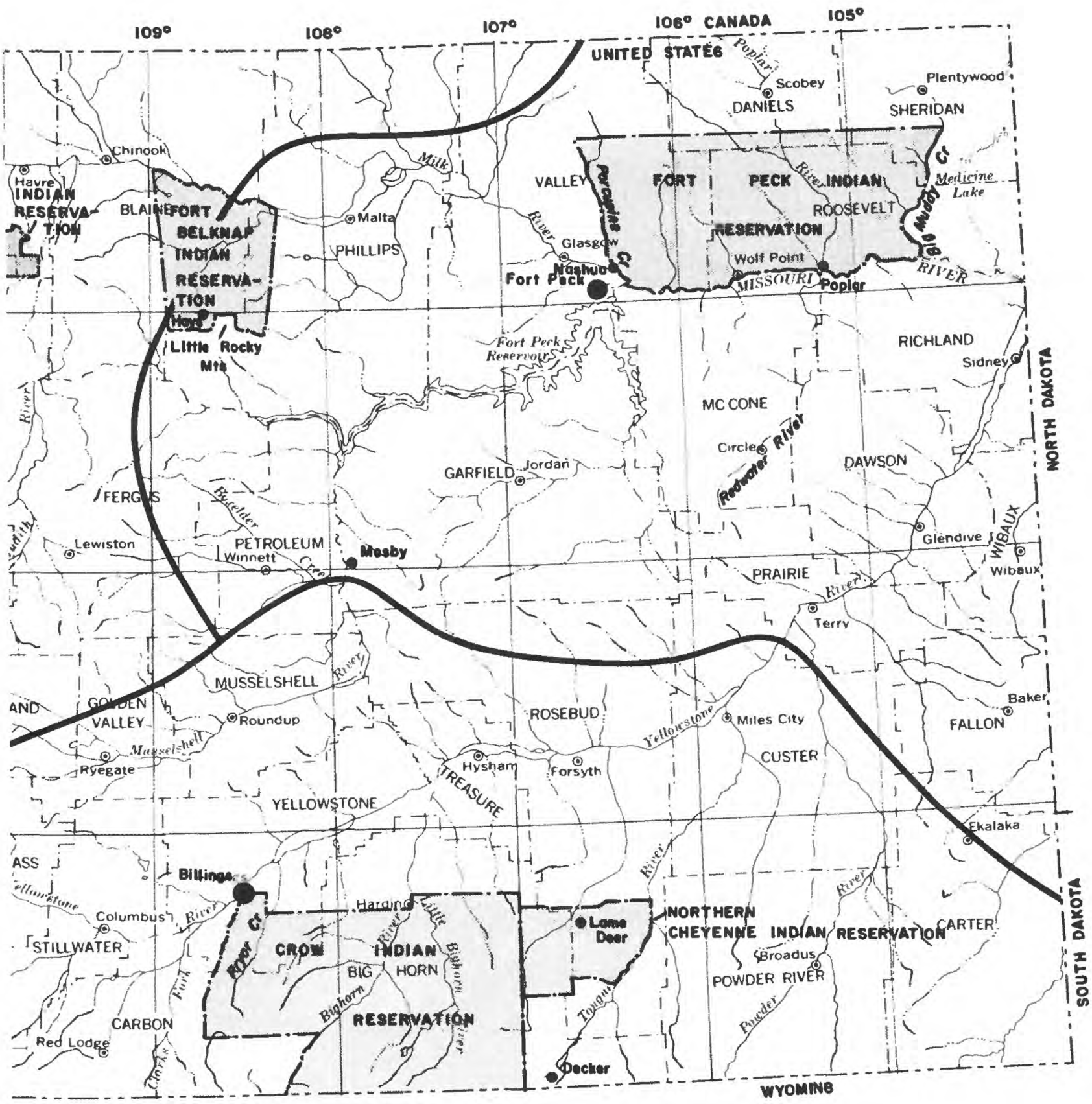


Figure 1. Location of offices in the Montana District, general



areas of responsibility, and selected geographic features.

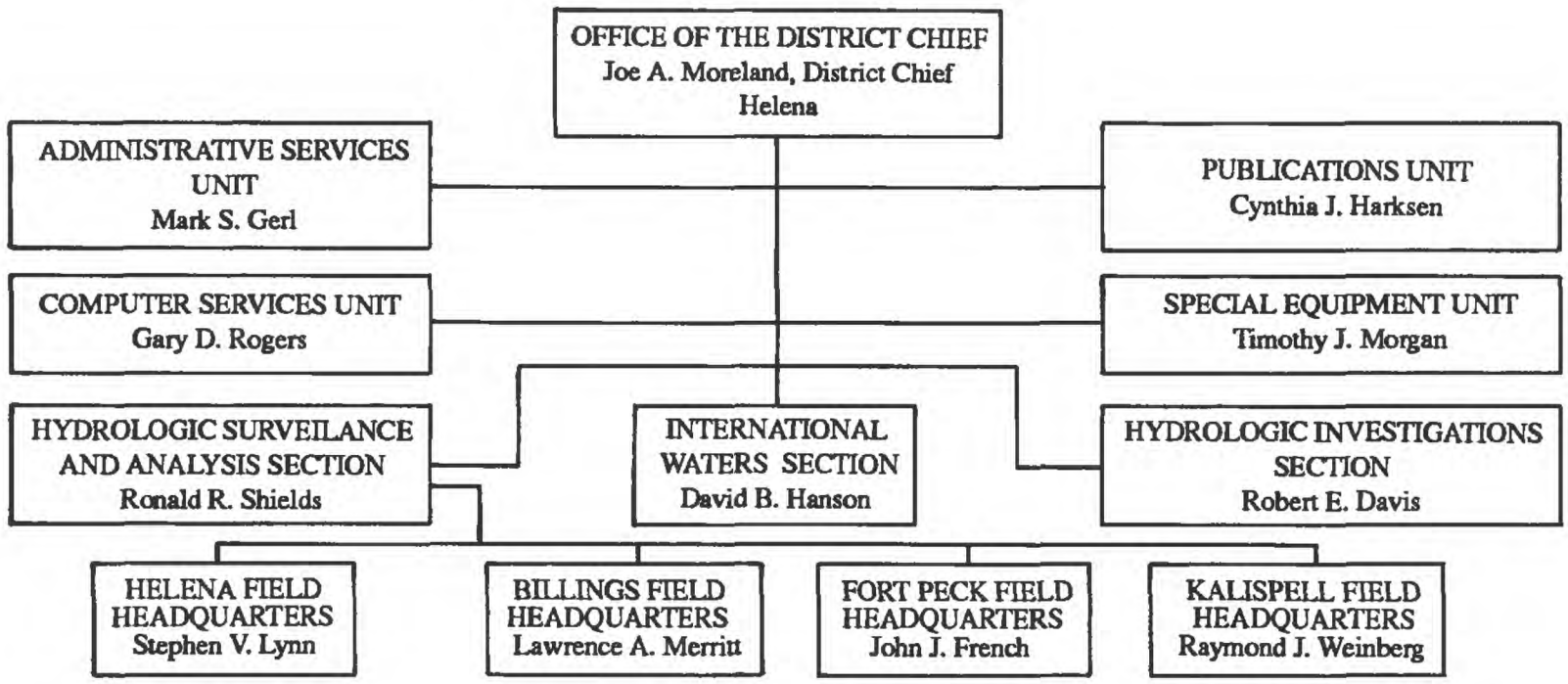


Figure 2. Organization chart for the Montana District.

or prediction of the effects of natural forces or human activities on the quality of water in hydrologic systems.

Support Units

The Administrative Services Unit provides administrative support for the District in the form of programming, budgeting, accounting, management of personnel, property inventory, travel records, vehicle management, and related services. The Computer Services Unit is responsible for day-to-day operation of the District's computer and peripheral equipment, programming support to the staff, and recommendations for hardware and software that can enhance computer capability. The Publications Unit is responsible for adequacy of publications and adherence to Survey and Division policy and format; the Unit assists the District staff in the design, preparation, and processing of publications. The Special Equipment Unit fulfills the equipment needs of the staff by stocking routine materials and supplies, ordering needed equipment, maintaining and repairing major equipment, monitoring equipment inventories, and providing technical assistance for construction activities.

Office Addresses

Inquiries regarding projects and available data may be directed to the District Office. Requests for current streamflow may be directed to the Field Headquarters nearest the area of concern, or to the District Office.

The offices have the following telephone numbers and addresses:

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:** **Stephen V. Lynn**	**(406) 449-5263**	**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** **Montana State University--Billings** **1500 North 30th, Box 111** **Billings, MT 59101-0111**
Fort Peck Field Headquarters **Technician-in-charge:** **John J. French**	**(406) 526-3532**	**U.S. Geological Survey** **Water Resources Division** **Administration Building** **P.O. Box 124** **Fort Peck, MT 59223-0124**
Kalispell Field Headquarters **Technician-in-charge:** **Raymond J. Weinberg**	**(406) 755-6686**	**U.S. Geological Survey** **Water Resources Division** **1015 East Idaho Street** **P.O. Box 1012** **Kalispell, MT 59903-1012**

Types of Funding

The Montana District is supported by funds appropriated directly to the U.S. 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[1] 1994, total funding support for program operation in Montana was $4,622,432. Funding sources are illustrated in figure 3.

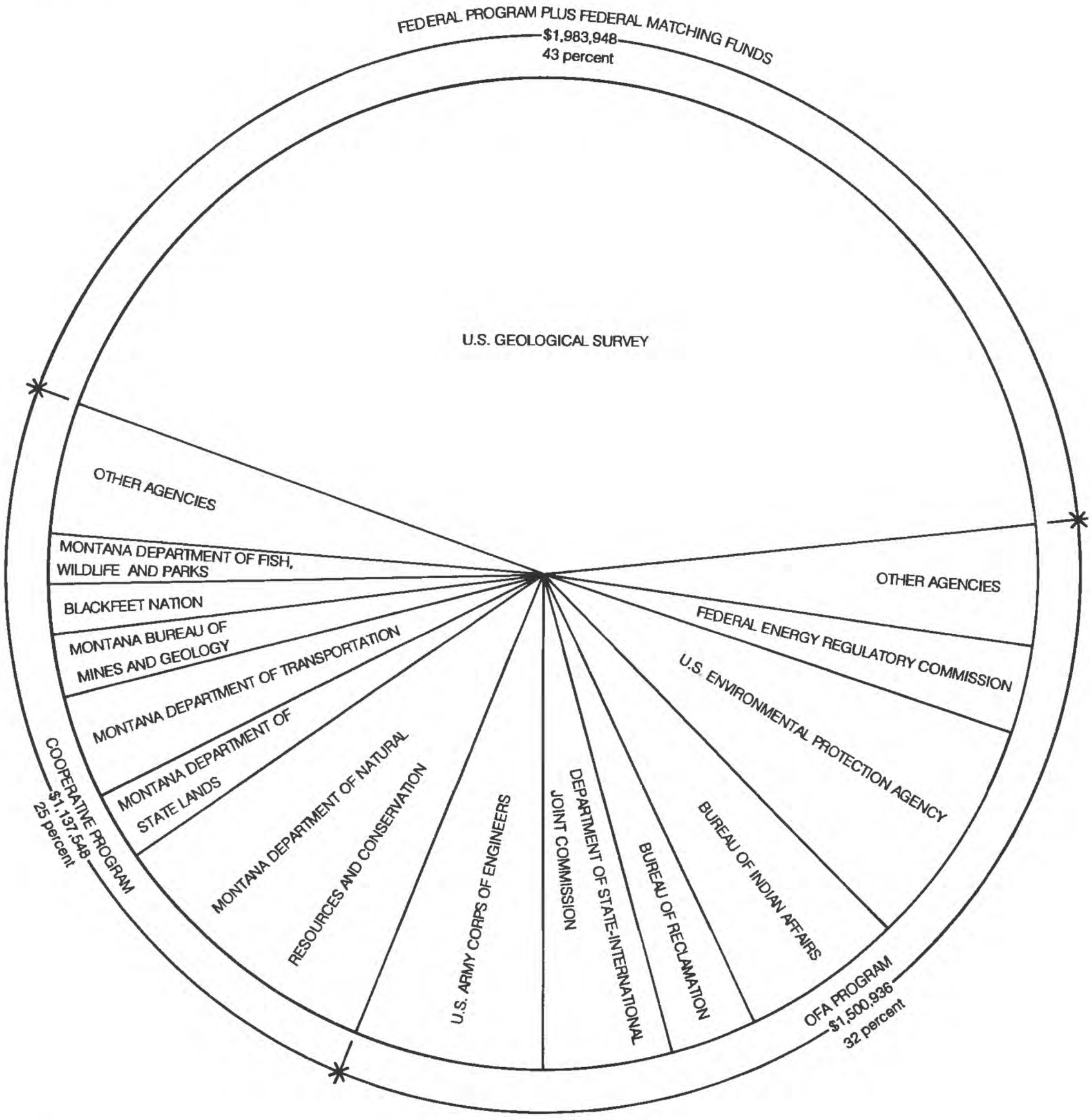


Figure 3. Funding sources for the water-resources program in Montana. Funding amounts are for Federal fiscal year 1994.

[1]A fiscal year is the 12-month period October 1 through September 30. It is designated by the calendar year in which it ends. Thus, fiscal year 1994 extends from October 1, 1993, through September 30, 1994.

Cooperating Agencies

The following agencies participated in program operation of the Montana District in fiscal year 1994 by providing funds and (or) services:

Federal Agencies

- Bonneville Power Administration
- Department of Agriculture
  - U.S. Forest Service
- Department of the Interior
  - Bureau of Indian Affairs
  - Bureau of Land Management
  - Bureau of Reclamation
  - National Park Service
  - Office of the Secretary
  - U.S. Fish and Wildlife Service
  - U.S. Geological Survey
- Department of State, International Joint Commission, Waterways Treaty
- Federal Energy Regulatory Commission
- Federal Highway Administration
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency

Tribal Agencies

- Blackfeet Nation
- Confederated Salish and Kootenai Tribes of the Flathead Reservation
- Fort Peck Tribes
- Northern Cheyenne Tribe

State Agencies

- Greenfield Irrigation District
- Montana Bureau of Mines and Geology
- Montana Department of Fish, Wildlife and Parks
- Montana Department of Health and Environmental Sciences
- Montana Department of Natural Resources and Conservation
- Montana Department of State Lands
- Montana Department of Transportation
- Wyoming State Engineer

Local Agencies

- City of Helena
- Helena Valley Irrigation District
- Lewis and Clark County Health Department
- Ravalli County Board of Commissioners
- Two Leggings Water Users

GENERAL HYDROLOGIC DESCRIPTION OF MONTANA

Montana has two distinct hydrologic regions: mountains and intermontane valleys in the western and south-central areas, and plains in the eastern and north-central areas. Precipitation and mountain snowpack generally provide abundant streamflow suitable for most uses in the west and south (fig. 4). However,

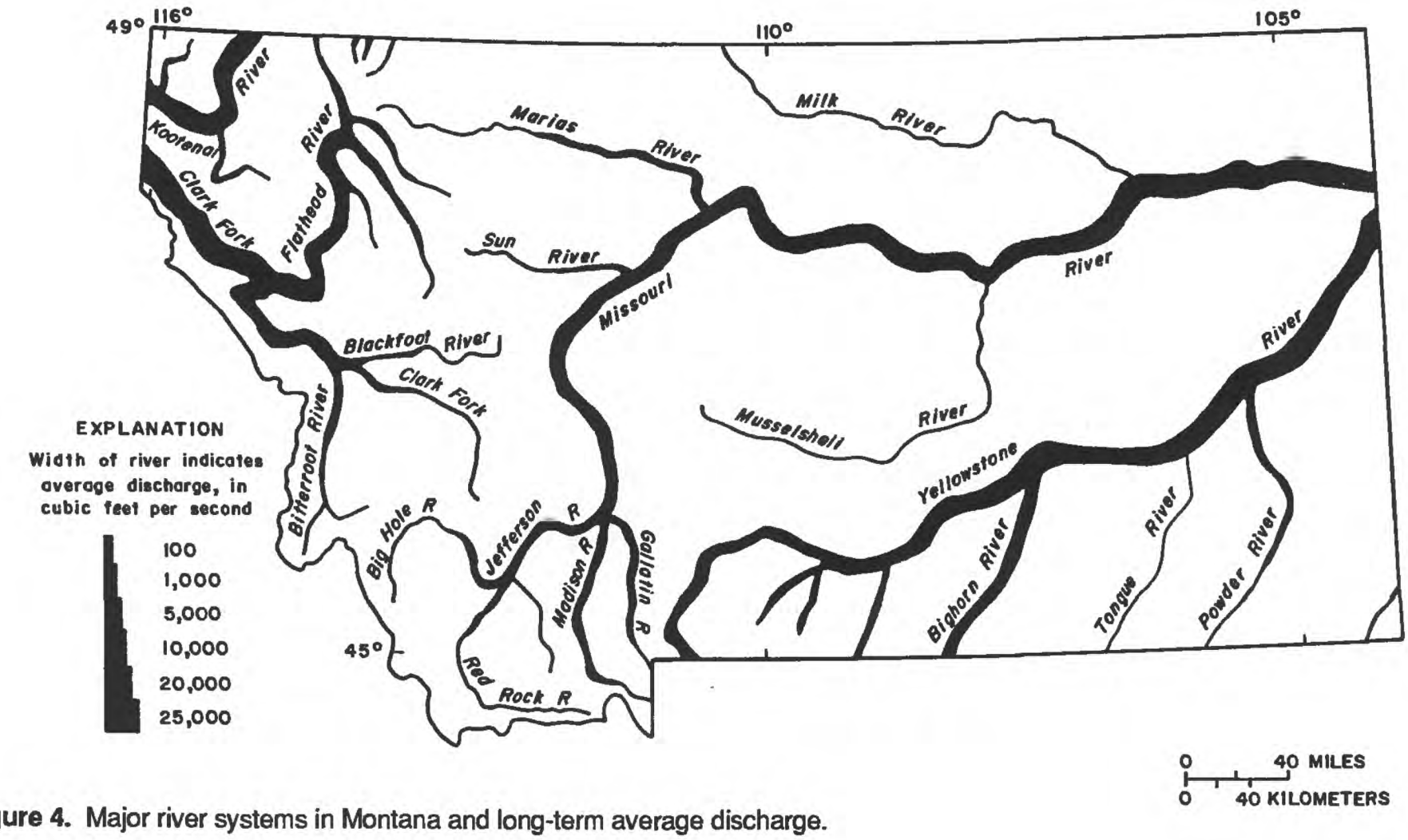


Figure 4. Major river systems in Montana and long-term average discharge.

streamflows are depleted by irrigation during the summer and fall of some years. Smaller streams, particularly in the eastern and north-central areas of the State, do not provide dependable supplies except during spring runoff.

Periodic flooding can occur suddenly in low-lying areas along most streams in the State. Studies are currently underway to delineate flood-prone areas on maps for selected streams on the Northern Cheyenne and Fort Peck Indian Reservations. The maps, together with calculated flood-depth information, are intended to assist administrators, planners, and engineers concerned with future land development.

Streamflow quality generally is suitable for most uses statewide, except in parts of eastern Montana where large dissolved-solids concentrations periodically render the water unsuitable for some domestic and agricultural uses. Current concerns focus on trace-metal concentrations as a result of past mining activities in the Clark Fork basin; arsenic inputs to the Missouri River from geothermal sources in Yellowstone National Park; effects of return flows from irrigation statewide; the effects of nutrient enrichment from point and nonpoint sources; and the transport of suspended sediment at several stream sites throughout the State.

Irrigation in Montana is dependent on abundant surface-water sources. During 1990, the date of the most recent water-use compilation, irrigation accounted for about 8,910 million gallons per day of the total 9,320 million gallons per day withdrawn from Montana's surface- and ground-water sources[2]. Total water use by county is shown in figure 5. Surface water was the source for 97.6 percent of the total water withdrawals in Montana, and 97.9 percent of the surface-water withdrawals was for irrigated agriculture. About 205 million gallons per day of fresh water was withdrawn from ground-water sources during 1990. About 49.3 percent of all ground-water withdrawals were used for irrigated agriculture.

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

Hydrologic information is being collected to address several issues concerning ground water in

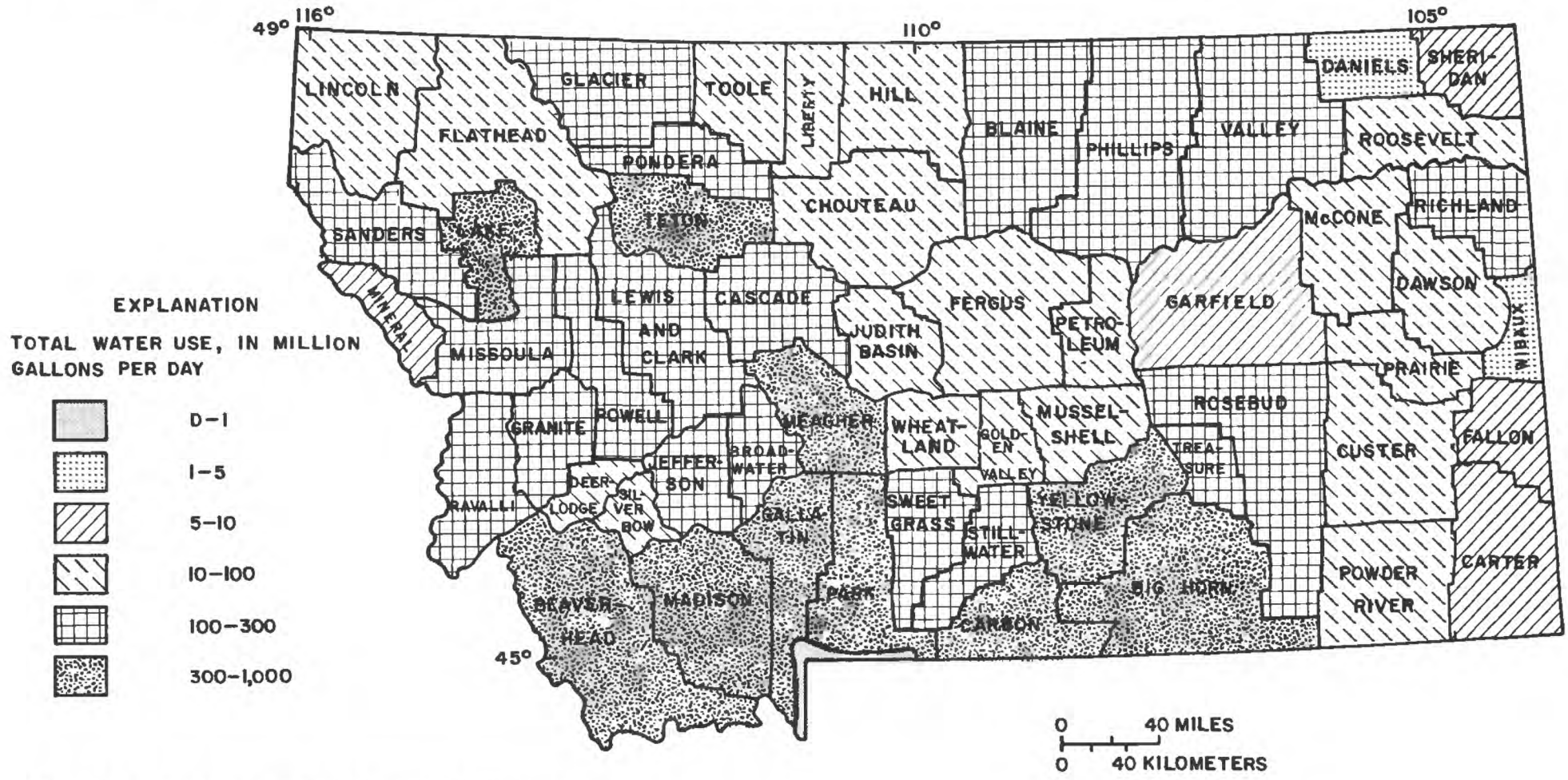


Figure 5. Total water use in Montana counties, 1990.

[2]Solley, W.B., Pierce, R.R., and Perlman, H.A., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p.

Montana. In some areas, ground-water levels have declined or may decline in response to past, present, or projected water use, drought, and low-streamflow conditions. The potential for degradation of ground-water quality is a major concern, and the effects of human activities on ground-water resources are being evaluated by hydrologic study and research. As examples, the effects on water quality of disposal of oil-field brine in northeastern Montana, of residential development in southwestern Montana, and of irrigation in west-central Montana are being investigated. Other investigations are focused on defining the geohydrologic systems and the availability of ground water in areas throughout 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 information needed for optimal utilization of Montana's water resources.

DATA-COLLECTION PROGRAMS

Hydrologic-data stations are maintained at selected sites throughout Montana for the collection of information concerning stream discharge and stage, reservoir and lake storage, ground-water levels, quality of surface and ground water, quality of atmospheric water, and water use. The station networks are revised periodically in response to changing needs for information to ensure collection of relevant data. Much of this information is published annually in a water-data report. Most is stored in computer files for efficient processing and retrieval. The computer-stored data are maintained in the U.S. 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 were being obtained in October 1994 at the following number of stations.

The location of active continuous-record surface-water gaging stations on streams, reservoirs, and lakes is shown in figure 6 at the back of the report; corresponding information on financial support and

Station classification		Number of stations
Stream stations		329
Continuous record:		
Discharge and stage, annual	150	
Discharge and stage, seasonal	66	
Stage only (identified as "stage station" in table 1)	4	
Partial record:		
Crest stage (peak flow only)	109	
Lake and reservoir stations		64
Stage and contents	64	
Total		393

gage equipment is given in table 1. The location of active crest-stage (peak-flow) gaging 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 from the District Office for 649 continuous-record surface-water gaging stations and 228 partial-record crest-stage gaging stations discontinued in previous years.

Water-quality data were obtained at 98 streamflow-gaging stations during October 1993 through September 1995. Fifteen of the stations are part of a U.S. Geological Survey nationwide network known as the National Stream Quality Accounting Network (NASQAN), which is used to assess the quality of the Nation's streams. The number of stations in this national network will be reduced beginning October 1, 1995, with three stations being retained in Montana. The types of data collected at the surface-water-quality stations are given below. Inasmuch as several types of data may be collected at a particular site and not all types of data are collected at each site, the numbers given will not equal the total number of stations.

Type of data	Number of sites
Chemical	73
Sediment	40
Biological	18
Water temperature, daily	8
Specific conductance, daily	5

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 water from wells and springs, and water-quality data are key characteristics in monitoring ground-water trends. However, these hydrologic characteristics need to be integrated with other observations and ground-water-system studies to have the most meaning and usefulness. In Montana, the 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 fiscal year 1994 are given below.

Site classification	Number of sites
Observation wells	91
Project wells	413
Project springs	2

The basic observation-well network for fiscal year 1994 is shown in figure 9 at the back of the report; corresponding information on water-level measurements and chemical analyses is given in table 4. Project wells and springs are not identified. The basic observation-well network for fiscal year 1994 is significantly smaller than in previous years.

Water-quality data are obtained at some of the wells and springs listed above. The types of water-quality data determined at these ground-water 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.

Type of data	Wells	Springs
Onsite:	415	5
Water temperature	393	5
Specific conductance	393	5
pH	343	5
Chemical (inorganic constituents)	101	2

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

Description of Projects

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

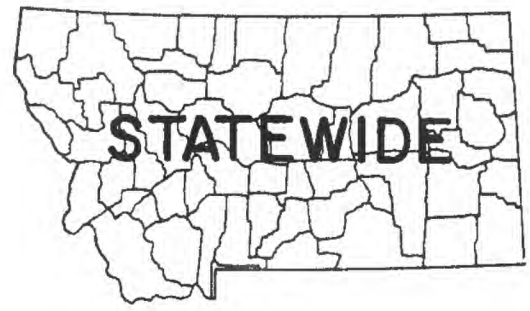
PROJECT TITLE: Surface-Water Stations (MT001)

LOCATION: Statewide

PERIOD OF PROJECT: Continuing

PROJECT CHIEF: Ronald R. Shields, Helena

FUNDING SOURCES: Multiple agencies identified in tables 1 and 2



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. To provide this information an appropriate data base is necessary.

OBJECTIVES: (1) To collect surface-water data sufficient to satisfy needs for multipurpose 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." Use partial-record gaging instead of complete-record gaging where it serves the required purpose.

PROGRESS DURING FISCAL YEAR 1994: Data collection, computation, and compilation were continued as planned for all stations in the network. Severe drought conditions persisted throughout the year. Minor snowmelt flooding occurred in the southeastern part of the State in March.

PLANS FOR FISCAL YEAR 1995: Continue to operate the streamflow-gaging stations in the network. When appropriate, make changes in the network based on user needs and available funding.

INFORMATION PRODUCTS: Shields, R.R., White, M.K., Brosten,T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

Yellowstone River Compact Commission, 1993, Forty-second annual report, Yellowstone River Compact Commission: Annual report, 31 p.

MT001 Streamflow discharge measurements on the Clark Fork at St. Regis. Photograph by L.G. Sultz, U.S. Geological Survey.

PROJECT TITLE: Ground-Water Stations (MT002)

LOCATION: Statewide

PERIOD OF PROJECT: Continuing

PROJECT CHIEF: Clarence L. Chambers, Helena

FUNDING SOURCES: Montana Bureau of Mines and Geology, Bureau of Indian Affairs, and U.S. Geological Survey

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 prediction of future supplies, and to provide data for management of the resource.

OBJECTIVES: (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 may (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: Evaluate the regional geology to permit a broad, general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of the stress on the system in time and space and the hydrologic properties of the aquifers, determine the most advantageous locations for observation of long-term system behavior. Refine this network 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 DURING FISCAL YEAR 1994: Collected, reviewed, and entered water-level data into data base. Revised summary data report for 1985-92 in preparation for colleague review.

PLANS FOR FISCAL YEAR 1995: Continue data collection at approximately 77 sites. Complete colleague review for summary data report, obtain approval, and publish.

INFORMATION PRODUCTS: Chambers, C.L., Records of wells and water-level fluctuations from the statewide observation-well network in Montana from October 1985 through October 1992: U.S. Geological Survey Open-File Report (planned).

Kendy, Eloise, 1993, A forthcoming U.S. Geological Survey report--NationalWater Summary 1992-93, Hydrologic events and wetland resources: Thorne Ecological Institute, Western Wetlands and Riparian Areas--Public/Private Efforts in Recovery, Management and Education Conference, Salt Lake City, Utah, September 9-11, 1993.

Shields, R.R., White, M.K., Brosten,T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

MT002 Installation of a U.S. Geological Survey monitoring well. Photograph from U.S. Geological Survey files.

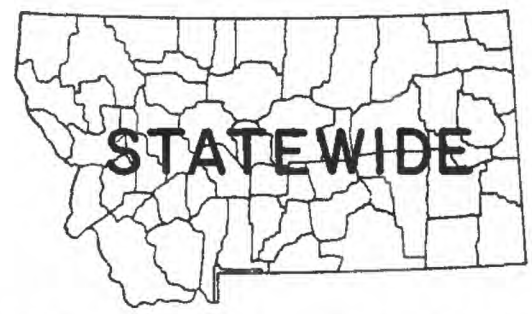
PROJECT TITLE: Water-Quality Stations (MT003)

LOCATION: Statewide

PERIOD OF PROJECT: Continuing

PROJECT CHIEF: John H. Lambing, Helena

FUNDING SOURCES: Multiple agencies identified in table 3



PROBLEM: Water-resource planning and water-quality assessment require a nationwide data base of relatively standardized information. For effective planning and realistic assessment of the water resource, the chemical and physical quality of the rivers and streams needs to be defined and monitored.

OBJECTIVES: (1) To provide a national bank of water-quality data for broad Federal and State planning and action programs. (2) To provide data for Federal management of interstate and international waters. (3) To provide data necessary for statistical analysis of current water-quality conditions and trends with time.

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

PROGRESS DURING FISCAL YEAR 1994: Continued data collection on schedule at all stations in the network. Analyzed and prepared the annual records for publication.

PLANS FOR FISCAL YEAR 1995: Continue data collection and analysis of samples from the network. Evaluate the network to accommodate user needs and available funding levels where appropriate.

INFORMATION PRODUCTS: Shields, R.R., White, M.K., Brosten,T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

MT003 Water-sample collection from a cableway over the Blackfoot River near Bonner. Photograph by J.H. Lambing, U.S. Geological Survey.

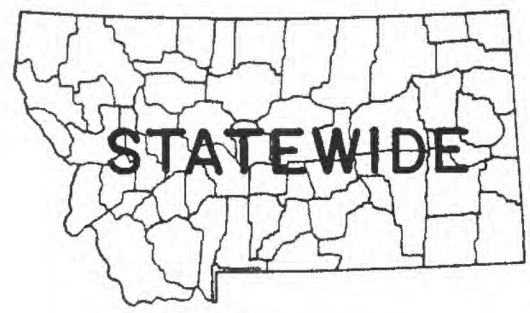
PROJECT TITLE: Sediment Stations (MT004)

LOCATION: Statewide

PERIOD OF PROJECT: Continuing

PROJECT CHIEF: John H. Lambing, Helena

FUNDING SOURCES: Multiple agencies identified in table 3



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

OBJECTIVES: (1) To provide a national bank of sediment data for use in broad Federal and State planning and action programs. (2) To provide data for Federal management of interstate and international waters. (3) To provide data necessary to define the sediment-transport characteristics of streams and the relation to water quality.

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 DURING FISCAL YEAR 1994: Maintained data collection on schedule. Established two additional daily sediment stations in the Clark Fork Basin.

PLANS FOR FISCAL YEAR 1995: Maintain daily sediment program at current level if cooperator funding is available.

INFORMATION PRODUCTS: Shields, R.R., White, M.K., Brosten,T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

Lambing, J.H., and Dodge, K.A., 1993, Quality assurance for laboratory analysis of suspended-sediment samples by the U.S. Geological Survey in Montana: U.S. Geological Survey Open-File Report 93-131, 34 p.

MT004 Sediment laboratory at U.S. Geological Survey District Office in Helena. Photograph by J.H. Lambing, U.S. Geological Survey.

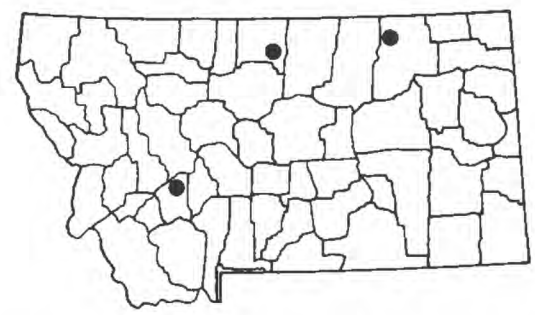
PROJECT TITLE: Precipitation Stations (MT005)

LOCATION: West-central and northern Montana

PERIOD OF PROJECT: Continuing

PROJECT CHIEF: Ronald R. Shields, Helena

FUNDING SOURCES: U.S. Geological Survey



PROBLEM: Water-resource planning and water-quality assessment require a nationwide data base of relatively standardized information. For effective planning and realistic assessment of the water resource, the chemical quality and the quantity of precipitation need to be monitored.

OBJECTIVES: To obtain chemical quality and quantity data for two stations operated in the National Trends Network and one station in the U.S. Geological Survey Bench Mark program network.

APPROACH: Operate an existing network of precipitation collectors at sites in the National Trends Network in Montana to provide chemical analysis of precipitation. Monitor quantity of precipitation to provide information to be used in time-trend analysis.

PROGRESS DURING FISCAL YEAR 1994: Precipitation and water-quality data were collected, processed, and analyzed for two National Trends Network stations (Clancy and Havre). Precipitation data were collected and processed for the hydrologic bench-mark station, Rock Creek below Horse Creek, near International Boundary. All data were compiled and published in the annual water-data report.

PLANS FOR FISCAL YEAR 1995: Collect precipitation and water-quality data for two National Trends Network stations and precipitation data for the Rock Creek below Horse Creek, near International Boundary station.

INFORMATION PRODUCTS: Shields, R. R., White, M.K., Brosten, T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

MT005 National Atmospheric Deposition Program/National Trends Network precipitation collection site, near Clancy. Photograph by J.R. Knapton, U.S. Geological Survey.

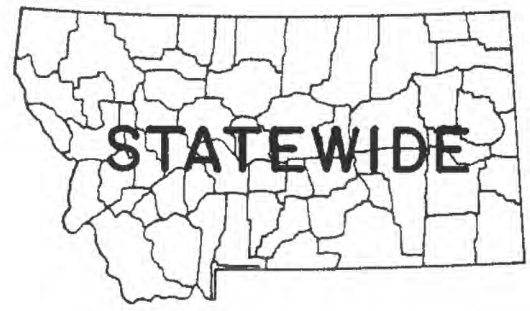
PROJECT TITLE: Water Use (MT007)

LOCATION: Statewide

PERIOD OF PROJECT: Continuing

PROJECT CHIEF: Dave R. Johnson, Helena

FUNDING SOURCES: Montana Department of Natural Resources and Conservation, Blackfeet Nation, Bureau of Indian Affairs, and U.S. Geological Survey



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.

OBJECTIVES: (1) To obtain water-use data responsive to the needs of local, State, and Federal agencies and private individuals. (2) To develop means for efficiently storing, retrieving, and disseminating the data.

APPROACH: Develop joint water-use data collection and analysis plans and strategies with the Montana Department of Natural Resources and Conservation each year. Conduct cooperative data collection and analysis projects using techniques and procedures approved by both agencies.

PROGRESS DURING FISCAL YEAR 1994: Prepared land-use map of the Gallatin Valley. Map is to be used to update estimates of irrigated acres. Made estimates of irrigation water use for Reno Canal on the Crow Indian Reservation, southeastern Montana, but estimates were found to be unreliable because of greater than average rainfall and unanticipated ground-water inflow to Reno Canal.

PLANS FOR FISCAL YEAR 1995: Conduct gain-loss measurements on Little Bighorn River, Crow Indian Reservation, to help quantify ground-water/surface-water relations. Results will be used to improve reliability of irrigation water-use estimates for Reno Canal area. Update water-use data statewide, as applicable.

INFORMATION PRODUCTS: Johnson, D.R., Irrigation water use in the Reno Canal Unit, Little Bighorn Irrigation Project, Crow Indian Reservation, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

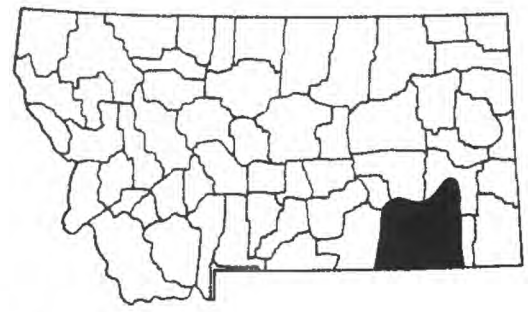
MT007 Diversion structure for the Reno Canal on the Little Bighorn River, Crow Indian Reservation. Photograph by L.A. Merritt, U.S. Geological Survey.

INVESTIGATIVE STUDIES

The Geological Survey is commonly 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 in local areas, may or may not be of a recurring nature.

The 26 projects described on the following pages are concerned mainly with collection and analysis of hydrologic data and application of results to the solution of hydrologic problems. The project number is given after each project title.

PROJECT TITLE: Powder River Coal Region Geographic Information System Data Base and Mine-Spoils Geochemistry (MT118)



LOCATION: Southeastern Montana

PERIOD OF PROJECT: July 1987 through September 1990

PROJECT CHIEF: David W. Clark, Helena

FUNDING SOURCES: Montana Department of State Lands, Bureau of Land Management, and U.S. Geological Survey

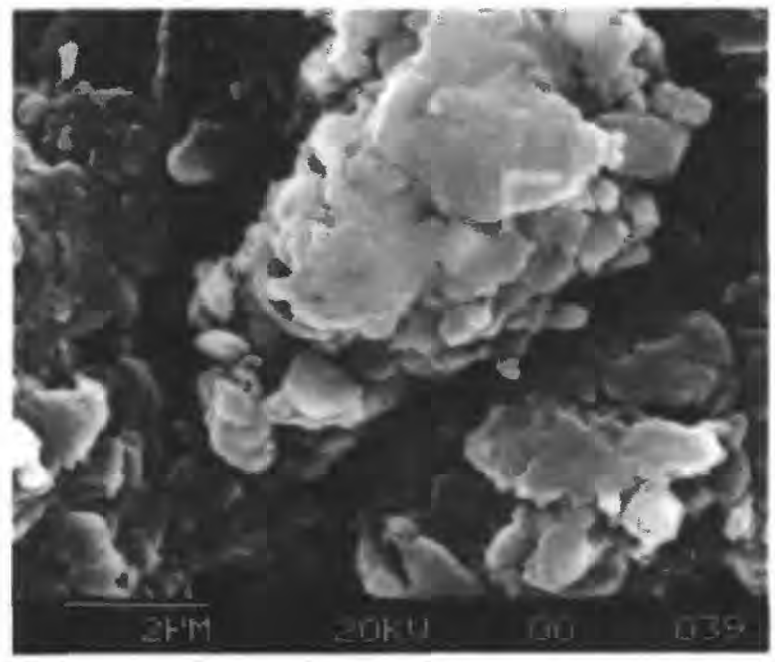
PROBLEM: (1) Attempts to use the considerable amount of data available for Cumulative Hydrologic Impact Analyses (CHIA) require considerable effort to review and compile the data. Recent advances in computer technology make the Geographic Information System (GIS) a logical tool to surmount this problem. (2) Additional knowledge of the hydrogeochemical processes affecting mine-spoils water, both onsite and offsite, is necessary to fully understand how water-quality changes occur and to more accurately predict the effects of mining.

OBJECTIVES: (1) To develop a GIS data base from relevant and available industry, State, and Federal data files for future use in CHIA studies. (2) To expand the knowledge of hydrogeochemical processes which occur both onsite and offsite in ground water as a result of surface coal mining in southeastern Montana.

APPROACH: (1) Determine data availability and form, acquire necessary software and hardware, enter data into GIS, demonstrate system capabilities to cooperator, transfer data files to cooperator, and prepare report. (2) Select drilling sites at two mines; prepare drilling contract; complete drilling and sampling of solid and aqueous phases for chemical and mineralogical characteristics, including isotopes; model the geochemical characteristics; and prepare report.

PROGRESS DURING FISCAL YEAR 1994: Draft report on geochemical processes in ground water in mine spoils reviewed by District Publications Unit. Report reviewed by colleagues and revised.

PLANS FOR FISCAL YEAR 1995: Complete revisions based on colleague-review comments. Submit report for approval. Publish report.



MT118 Photomicrograph of a coal sample collected from the West Decker Mine area, southeastern Montana. Photograph by D.W. Clark, U.S. Geological Survey.

INFORMATION PRODUCTS: Cannon, M.R., 1990, A Geographic Information System data base for coal and water resources of the Powder River coal region, southeastern Montana: U.S. Geological Survey Open-File Report 90-568, 83 p.

Clark, D.W., Geochemical processes in ground water resulting from surface mining of coal at the Big Sky and West Decker mine areas, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

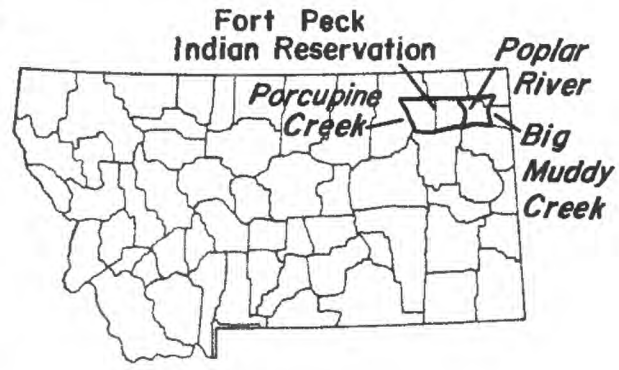
PROJECT TITLE: Fort Peck Indian Reservation 100-Year Flood Plains (MT124)

LOCATION: Northeastern Montana

PERIOD OF PROJECT: October 1988 through September 1995

PROJECT CHIEF: Robert J. Omang, Helena

FUNDING SOURCES: Fort Peck Tribes and U.S. Geological Survey



PROBLEM: In order for the Fort Peck Tribes to be able to make decisions concerning the location of buildings, structures, roads, or other facilities so as to preclude the uneconomic, hazardous, or unnecessary use of the flood plain in connection with such facilities, information is needed to adequately delineate areas prone to flooding along rivers.

OBJECTIVES: To determine the extent of flooding that would occur as the result of a 100-year recurrence-interval flood along Porcupine Creek, Big Muddy Creek, and the Poplar River.

APPROACH: (1) Conduct reconnaissance and surveying of channel and flood-plain cross sections for Porcupine and Big Muddy Creeks and the Poplar River. (2) Identify existing reference marks and, if necessary, establish new ones. (3) Determine Manning's roughness coefficient for each section. (4) Determine 100-year-discharge for each study reach. (5) Determine water-surface elevations for a 100-year flood using the computer program WSPRO. Delineate areas of potential flooding on maps of scale 1:24,000. Prepare and publish reports.

PROGRESS DURING FISCAL YEAR 1994: Hydraulic analysis completed and flood-plain limits for Big Muddy Creek were delineated. Draft report prepared for colleague review.

PLANS FOR FISCAL YEAR 1995: Complete review process, obtain approval, and publish report for Big Muddy Creek.

INFORMATION PRODUCTS: Omang, R.J., 1990, Water-surface profile and flood boundaries for the computed 100-year flood, Poplar River, Fort Peck Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report 90-4169, 2 sheets.

_____1993, Water-surface profile and flood boundaries for the computed 100-year flood, Porcupine Creek, Fort Peck Indian Reservation and adjacent area, Montana: U.S. Geological Survey Water-Resources Investigations Report 92-4185, 1 sheet.

_____Water-surface profile and flood boundaries for the computed 100-year flood, Big Muddy Creek, Fort Peck Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT124 Downstream view of Porcupine Creek and its flood plain near mouth, 0.5 mile east of Nashua. Photograph by K.C. Jenewein, U.S. Geological Survey.

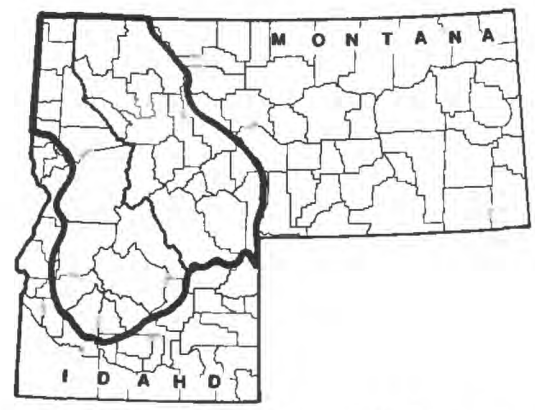
PROJECT TITLE: Northern Rocky Mountains Intermontane Basins Regional Aquifer-System Analysis (MT128)

LOCATION: Western Montana, northern and central Idaho

PERIOD OF PROJECT: January 1990 through September 1994

PROJECT CHIEF: David W. Clark, Helena

FUNDING SOURCE: U.S. Geological Survey



PROBLEM: Unconsolidated deposits in numerous valleys in western Montana and northern and central Idaho are important aquifers. For many residents, these aquifers are the main source of water for public-supply, rural-domestic, agricultural, and industrial uses. The ground-water resource is hydraulically connected to the surface-water resource, which is used extensively for recreation and irrigation. Knowledge of the ground-water resource is needed for effective management, utilization, and protection.

OBJECTIVES: To document and describe: (a) hydrogeologic systems within intermontane basins, (b) relations between ground water and surface water in individual basins, (c) the hydrologic relations between selected basins, and (d) baseline water quality.

APPROACH: Compile existing data, inventory wells onsite, develop a geographic information system data base, measure streamflow gain and loss, establish surface-water-flow monitoring sites, and describe recharge, discharge, ground-water flow, and water budget. For four selected basins, conduct test drilling, surface geophysics, aquifer tests, and flow modeling.

PROGRESS DURING FISCAL YEAR 1994: Compiled and evaluated hydrologic, geologic, and water-quality data. Submitted draft data report for the Montana part of the study for colleague review. Continued preparation of draft map-format reports on ground-water levels, hydrogeology, and water quality, and a report summarizing characteristics of basins in the Montana part of the study area.

MT128 Bitterroot River in the Bitterroot Valley, near Missoula. Photograph by D.W. Clark, U.S. Geological Survey.

PLANS FOR FISCAL YEAR 1995: Complete draft reports, submit for review, obtain approval, and publish.

INFORMATION PRODUCTS: Clark, D.W., and Briar, D.W., 1993, Radon in ground water of western Montana: U.S. Geological Survey Water Fact Sheet Open-File Report 93-64, 2 p.

Briar, D.W., Lawlor, S.M., Stone, M.A.J., Parliman, D.J., and Schaefer, J.L., Ground-water levels in intermontane basins of the Northern Rocky Mountains, Montana and Idaho: U.S. Geological Survey Hydrologic Investigations Atlas (planned).

Clark, D.W., and Dutton, D.M., Quality of ground water and surface water in intermontane basins of the Northern Rocky Mountains, Montana and Idaho: U.S. Geological Survey Hydrologic Investigations Atlas (planned).

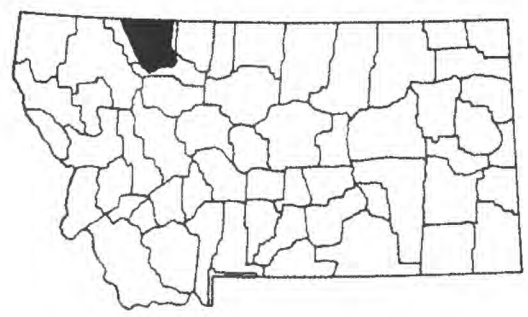
Dutton, D.M., Lawlor, S.M., Briar, D.W., and Tresch, R.E., in press, Hydrogeologic data for the Northern Rocky Mountains intermontane basins, Montana: U.S. Geological Survey Open-File Report 95-143, 94 p.

Kendy, Eloise, Tresch, R.E, and Briar, D.W., Geographic, geologic, and hydrologic summaries of selected intermontane basins in the Northern Rocky Mountains, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Tuck, L.K., Briar, D.W., and Clark, D.W., Hydrogeology of intermontane basins of the Northern Rocky Mountains, Montana and Idaho: U.S. Geological Survey Hydrologic Investigations Atlas (planned).

Reports containing hydrogeologic data and summaries of hydrogeologic characteristics of the Idaho part of the study area are planned by the Idaho District of the U.S. Geological Survey.

PROJECT TITLE: Blackfeet Indian Reservation Ground-Water Resources (MT129)



LOCATION: Northwestern Montana

PERIOD OF PROJECT: March 1990 through September 1994

PROJECT CHIEF: Michael R. Cannon, Helena

FUNDING SOURCES: Blackfeet Nation and U.S. Geological Survey

PROBLEM: Water resources are important to the Blackfeet Nation. Surface-water resources are used extensively for irrigation and recreation purposes. Ground water provides most of the drinking water for residents of the reservation. However, knowledge of the water resources is insufficient for proper utilization and protection.

OBJECTIVES: To describe the ground-water resources of the Blackfeet Indian Reservation. Specific objectives are to (a) identify hydrogeologic units and describe the water-bearing characteristics of each, (b) determine recharge-discharge relations between aquifers and major streams, (c) determine water quality of aquifers, and (d) establish a ground-water data base for tribal use.

APPROACH: Compile existing data, conduct onsite inventory of wells and springs, map hydrogeologic units, collect and analyze about 50 water samples from wells and springs for chemical characteristics, conduct streamflow gain-loss measurements, establish data base, prepare and publish report.

PROGRESS DURING FISCAL YEAR 1994: Prepared draft report on geology and ground-water resources and received colleague review. Revised report based on reviewers' comments.

PLANS FOR FISCAL YEAR 1995: Submit report for approval. Publish report.

INFORMATION PRODUCTS: Cannon, M.R., in press, Geology and ground-water resources of the Blackfeet Indian Reservation, northwestern Montana [abs.]: Geological Society of America, Rocky Mountain Section Meeting, May 18-19, 1995, Bozeman, Montana.

Cannon, M.R., Geology and ground-water resources of the Blackfeet Indian Reservation, northwestern Montana: U.S. Geological Survey Hydrologic Investigations Atlas, 2 sheets, (planned).

MT129 Test drilling, Blackfeet Indian Reservation, northwestern Montana. Photograph by C.L. Chambers, U.S. Geological Survey.

PROJECT TITLE: Sun River Irrigation Drainage Project, Detailed Study, Part Two (MT132)

LOCATION: West-central Montana

PERIOD OF PROJECT: May 1990 through September 1995

PROJECT CHIEF: John H. Lambing, Helena

FUNDING SOURCE: U.S. Department of the Interior, Office of the Secretary

PROBLEM: Results of the 1990-92 detailed study indicated that selenium delivered from irrigated glacial-lake deposits accumulates in sediment and biota in parts of Freezout Lake Wildlife Management Area. Concentrations in some samples exceeded concern levels. Additional data are needed to better define selenium mobilization processes, transport rates, and accumulation in wetlands in this part of the irrigation district.

OBJECTIVE: To collect supplemental data in sufficient detail to describe the magnitude, spatial variability, and causes of selenium and related chemical constituents in ground water, irrigation drainage, and wetlands.

APPROACH: Data for ground water, surface water, soils and aquifer materials, and bottom sediment will be collected during fiscal year 1995 at key locations and times to more clearly identify spatial and temporal variability of selenium concentrations. Geochemical analyses and refined estimates of selenium loading from irrigation drainage should provide insight to the likely processes of selenium mobilization, rate of transport, and accumulation. Biological samples will be collected by the U.S. Fish and Wildlife Service.

PROGRESS DURING FISCAL YEAR 1994: Published data report and prepared draft interpretive report for 1990-92 field work.

PLANS FOR FISCAL YEAR 1995: Complete review process, obtain approval, and publish interpretive report on 1990-92 work. Initiate and complete data collection for part two of study.

INFORMATION PRODUCTS: Lambing, J.H., Nimick, D.A., and Knapton, J.R., U.S. Geological Survey, and Palawski, D.U., U.S. Fish and Wildlife Service, 1994, Physical, chemical, and biological data for detailed study of the Sun River Irrigation Project, Freezout Lake Wildlife Management Area, and Benton Lake National Wildlife Refuge, west-central Montana, 1990-92, with selected data for 1987-89: U.S. Geological Survey Open-File Report 94-120, 171 p.

Nimick, D.A., and Lambing, J.H., U.S. Geological Survey, and Palawski, D.U., and Malloy, J.C., U.S. Fish and Wildlife Service, Detailed study of selenium in soils, water, bottom sediment, and biota in the Sun River Irrigation Project, Freezout Lake Wildlife Management Area, and Benton Lake National Wildlife Refuge, west-central Montana, 1990-92: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT132 Irrigation supply canal on Greenfields Bench near Fairfield. Photograph by D.A. Nimick, U.S. Geological Survey.

PROJECT TITLE: Silver Bow Creek National Priorities List Site--Technical Assistance (MT133)

LOCATION: Silver Bow Creek drainage, near Butte, Montana

PERIOD OF PROJECT: October 1989 through September 1996

PROJECT CHIEF: Robert E. Davis, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency

PROBLEM: Heavy metals from historic mining and milling operations have contaminated soils, ground water, and surface water in the Silver Bow Creek area near Butte. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List for remedial activities.

OBJECTIVES: To provide technical review of data and project evaluations to EPA.

APPROACH: Review draft documents and data, and provide comments to EPA.

PROGRESS DURING FISCAL YEAR 1994: No technical assistance was requested or provided.

PLANS FOR FISCAL YEAR 1995: Provide technical assistance as requested.

INFORMATION PRODUCTS: None.

PROJECT TITLE: Silver Bow Creek National Priorities List Site, Butte Portion--Technical Assistance (MT134)

LOCATION: Silver Bow Creek drainage, near Butte, Montana

PERIOD OF PROJECT: October 1989 through September 1996

PROJECT CHIEF: Robert E. Davis, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency

PROBLEM: Heavy metals from mining and milling operations near Butte have contaminated soils, ground water, and surface water in the Silver Bow Creek area. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List for remedial activities.

OBJECTIVES: (1) To provide technical assistance in assembling and evaluating existing technical data. (2) To provide input into the work plan development. (3) To provide other document review and project evaluations related to the site.

APPROACH: Review reports and provide technical assistance to EPA on work plans and related documents.

PROGRESS DURING FISCAL YEAR 1994: No technical assistance was requested or provided.

PLANS FOR FISCAL YEAR 1995: Provide technical assistance as requested.

INFORMATION PRODUCTS: None.

PROJECT TITLE: Upper Clark Fork Basin Fine-Bed Sediment Sampling (MT135)

LOCATION: Southwestern Montana

PERIOD OF PROJECT: March 1993 through September 1995

PROJECT CHIEF: John H. Lambing, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency

PROBLEM: Tailings from hardrock mining and milling activities in the upper Clark Fork Basin have contaminated the Clark Fork streambed and flood plain from the headwaters to Milltown Dam, near Missoula. The U.S. Environmental Protection Agency (EPA) has designated the river as an extended National Priorities List site.

OBJECTIVES: To collect fine (less than 0.063-micrometer diameter) bed sediment from 13 sites on the Clark Fork mainstem and near the mouths of selected major tributaries. Determine spatial concentration patterns of trace metals within the upper basin. Report annual results and assess changes in concentration with time.

APPROACH: Collect samples of fine-bed sediment once annually at mainstem and tributary sites in the upper basin. Analyze the fine fraction of bed sediment for trace metals. Prepare and publish a report describing results of data collection and analysis.

PROGRESS DURING FISCAL YEAR 1994: Conducted data collection, review, and compilation for fine-bed sediment samples. Published analytical results for samples collected during water year 1993.

PLANS FOR FISCAL YEAR 1995: Collect samples of fine-bed sediment and publish results of trace-metal analyses.

INFORMATION PRODUCTS: Shields, R.R., White, M.K., Brosten,T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

Lambing, J.H., Hornberger, M.I., Axtmann, E.V., and Pope, D.A., 1994, Water-quality, bed-sediment, and biological data (October 1992 through September 1993) and statistical summaries of water-quality data (March 1985 through September 1993) for streams in the upper Clark Fork Basin, Montana: U.S. Geological Survey Open-File Report 94-375, 85 p.

MT135 Sampling deposits of fine-bed sediments, Clark Fork near Galen.
Photograph by J.H. Lambing, U.S. Geological Survey.

PROJECT TITLE: Idaho Pole National Priorities List Site--Technical Assistance (MT136)

LOCATION: Bozeman, Montana

PERIOD OF PROJECT: October 1989 through September 1996

PROJECT CHIEF: Robert E. Davis, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency

PROBLEM: Creosote and pentachlorophenol from wood-treatment facilities at the Idaho Pole site near Bozeman have contaminated soils, surface water, and ground water. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List for remedial activities.

OBJECTIVES: To provide technical assistance to EPA on remedial activities.

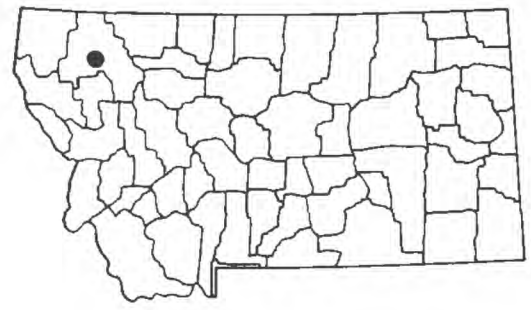
APPROACH: Review and comment on draft project plans. Assess the technical adequacy of project plans for (a) monitoring and sampling surface water and ground water, and (b) developing adequate information on the hydrogeological system of the site to predict contaminant migration. Review plans to remediate the contamination. Provide field oversight and review reports.

PROGRESS DURING FISCAL YEAR 1994: No technical assistance was requested or provided.

PLANS FOR FISCAL YEAR 1995: Provide technical assistance as requested.

INFORMATION PRODUCTS: None.

PROJECT TITLE: Burlington Northern National Priorities List Site--Technical Assistance (MT137)



LOCATION: Somers, Montana

PERIOD OF PROJECT: October 1989 to September 1996

PROJECT CHIEF: Joe A. Moreland, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency

PROBLEM: Chromated zinc chloride and creosote used to treat railroad ties at the Burlington Northern Tie Plant at Somers have contaminated soils and ground water. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List for remedial activities.

OBJECTIVES: (1) To provide technical assistance to EPA. (2) To assist EPA in overseeing remedial design and remedial activities.

APPROACH: Review and comment on draft project plans, including a work plan and plans for pilot testing of the ground-water remedy. Provide technical support and oversight of onsite activities involved in designing the ground-water remedy.

PROGRESS DURING FISCAL YEAR 1994: No technical assistance was requested or provided.

PLANS FOR FISCAL YEAR 1995: Provide technical assistance as requested.

INFORMATION PRODUCTS: None.

PROJECT TITLE: Fort Peck Indian Reservation Brine (MT138)

LOCATION: Fort Peck Indian Reservation, northeastern Montana

PERIOD OF PROJECT: January 1991 through September 1995

PROJECT CHIEF: Joanna N. Thamke and Steven D. Craigg, Helena

FUNDING SOURCES: Fort Peck Tribes and U.S. Geological Survey

PROBLEM: Brine from oil-production activities in the East Poplar oil field has been disposed of in evaporation pits or injected into subsurface geologic units. Disposal of the brine apparently has resulted in contamination of shallow ground water in Quaternary deposits. Although contamination has been documented in some areas, the extent, magnitude, and movement of the contamination are unknown.

OBJECTIVES: To determine (1) the areas of contamination, (2) the chemical characteristics of the brine, (3) possible geochemical reactions that may occur, (4) direction and rate of movement of conservative constituents, (5) source areas, and (6) the possible effect of contamination on other water resources, such as the Poplar River.

APPROACH: Compile existing data, inventory existing wells, install monitoring wells, collect water-quality samples, conduct geophysical surveys, conduct geochemical interpretation, and prepare and publish report.

PROGRESS DURING FISCAL YEAR 1994: Completed chemical analyses. Prepared draft data report. Began data analysis. Prepared paper for U.S. Geological Survey McKelvey Forum.

PLANS FOR FISCAL YEAR 1995: Submit draft data report for review, complete review process, obtain approval, and publish. Present paper at 1995 McKelvey Forum, Washington, D.C., February 1995. Complete data analysis. Prepare draft interpretive report, complete review process, obtain approval, and publish.

INFORMATION PRODUCTS: Craigg, S.D., and Thamke, J.N., 1992, Overview of possible effects of brine disposal on shallow ground-water resources in the East Poplar oil field, Fort Peck Indian Reservation, northeastern Montana: American Water Resources Association, Montana Section Meeting, Helena, Montana, September 17-18, 1992 [handout].

____1993, Hydrogeologic aspects of brine disposal in the East Poplar oil field, Fort Peck Indian Reservation, northeastern Montana [abs.]: Geological Society of America, Cordilleran and Rocky Mountain Section Meeting, Reno, Nevada, May 19-21, 1993, Abstracts with programs, p. 25.

MT138 Water-level measurement in observation well along Poplar River, Fort Peck Indian Reservation. Photograph by J.N. Thamke, U.S. Geological Survey.

____1995, The effects of oil-field brines on aquifers--Brine disposal in the East Poplar oil field, Fort Peck Indian Reservation, northeastern Montana, *in* Carter, L.M.H., ed., Energy and the environment--Application of geosciences to decision-making; Program and short papers; Tenth V.E. McKelvey Forum on Mineral and Energy Resources, 1995: U.S. Geological Survey Circular 1108, p. 95-98.

Mendes, T.M., Thamke, J.N., and Craigg, S.D., 1992, Application of electromagnetic geophysical techniques to delineate saline-water plumes in shallow aquifers of the East Poplar oil field, Fort Peck Indian Reservation, northeastern Montana: American Water Resources Association, Montana Section Meeting, Helena, Montana, September 17-19, 1992 [handout].

Thamke, J.N., and Craigg, S.D., Extent, magnitude, and movement of contamination in unconsolidated Quaternary aquifers in and near the East Poplar oil field, northeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Thamke, J.N., Craigg, S.D., and Mendes, T.M., 1992, Changes in ground-water quality resulting from saline-water migration in a shallow glacial aquifer in the East Poplar oil field, Fort Peck Indian Reservation, northeastern Montana: American Water Resources Association, Montana Section Meeting, Helena, Montana, September 17-18, 1992 [handout].

____ 1993, Use of electromagnetic geophysical techniques and auger drilling to delineate saline-water plumes in the East Poplar oil field, Fort Peck Indian Reservation, northeastern Montana: AAPG Bulletin, v. 77, no. 8, p. 1,461.

____Hydrologic data for the East Poplar Oil Field, Fort Peck Indian Reservation, northeastern Montana: U.S. Geological Survey Open-File Report (planned).

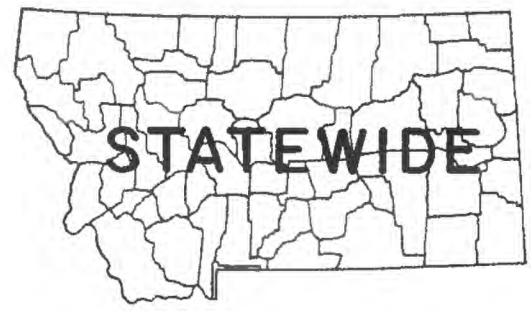
PROJECT TITLE: Bridge Scour, Montana (MT141)

LOCATION: Statewide

PERIOD OF PROJECT: May 1991 through September 1999

PROJECT CHIEF: Stephen R. Holnbeck, Helena

FUNDING SOURCES: Montana Department of Transportation and U.S. Geological Survey



PROBLEM: Scour of the streambed in the vicinity of highway bridge piers and abutments during floods has resulted in more bridge failures nationally than all other causes in recent history. Sudden bridge failure due to scour may result in tragic loss of life as well as large economic loss. A preliminary screening study by the Montana Department of Transportation has identified about 83 bridges that might, because of various structural limitations, be susceptible to scour. As many as 1,550 additional bridges need to be evaluated for scour potential at a less-detailed level. Scour results are needed by early 1997 as part of a national bridge-scour program administered by the Federal Highway Administration.

OBJECTIVES: (1) To evaluate and rank the 83 bridges in order of their susceptibility to scour based on hydraulic and geomorphic considerations. (2) To conduct detailed bridge-scour analyses at the 83 bridges to estimate scour depth for various flood magnitudes. (3) To develop a procedure for assessing scour at the 1,550 bridges based on the more detailed analyses conducted at the 83 bridges. (4) To obtain about 20 onsite measurements of scour during high-flow discharge at selected sites.

APPROACH: Conduct detailed bridge-scour analyses at the 83 sites for the first 3 years of the study. Each analysis will consist of a hydrologic investigation to determine flood-frequency characteristics of the site and a hydraulic analysis to determine water-surface elevations for selected flood magnitudes. Apply various scour-prediction equations to estimate maximum scour depth. Based on detailed analyses, develop an envelope-curve approach relating scour to readily measurable field variables and apply the procedure to as many as 1,550 bridges statewide. Onsite scour measurements will include high-flow velocity measurements, collection of bed-material samples, and depth soundings at the bridge cross section.

PROGRESS DURING FISCAL YEAR 1994: Completed surveying tasks for 79 of 83 bridges for detailed bridge-scour analysis. Completed detailed analyses for about 20 sites. Met with cooperator to discuss progress, technical methods, and future plans. As a result of meetings, the project was changed so that the next 2 years will be devoted to completing both detailed scour analyses for the 83 sites and less-detailed analyses using the envelope-curve approach at as many as 1,550 additional sites.

MT141 Bridge-scour investigation, Sweet Grass Creek near Big Timber. Photograph by S.R. Holnbeck, U.S. Geological Survey.

PLANS FOR FISCAL YEAR 1995: Visit as many as several hundred bridge sites and estimate scour depth using envelope-curve approach. Estimates will be based on measurements of only a few hydraulic variables. Continue detailed analyses for sites from the original 83 that have not been completed.

INFORMATION PRODUCTS: Holnbeck, S.R., Parrett, Charles, and Tillinger, T.N., 1993, Bridge scour and change in contracted section, Razor Creek, Montana, *in* Hydraulic Engineering '93, volume 2, Proceedings of the 1993 Conference, San Francisco, California, July 25-30, 1993: New York, American Society of Civil Engineers, p. 2,249-2,254.

Holnbeck, S.R., Evaluation of potential bridge scour in Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Holnbeck, S.R., and Parrett, Charles, Method for estimation of scour at highway bridges based on limited site data: U.S. Geological Survey Water-Resources Investigations Report (planned).

PROJECT TITLE: East Helena National Priorities List Site--Technical Assistance (MT142)

LOCATION: East Helena, Montana

PERIOD OF PROJECT: April 1991 to June 1996

PROJECT CHIEF: Robert E. Davis, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency

PROBLEM: Smelting activities have resulted in contamination of ground water by arsenic and possibly heavy metals. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List for remedial activities.

OBJECTIVES: (1) To provide technical assistance to EPA by reviewing and evaluating existing data and interpretations. (2) To attend technical meetings with regulatory agencies or responsible parties.

APPROACH: Provide technical assistance as requested by EPA.

PROGRESS DURING FISCAL YEAR 1994: No technical assistance was requested or provided.

PLANS FOR FISCAL YEAR 1995: Provide technical assistance as requested.

INFORMATION PRODUCTS: None.

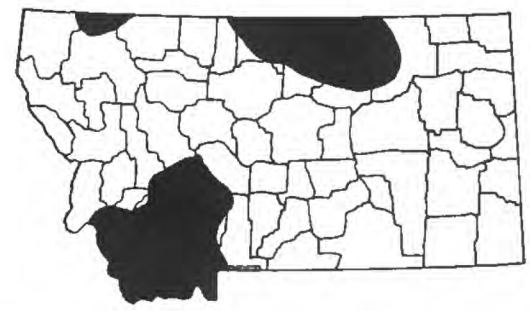
PROJECT TITLE: Estimation of Natural Flows in Selected River Basins (MT143)

LOCATION: Montana

PERIOD OF PROJECT: October 1991 to September 1994

PROJECT CHIEF: Charles Parrett, Helena

FUNDING SOURCE: Bureau of Reclamation



PROBLEM: The Bureau of Reclamation is developing monthly streamflow accounting models for use in various basins in Montana. To make comparisons between alternative water-allocation schemes, the Bureau of Reclamation requires a consistent data base of natural streamflow (no human flow adjustments or depletions) at selected sites in selected basins.

OBJECTIVES: To develop a record of natural monthly streamflows for selected base periods at selected sites in various river basins in Montana.

APPROACH: Use natural flows previously computed by the U.S. Geological Survey for other purposes and projects whenever possible. Use methods previously used by the U.S. Geological Survey, based on data transfer from nearby gaged sites and estimation by regression equations, at sites where existing natural-flow data are not available. All calculated natural flows will be extended to a selected base period using a streamflow-record extension program.

PROGRESS DURING FISCAL YEAR 1994: Prepared and received review for draft reports documenting natural-flow computations in the Milk River and Missouri River Basins. Computed natural flow for 12 sites in the Musselshell River Basin.

PLANS FOR FISCAL YEAR 1995: Submit draft report for Musselshell River Basin for review. Submit reports for Milk River, Missouri River, and Musselshell River Basins for approval and publish.

INFORMATION PRODUCTS: Cary, L.E., Synthesis of natural flows at selected sites in the upper Missouri River Basin, 1928-89: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT143 Streamflow-gaging station at North Milk River near International Boundary, near Del Bonita. Photograph by Donald A. Bischoff, U.S. Geological Survey.

Cary, L.E., and Parrett, Charles, 1995, Synthesis of natural flows at selected sites in and near the Milk River Basin, Montana, 1928-89: U.S. Geological Survey Water-Resources Investigations Report 95-4022, 42 p

Vining, K.C., and Johnson, D.R., Determination of natural flows for selected sites in the Musselshell River Basin, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

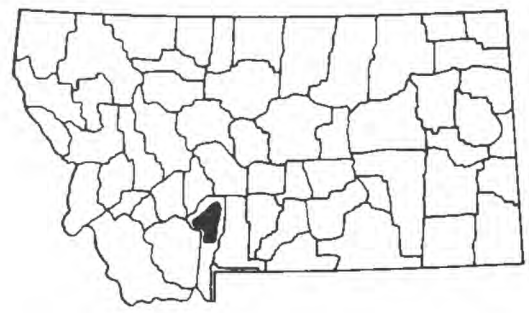
PROJECT TITLE: Gallatin Valley Ground Water (MT145)

LOCATION: Southwestern Montana

PERIOD OF PROJECT: February 1992 to April 1994

PROJECT CHIEF: Steven E. Slagle, Helena

FUNDING SOURCES: Montana Bureau of Mines and Geology and U.S. Geological Survey



PROBLEM: Increases in population in the Gallatin Valley have resulted in increased domestic water use, particularly from ground water. The increase in population also has resulted in increased potential for degradation of the ground water by septic systems and surface applications of chemicals, including fertilizers and pesticides.

OBJECTIVES: (1) To evaluate the hydrology, including water quality, of unconsolidated deposits in the Gallatin Valley. (2) To document hydrologic changes resulting from changes in land use. Specific objectives are (a) characterize the present ground-water flow system, (b) compile information on aquifer characteristics, (c) determine present ground-water quality, (d) determine general land-use distribution, and (e) determine changes in geohydrologic conditions and land use.

APPROACH: Compile existing data, prepare base map, measure water levels, establish monitoring network, sample selected wells for water quality, analyze data, and prepare report.

PROGRESS DURING FISCAL YEAR 1994: Prepared draft data report and draft interpretive report. Received colleague review for both reports.

PLANS FOR FISCAL YEAR 1995: Submit reports for approval and publish reports.

INFORMATION PRODUCTS: Craigg, S.D., in press, Hydrogeologic conditions and land use in the Gallatin Valley near Bozeman, southwestern Montana [abs.]: Geological Society of America Meeting, Rocky Mountain Section, May 18-19, 1995, Bozeman, Montana

Slagle, S.E., in press, Records of water levels in monitoring wells in the Gallatin Valley, southwestern Montana, 1947-93: U.S. Geological Survey Open-File Report 94-536, 41 p.

Slagle, S.E., in press, Geohydrologic conditions and land use in the Gallatin Valley, southwestern Montana, 1992-93: U.S. Geological Survey Water-Resources Investigations Report WRIR 95-4034, 2 sheets.

MT145 Gallatin Valley, view northeast from about 10 miles west of Bozeman. Bridger Range in background. Photograph by L.K. Tuck, U.S. Geological Survey.

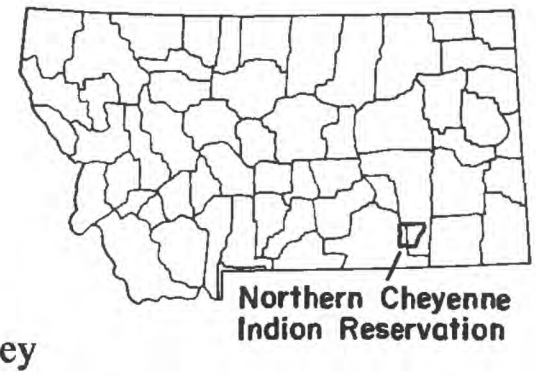
PROJECT TITLE: Northern Cheyenne Indian Reservation 100-Year Flood Plains (MT146)

LOCATION: Southeastern Montana

PERIOD OF PROJECT: October 1991 to September 1995

PROJECT CHIEF: Robert J. Omang, Helena

FUNDING SOURCES: Northern Cheyenne Tribe and U.S. Geological Survey



PROBLEM: The areas that would be inundated by a 100-year flood along streams in the Northern Cheyenne Indian Reservation are of interest to the Northern Cheyenne Tribe. The Tribe needs information on areas prone to flooding concerning the location of buildings, structures, roads, and other facilities in order to preclude the uneconomic, hazardous, or unnecessary use of the flood plain.

OBJECTIVES: To determine the extent of flooding that would occur as the result of a 100-year recurrence-interval flood along Lame Deer Creek, Muddy Creek, Rosebud Creek, and the Tongue River.

APPROACH: (1) Conduct reconnaissance and surveying of channel and flood-plain cross sections for Lame Deer, Muddy, and Rosebud Creeks, and the Tongue River. (2) Identify existing reference marks and, if necessary, establish new ones. (3) Determine Manning's roughness coefficient for each section. (4) Determine 100-year discharge for each study reach. (5) Determine water-surface elevations for a 100-year flood using the computer program WSPRO. Delineate areas of potential flooding on maps of scale 1:24,000. Prepare and publish reports.

PROGRESS DURING FISCAL YEAR 1994: Published reports for Lame Deer Creek and Muddy Creek. Prepared draft report for Rosebud Creek and received colleague review. Completed field work for Tongue River part of study and began analysis of data.

PLANS FOR FISCAL YEAR 1995: Complete data analysis and prepare draft report for Tongue River. Obtain approval and publish report for Rosebud Creek.

MT146 Upstream view of culverts on Lame Deer Creek at Lame Deer. Photograph by R.J. Omang, U.S. Geological Survey.

INFORMATION PRODUCTS: Omang, R.J., 1994, Water-surface profile and flood boundaries for the computed 100-year flood, Muddy Creek, Northern Cheyenne Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report 93-4215, 1 sheet, scale 1:18,000.

Omang, R.J., 1994, Water-surface profile and flood boundaries for the computed 100-year flood, Lame Deer Creek, Northern Cheyenne Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report 93-4216, 1 sheet, scale 1:18,000.

Omang, R.J., Water-surface profile and flood boundaries for the computed 100-year flood, Rosebud Creek, Northern Cheyenne Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Omang, R.J., Water-surface profile and flood boundaries for the computed 100-year flood, Tongue River, Northern Cheyenne Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

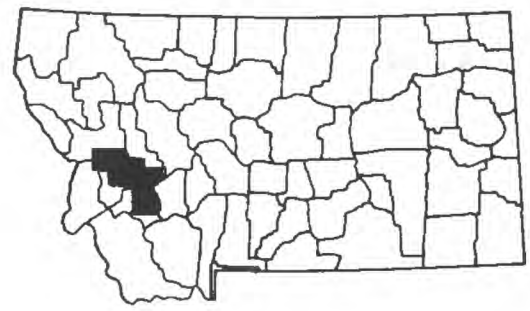
PROJECT TITLE: Upper Clark Fork Monitoring (MT148)

LOCATION: Western Montana

PERIOD OF PROJECT: March 1993 through September 1995

PROJECT CHIEF: John H. Lambing, Helena

FUNDING SOURCE: U.S. Environmental Protection Agency



PROBLEM: Mine and mill tailings have contaminated the Clark Fork streambed and flood plain from the headwaters to Milltown Dam near Missoula. The U.S. Environmental Protection Agency (EPA) has designated the river as an extended National Priorities List site, the largest in the Nation. A long-term program was initiated to document water quality and the transport and accumulation of metals throughout the upper basin. Identification of changes with time can be used to evaluate the effectiveness of remediation efforts.

OBJECTIVES: To operate streamflow-gaging stations, daily suspended-sediment monitoring sites, and periodic water-quality monitoring sites on the mainstem of the Clark Fork and its major tributaries in order to quantify transport of suspended sediment and metals through the system. Bed sediment and aquatic insects are sampled once-annually to describe accumulation in the benthic environment.

APPROACH: Operate streamflow-gaging stations at 16 sites (7 of which are operated as part of this project, 9 as part of other activities), collect periodic water-quality samples at 16 sites, and collect daily suspended-sediment samples at 6 sites to document water quality and the transport of metals and sediment. Collect bed sediment and biota samples at 13 sites to describe accumulation patterns. Prepare reports describing data collection and analytical results annually. Prepare an interpretive report based on data collected from 1991-95 in 1996.

MT148 Sampling aquatic insects in the Clark Fork near Galen. Photograph by J.H. Lambing, U.S. Geological Survey.

PROGRESS DURING FISCAL YEAR 1994: Collected, reviewed, and compiled data for 16 sites on the Clark Fork mainstem and selected tributaries. Published an open-file report for data collected during water year 1993.

PLANS FOR FISCAL YEAR 1995: Continue long-term sampling program.

INFORMATION PRODUCTS: Lambing, J.H., Hornberger, M.I., Axtmann, E.V., and Pope, D.A., 1994, Water-quality, bed-sediment, and biological data (October 1992 through September 1993) and statistical summaries of water-quality data (March 1985 through September 1993) for streams in the upper Clark Fork Basin, Montana: U.S. Geological Survey Open-File Report 94-375, 85 p.

Shields, R.R., White, M.K., Brosten,T.M., and Chambers, C.L., 1994, Water resources data, Montana, water year 1993: U.S. Geological Survey Water-Data Report MT-93-1, 512 p.

Lambing, J.H., Water-quality characteristics of the upper Clark Fork Basin, Montana, water years 1991-95: U.S. Geological Survey Water-Resources Investigations Report (planned).

Lambing, J.H. ,Water-quality data for the upper Clark Fork Basin, water year 1994: U.S. Geological Survey Open-File Report (planned).

PROJECT TITLE: Ground Water in Unconsolidated Deposits, Blackfeet Indian Reservation (MT149)

LOCATION: Northwestern Montana

PERIOD OF PROJECT: August 1993 through July 1995

PROJECT CHIEF: Michael R. Cannon, Helena

FUNDING SOURCES: Blackfeet Nation and U.S. Geological Survey

PROBLEM: Browning, the largest community in the Blackfeet Reservation, has a severe shortage of water. The public water-supply system is inadequate to meet needs for homes, businesses, and fire protection. Development of ground water has not been adequate to meet demands because bedrock and glacial-deposit aquifers underlying Browning yield only a small quantity of water to wells. Exploration for aquifers capable of supporting municipal wells is needed as a first step in developing an adequate water supply.

OBJECTIVES: (1) To explore unconsolidated deposits in the Browning area for coarse-grained aquifers. (2) Determine hydraulic properties, water quality, recharge, and discharge of aquifers.

APPROACH: Map alluvial terraces, flood-plain alluvium, and meltwater channels in the Browning area. Use seismic-refraction and well data to determine thickness of unconsolidated deposits. Drill test wells in areas most favorable for water development. Conduct aquifer tests to determine well yield and hydraulic properties of aquifers. Collect and analyze water samples to determine water quality. Prepare and publish report.

PROGRESS DURING FISCAL YEAR 1994: Obtained and interpreted seismic refraction data. Completed three test wells in alluvium along Cut Bank Creek. Completed geologic mapping. Data indicate that saturated thickness of gravel deposits on Starr School Flat is relatively small. Test drilling in alluvium indicates large well yields are possible in some areas along Cut Bank Creek.

PLANS FOR FISCAL YEAR 1995: Complete test drilling. Conduct long-term aquifer test. Prepare draft report, complete review process, obtain approval, and publish.

INFORMATION PRODUCTS: Cannon, M.R., Hydrogeology of unconsolidated deposits in the Browning area, Blackfeet Indian Reservation, northwestern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT149 Test-well drilling in alluvium along Cut Bank Creek near Starr School, northwest of Browning, Blackfeet Indian Reservation. Photograph by M.R. Cannon, U.S. Geological Survey.

PROJECT TITLE: Madison and Upper Missouri River Arsenic (MT150)

LOCATION: Southwestern Montana

PERIOD OF PROJECT: July 1993 through July 1996

PROJECT CHIEF: David A. Nimick

FUNDING SOURCES: Montana Department of Natural Resources and Conservation and U.S. Geological Survey

PROBLEM: Geothermal water in Yellowstone National Park causes elevated arsenic concentrations in the Madison and upper Missouri Rivers. The arsenic may pose a public health risk where river water or ground water recharged by river water is used for drinking water. Use of river water for irrigation may also increase arsenic concentrations in the rivers and cause exceedances of current water-quality standards.

OBJECTIVES: (1) To provide hydrologic information needed to more fully understand the extent, magnitude, and causes of arsenic in surface and ground water in the Madison and Missouri River valleys. (2) To assess the net effect of irrigation on arsenic concentrations.

APPROACH: Compile existing data and collect water-level and water-quality data to document areal occurrence of arsenic in ground water and establish a geographic information system data base for aiding data interpretation and presentation. Conduct geochemical study near Three Forks to determine relation between irrigation and arsenic in ground water and collect surface-water-quality and discharge data.

PROGRESS DURING 1994: Completed well inventory and ground-water-quality sampling. Began data compilation. Conducted periodic sampling at mainstem sites. Completed most of the data collection for the geochemical study of the lower Madison River Valley and began data analysis.

PLANS FOR FISCAL YEAR 1995: Complete periodic sampling of mainstem sites and data collection for lower Madison River Valley. Complete data report. Prepare draft map report and interpretive report and complete review process. Obtain approval and publish.

INFORMATION PRODUCTS: Nimick, D.A., Geochemical controls on arsenic in ground water under an irrigated valley, lower Madison River Valley, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Tuck, L.K., and Nimick, D.A., Arsenic data for the Madison and upper Missouri River Valleys, Montana: U.S. Geological Survey Open-File Report (planned).

Tuck, L.K., and Nimick, D.A., Occurrence and sources of arsenic in ground water in the Madison and upper Missouri River Valleys, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT150 Irrigation diversion canal from Madison River near Three Forks. Photograph by D.A. Nimick, U.S. Geological Survey.

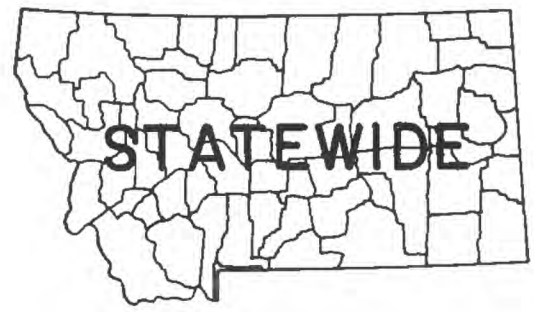
PROJECT TITLE: Extreme Hydrologic Events (MT151)

LOCATION: Statewide

PERIOD OF PROJECT: August 1993 through September 1996

PROJECT CHIEF: Charles Parrett, Helena

FUNDING SOURCES: Montana Department of Natural Resources and Conservation, Dam Safety Section, and U.S. Geological Survey



PROBLEM: Design floods for sizing spillways for dams are typically developed using the probable maximum precipitation (PMP) standard for calculating a probable maximum flood (PMF). The PMF standard has been criticized because it represents "worst-case" conditions and results in calculating an extremely rare, large flood. Because the probability of occurrence of the PMP storm is unknown and may vary from site to site, accurate assessment of risk is impossible.

OBJECTIVES: (1) To analyze annual precipitation maxima for Montana. (2) To analyze temporal characteristics of extreme storms and develop methods for estimating design storms. (3) To compare calculated design-flood peaks to historic peaks determined by paleohydrologic techniques.

APPROACH: Divide the study into four tasks: (1) Complete a regional analysis of annual precipitation maxima in Montana, initiated by the Dam Safety Section, Montana Department of Natural Resources and Conservation. (2) Compile and analyze the temporal characteristics of extreme storms in Montana and develop methods for estimating design storms using procedures developed in Washington State. (3) Compare calculated design-flood peaks to historic peaks determined by paleohydrologic techniques at several selected sites in Montana. (4) Document study findings in one or more reports.

PROGRESS DURING FISCAL YEAR 1994: Compiled data for 24-hour duration storms for 355 sites and for 1-, 2-, and 6-hour duration storms for 120 sites. Completed regional analysis using L-moment statistics. Presented paper describing the relation of elevation and flooding in Montana at a national meeting of the American Society of Civil Engineers in Buffalo, New York, August 1994.

MT151 Tipping-bucket gage and recorder near Mosby, central Montana. Photograph by Charles Parrett, U.S. Geological Survey.

PLANS FOR FISCAL YEAR 1995: Complete analysis of temporal characteristics of large storms, complete report documenting regional analysis, begin report describing analysis of temporal characteristics of large storms, and complete reconnaissance of potential paleoflood-investigation sites.

INFORMATION PRODUCTS: Parrett, Charles, and Holnbeck, S.R., 1994, Relation between largest known flood discharge and elevation in Montana, *in* Cotroneo, G.V., and Rumer, R.R., eds., Hydraulic Engineering '94, volume 2, Proceedings of the 1994 Conference, Buffalo, New York, August 1-5,1994: New York, American Society of Civil Engineers, p. 870-874.

Parrett, Charles, Methods for determining synthetic design storms in Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Parrett, Charles, Regionalization of annual precipitation maxima in Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

PROJECT TITLE: Northern Rocky Mountains National Water-Quality Assessment Program (MT152)

LOCATION: Western Montana, northern Idaho, and eastern Washington

PERIOD OF PROJECT: October 1993 through September 1995

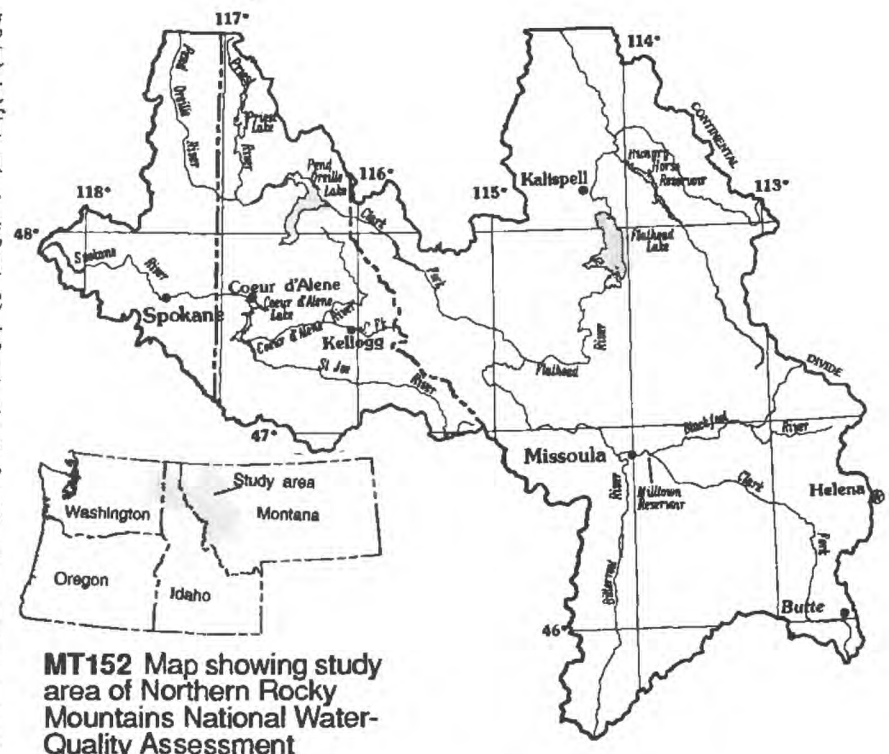
PROJECT CHIEF: David W. Clark, Helena

FUNDING SOURCE: U.S. Geological Survey

PROBLEM: Nationally consistent information is needed to make valid regional comparisons and national statements about current water-quality conditions and about changes in these conditions. The U.S. Geological Survey began implementing a full-scale National Water-Quality Assessment (NAWQA) program in 1991 to address this need. The Northern Rockies Intermontane Basins area was selected as 1 of 60 study units because the basin represents an important hydrologic region where good-quality water is a valued resource vital to the region's economy and the northern location and potential interaction of surface and ground water are essential physical factors necessary for a complete national assessment of water quality. Effects on the quality of ground water, surface water, sediment, and biota, mostly related to precious-metal mining and mineral processing operations, are among the major water-quality concerns in the study unit.

OBJECTIVES: (1) To describe the status and trends in the quality of a representative part of the basins' surface- and ground-water resources. (2) To provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources. Specifically (a) identify the regional physical, chemical, and biological constituents of water quality (herein called target constituents) that are of concern in the Northern Rockies Intermontane Basins study unit, (b) estimate the distribution and annual stream load of selected pesticides, nutrients, and sediments in the basin, (c) describe the relation of water quality to regional land-use practices in aquifers and in major streams, (d) identify the predominant natural and human factors that affect the load and concentration of target constituents measured in water and aquatic animals, (e) describe the long-term regional and sub-regional trends of target constituents in surface water and ground water, (f) design sampling schemes for surface water, ground water, and aquatic animals to effectively monitor for long-term trends in water quality.

APPROACH: Plan project, compile, and analyze existing data during years 1 and 2. If future funding is available, collect and analyze data during years 3 through 5. Prepare report during year 6. Continue data collection at a lower level of activity for the subsequent 5 to 6 years to evaluate long-term trends in the water quality, after which the more intensive data-collection cycle will be repeated. Coordinate project planning through a liaison committee made up of State, Federal and local agencies, and private industries. Compile available water-quality and ancillary data into data bases, including geographical information systems (GIS) for spatial comparisons and statistical analysis. Information from the available data will be used to design data collection needed to accomplish a comprehensive assessment of the basin water quality. Prepare short reports on specific water-quality topics throughout the study. Complete a comprehensive report summarizing the results of the first 6-year cycle in year 7.



MT152 Map showing study area of Northern Rocky Mountains National Water-Quality Assessment Program, western Montana, northern Idaho, and eastern Washington.

PROGRESS DURING FISCAL YEAR 1994: Organized a liaison committee of about 60 organizations and individuals. Identified water-quality issues. Prepared and published a Water Fact Sheet. Initiated water-quality-data acquisition. Identified, evaluated and compiled GIS data bases. Developed staffing and work plans following National guidelines. Began preparation of draft environmental characterization.

PLANS FOR FISCAL YEAR 1995: Maintain contacts with liaison committee, continue preparation of environmental characterization, continue to retrieve water-quality and associated data and GIS coverages, create data-inventory tables and water-quality graphs, update work and staffing plans and vacancy announcements, and possibly begin site identification and field reconnaissance.

INFORMATION PRODUCTS: Clark, D.W., 1994, National Water-Quality Assessment Program--Northern Rockies Intermontane Basins: U.S. Geological Survey Water Fact Sheet Open-File Report 94-124, 2 p.

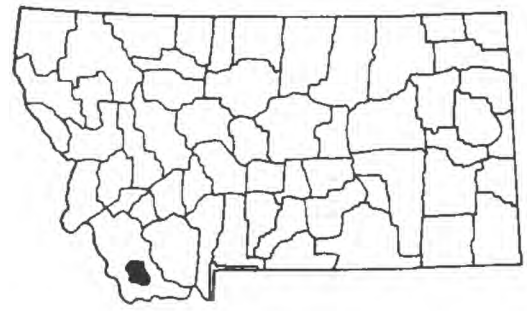
PROJECT TITLE: Ground-Water Tracers (MT153)

LOCATION: Southwestern Montana

PERIOD OF PROJECT: October 1993 through September 1995

PROJECT CHIEF: David W. Clark, Helena

FUNDING SOURCES: Montana Department of Natural Resources and Conservation and U.S. Geological Survey



PROBLEM: The definition of hydrogeologic flow systems, including the amount of water entering aquifers, is a requisite for most ground-water studies. However, conventional physical, chemical, and isotopic methods for defining flow paths, travel times and recharge rates have limitations. Atmospherically borne tracers including chlorofluorocarbons (CFC's) and the ratio of tritium to helium-3 have recently been used to evaluate flow systems. However, they have not been used together in a single study which compares the results of tracer analysis with those of ground-water flow models. Knowledge of a flow system gained from the tracers can place strong constraints on both numerical and conceptual models, and therefore can be helpful in the development, re-evaluation, and refinement of digital-flow models.

OBJECTIVE: (1) To compare techniques and results of using CFC's and ratio of tritium to helium-3 to determine the age dates of ground water in the relatively shallow aquifer system in the Blacktail Deer Creek near Dillon. (2) To determine when tracer age dates improve a ground-water flow model and when the model results identify problems and inconsistencies with tracers.

APPROACH: Water samples will be collected from a total of about 50 wells or bedrock springs located along flow paths from near or in the mountain-front recharge area to the area of natural discharge. Some nested wells with minimal screened intervals will be sampled to determine the vertical flow component and possible stratification of water within the aquifer system. Water samples will be analyzed for CFC's, common and trace constituents, and selected dissolved gases. After the analytical data have been evaluated in general terms, additional samples will be collected and analyzed for CFC's and the ratio of tritium to helium-3 from selected, previously sampled wells. The age dates calculated from the tracer analysis will be used to help determine flow paths, time of travel, potential recharge areas, and vertical components of flow. Cross-sectional flow models will be developed and calibrated for the Blacktail Deer Creek area based on well information, estimates of recharge and discharge, and results of tracer analysis.

MT153 Collection of water sample for age dating using chlorofluorcarbons, near Helena. Photograph by J.E. Elliott, U.S. Geological Survey.

PROGRESS DURING FISCAL YEAR 1994: Forty wells, including 10 pairs of nested deep and shallow wells, were installed by the cooperator. Samples were collected at 52 sites (47 wells, 3 streams, and 2 springs) for CFC analysis to determine age dates. Samples from 12 wells were collected for analysis of dissolved gases to determine ground-water recharge temperatures. Seventeen of the sites were resampled for CFC and tritium/helium analysis. Water samples were collected from a total of 73 wells, bedrock springs, and streams and analyzed for common ions and trace elements. Water-quality data are being used to help describe the ground-water flow system and help differentiate various sources of water.

PLANS FOR FISCAL YEAR 1995: Complete analysis of data after results of laboratory analyses are received. Complete flow-path models and comparisons of the tracer results. Complete draft of final report, complete review process, obtain approval to publish, and publish.

INFORMATION PRODUCTS: Pope, D.A., Clark, D.W., and Lawlor, S.M., Use of atmospherically borne tracers, simulation, water-quality analysis, and geophysics to describe the ground-water flow system near Dillon, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

PROJECT TITLE: Little Bighorn River Ground Water (MT154)

LOCATION: Southeastern Montana

PERIOD OF PROJECT: June 1994 through March 1997

PROJECT CHIEF: Lori K. Tuck, Helena

FUNDING SOURCE: Bureau of Indian Affairs

PROBLEM: Recent concerns about water availability for the Crow Indian Reservation have necessitated a detailed description of the water resources of the reservation. Ground water in alluvial and terrace deposits in the Little Bighorn River Basin may be an important part of the overall water resources of the Crow Indian Reservation.

OBJECTIVES: To describe (1) the geometry of alluvial and terrace deposits, (2) the potentiometric surface and general directions of ground-water flow, (3) hydraulic characteristics of the deposits, (4) recharge and discharge components, and hydraulic interactions with other hydrogeologic units, irrigation canals and the Little Bighorn River, (5) the general quality of water, and (6) the potential availability of ground water from bedrock aquifers.

APPROACH: Compile existing hydrogeologic data. Conduct an inventory of wells to obtain information on static water levels, aquifers, and selected water-quality characteristics. Determine specific capacity of selected wells. Determine aquifer geometry from drillers' logs and, if needed, from surface geophysical investigations. Determine the potentiometric surface from water-level information. Determine hydraulic characteristics from specific-capacity data. Conduct aquifer tests if suitable wells are found. Determine quality of water from about 20 water samples collected from selected wells. Determine recharge and discharge components from gain-loss measurements and analysis of existing data.

PROGRESS DURING FISCAL YEAR 1994: Compiled existing data. Completed the well inventory and entered about 90 percent of the data into data base. Initial well-inventory data indicate that water from alluvium is not extensively used. Many residents use water from the Judith River Formation. Therefore, scope of work will be expanded to include the Judith River Formation in addition to the alluvium.

PLANS FOR FISCAL YEAR 1995: Include both the Judith River Formation and the alluvium in the test-drilling and aquifer-testing activities. Conducted gain-loss measurements in October-November 1994. Water-quality sampling will be conducted in summer 1995.

INFORMATION PRODUCT: Tuck, L.K., Availability of ground water along the Little Bighorn River: U.S. Geological Survey Water-Resources Investigations Report (planned).

PROJECT TITLE: Geographic Information System Data Base, Belt-Sand Coulee Coal-Mining Area (MT155)

LOCATION: Central Montana

PERIOD OF PROJECT: August 1994 through September 1996

PROJECT CHIEF: Michael R. Cannon, Helena

FUNDING SOURCES: Montana Department of State Lands and U.S. Geological Survey

PROBLEM: Abandoned coal mines in the Belt-Sand Coulee area near Great Falls are the source of acidic, mineralized water. The Montana Department of State Lands is trying to minimize the effects of the acid mine drainage by developing and utilizing technologies and techniques to prevent, reduce, or treat the drainage water. A Geographic Information System (GIS) data base is needed to organize and analyze existing information and identify future data requirements.

OBJECTIVES: To develop the hydrogeologic parts of a GIS data base for the Belt-Sand Coulee area. Hydrogeologic parts of the GIS data base will include coverages related to geology, land use, land subsidence, mine discharge points, wells, test holes, ground-water levels, ground-water quality, surface-water quality, solid-phase geochemistry, and past and present monitoring sites.

APPROACH: Obtain geologic mapping of the area from open-file reports prepared by the Montana Bureau of Mines and Geology. Scan or digitize the geologic information on the maps for use in the GIS data base. Determine land use. Determine areas of subsidence from field reconnaissance and available small scale aerial photography. Determine mine-discharge points. Compile data for wells and test holes, ground-water levels, ground-water quality, surface-water quality, solid-phase geochemistry, and past monitoring sites from existing reports and data bases. Existing data will be checked and verified to eliminate obvious errors and duplications and field checked where appropriate.

PROGRESS DURING FISCAL YEAR 1994: Compiled, verified, and field checked existing hydrologic data. Inventoried wells. Evaluated methods for acquiring map data in a digital format.

PLANS FOR FISCAL YEAR 1995: Complete field verification and field checking of existing data. Complete inventory of wells. Complete land-use mapping. Digitize or scan all pertinent map information. Begin report preparation.

INFORMATION PRODUCT: Cannon, M.R., A geographic information system data base for the Belt-Sand Coulee coal-mining area, central Montana: U.S. Geological Survey Open-File Report (planned).

MT155 Sand Coulee at Tracy. Site is downstream from reclaimed mine and sampling sites. Photograph by S.V. Lynn, U.S. Geological Survey.

PROJECT TITLE: Nitrates in the Flaxville Aquifer, Fort Peck Indian Reservation (MT156)

LOCATION: Northeastern Montana

PERIOD OF PROJECT: July 1994 through June 1997

PROJECT CHIEF: Joanna N. Thamke, Helena

FUNDING SOURCES: Fort Peck Indian Reservation and U.S. Geological Survey

PROBLEM: Because of concerns about possible contamination of water supplies for Fort Peck Indian Reservation, the extent and origin of large concentrations of nitrates in the Flaxville aquifer need to be defined.

OBJECTIVES: To determine (1) the lateral distribution and concentration of nitrates in the Flaxville aquifer, (2) the vertical distribution of nitrates in the Flaxville aquifer, (3) possible factors which might affect nitrate concentrations in the Flaxville aquifer, (4) nitrate sources, and (5) hydraulic characteristics of the Flaxville aquifer to describe conditions in unsaturated zones that may influence nitrate concentrations.

APPROACH: Compile existing hydrogeologic data. Inventory 150 wells to obtain static-water levels, nitrate concentrations, and other selected water-quality characteristics. Determine factors which might affect nitrate concentration from land-use maps, fertilizer-use information, and inventory information. Determine possible nitrate sources from water-quality data, fertilizer-use information, and land-use maps. Determine vertical distribution of nitrates in the Flaxville aquifer from wells completed at discrete depths within the aquifer. Hydraulic characteristics will be determined using potentiometric-surface information and multiple-well aquifer tests. Determine chemical conditions in the unsaturated zone from pore-water samples. Document methods, interpretations, and results in a report. Develop a fact sheet using interpretations from the interpretive report, rewritten into a general format. Presentations to pertinent agencies will be developed from the report and fact sheet. Geographic information system coverages generated during the study will be provided to other agencies.

PROGRESS DURING FISCAL YEAR 1994: Inventoried about 150 wells completed in or near the Flaxville Formation. Collected water samples from inventoried wells for nitrate analysis. Compiled existing hydrologic, land-use, and soil-characteristics data from various agencies. Nitrate concentrations in water from wells completed in the Flaxville Formation varied with geographic location.

PLANS FOR FISCAL YEAR 1995: Select sites for drilling and for water-quality sampling. Drill six monitoring wells, two aquifer-test wells, and holes for lysimeters. Complete lysimeter installation. Sample ground water at about 40 sites. Conduct two multiple-well aquifer tests. Conduct pore-water sampling at six lysimeters.

INFORMATION PRODUCT: Thamke, J.N., Extent and origin of nitrates in the Flaxville aquifer, Fort Peck Indian Reservation, northeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT156 Abandoned farmhouse south of a gravel bench formed on the Flaxville Formation, Fort Peck Indian Reservation. Photograph by J.N. Thamke, U.S. Geological Survey.

PROJECT TITLE: Hydrogeologic Evaluation and Aquifer Sensitivity Assessment of the Bitterroot Valley (MT157)

LOCATION: Western Montana

PERIOD OF PROJECT: August 1994 through October 1997

PROJECT CHIEF: David W. Briar, Helena

FUNDING SOURCES: Ravalli County Commissioners and U.S. Geological Survey

PROBLEM: The population of the Bitterroot Valley in Ravalli County of western Montana has increased at one of the fastest rates in the State, nearly doubling from 14,400 in 1970 to 26,200 in 1991. Much of the increase in population has been outside of the established cities and towns and generally is concentrated in housing areas where each dwelling has its own well and septic system. The potential for contamination of local aquifers due to continued growth is large, yet data to determine the effects of this growth and to identify the areas where the aquifer may be sensitive to potential contamination are lacking.

OBJECTIVES: To evaluate the hydrogeology of the Bitterroot Valley and assess the sensitivity of the aquifers to contamination and depletion.

APPROACH: (1) Establish a ground-water-level and ground-water-quality monitoring network to obtain base-line information and to document potential changes in water levels and water quality since previous studies. (2) Implement a geographically indexed, computer-based data framework which will provide a basis for future assessment of impacts from various ground-water management options. (3) Define ground-water flow paths and describe ground-water recharge sources and areas of ground-water discharge. (4) Characterize the potential sources of ground-water contamination and, where possible, identify areas with existing contamination resulting from septic systems or other sources.

PROGRESS DURING FISCAL YEAR 1994: Began identification of areas to receive intensive study (focus areas) and initiated well inventory. Identified three of the four focus areas. Inventoried wells in two of the focus areas. About 85 wells have been inventoried in the study area.

PLANS FOR FISCAL YEAR 1995: Continue well inventory, select wells for monitoring-well network and measure water levels bimonthly, select a fourth focus area, conduct water-quality sampling, enter all data into the project geographic information system data base, compile existing data, and acquire needed digital data. Begin data interpretation and report preparation.

INFORMATION PRODUCT: Briar, D.W., Hydrogeologic evaluation and aquifer sensitivity assessment of the Bitterroot Valley, Ravalli County, 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 U.S. Geological Survey is involved in numerous activities in addition to regular programs of data collection and hydrologic investigation. For example, District employees serve as Federal or Geological Survey representatives on advisory committees or ad hoc groups established for specific purposes. Some of the current special activities are:

Committee and task force memberships.--Members of the District staff are working members and advisors to several committees and task forces. Included are the Poplar River Bilateral Monitoring Committee involving the United States and Canada; the Yellowstone River Compact Commission involving Montana, Wyoming, and North Dakota; the Technical Oversight Committee for the Yellowstone Water Rights Compact; the Montana Ground-Water Steering Committee; the Montana Water Research Center Advisory Board; the Montana Interagency Coordinating Committee; the Montana GIS Interagency Management Steering Committee; the Montana GIS Interagency Technical Working Group; the Clark Fork-Pend Oreille Basin Water Quality Monitoring Subcommittee of the Tri-State Implementation Council; the Montana Drought Advisory Committee; the Montana Nonpoint Source Task Force; the Blackfoot Challenge; and the Montana Wetlands Council.

Review of Environmental Impact Statements and other agency reports.--The Water Resources Division reviews Environmental Impact Statements or similar documents 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 also is asked to review reports and projects of other Federal and State agencies, primarily because of the Geological Survey's hydrologic expertise and impartiality. As an example, the District provides technical assistance to the U.S. Environmental Protection Agency concerning activities at Superfund sites throughout the State.

Assistance to other agencies and individuals.--In addition to the Geological Survey's formal programs and studies, water information and assistance are provided to other agencies having specific problems. The District continually receives calls, visits, and mail requests from landowners, consultants, public officials, and businesses for information and data on streamflow, water quality, water use, and ground-water availability. Federal regulations prohibit activity that encroaches on the work of professional consultants in the private sector, 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 U.S. GEOLOGICAL SURVEY PUBLICATIONS AND INFORMATION

Publications of the U.S. Geological Survey are available from various sources. Specific locations for different types of reports follow.

Books

Current reports are listed in a pamphlet, "New Publications of the U.S. Geological Survey." Subscription to the pamphlet, which is issued monthly, is free upon request to:

U.S. Geological Survey
582 National Center
Reston, VA 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:

U.S. Geological Survey
Information Services
Box 25286, Denver Federal Center
Denver, CO 80225-0286
Phone: (303) 236-7477

Records of streamflow, quality of water, and ground-water levels have been published for many years as U.S. Geological Survey Water-Supply Papers. Beginning with water year 1965, however, the data were released in a new publications series, U.S. Geological Survey Water-Data Reports. This series combines for each State: streamflow data, water-quality data for surface 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 1993: U.S. Geological Survey Water-Data Report MT-93-1." 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. Most reports in these series can be purchased in microfiche and paper-copy forms from:

U.S. Geological Survey
Information Services
Box 25286, Denver Federal Center
Denver, CO 80225-0286

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
Information Services
Box 25286, Denver Federal Center
Denver, CO 80225-0286

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:

Montana Bureau of Mines and Geology
Main Hall
Montana Tech of the
University of Montana
Butte, MT 59701

More detailed maps, prepared as part of flood insurance studies, are available for inspection at:

Montana Department of Natural
Resources and Conservation
1520 East Sixth Avenue
P.O. Box 202301
Helena, MT 59620-2301

Aerial photographs

Aerial photographs are available from the EROS Data Center, who provide high- and low-altitude photographs, as well as photographs from NASA's manned aircraft. Direct inquiries to:

U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198
(605) 594-6151

General Information

The Earth Science Information Center (ESIC) provides general information about the programs of the U.S. Geological Survey and its reports and maps. ESIC 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:

U.S. Geological Survey, ESIC
904 West Riverside Avenue, Room 135
Spokane, WA 99201
Phone: (509) 353-2524

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

Water Resources Division
U.S. Geological Survey
National Center, MS 440
12201 Sunrise Valley Drive
Reston, VA 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
National Center, MS 950
12201 Sunrise Valley Drive
Reston, VA 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 water.

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, CO 80225
Phone: (303) 236-5950

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

National maps: Chief, Rocky Mountain Mapping Center
Earth Science Information Center (ESIC)
U.S. Geological Survey
Mail Stop 504, Box 25046
Federal Center
Denver, CO 80225
Phone: (303) 236-5829

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." This 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.

REPORTS PUBLISHED OR RELEASED DURING PRECEDING 5 YEARS

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Cary, L.E., 1991a, Techniques for estimating selected parameters of the U.S. Geological Survey's Precipitation-Runoff Modeling System in eastern Montana and northeastern Wyoming: U.S. Geological Survey Water-Resources Investigations Report 91-4068, 39 p.

____1991b, Trends in selected water-quality characteristics, Powder River and tributaries, Montana and Wyoming, water years 1968-88 and 1975-88: U.S. Geological Survey Water-Resources Investigations Report 91-4029, 42 p.

Clark, D.W., 1991, Changes in ground-water quality resulting from surface mining of coal in the West Decker and Big Sky coal-mining areas, southeastern Montana: American Water Resources Association, Montana Section Meeting, Missoula, Montana, September 24-25, 1991 [handout].

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Clark, D.W., and Kendy, Eloise, 1992a, Plan of study for the regional aquifer-system analysis of the Northern Rocky Mountains intermontane basins, Montana and Idaho: U.S. Geological Survey Water-Resources Investigations Report 92-4116, 16 p.

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Harksen, C.J., and Midtlyng, K.S., compilers, 1991, Water-resources activities of the U.S. Geological Survey in Montana, October 1989 through September 1991: U.S. Geological Survey Open-File Report 91-191, 77 p.

Holnbeck, S.R., and Parrett, Charles, 1993, Estimation of unit hydrographs for large floods at ungaged sites in Montana: U.S. Geological Survey Open-File Report 93-168, 69 p.

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Johnson, D.R., 1992, Streamflow for irrigation in the upper Pryor Creek Basin, Montana, base period water years 1937-86: U.S. Geological Survey Water-Resources Investigations Report 92-4015, 18 p.

Kendy, Eloise, 1991, Regional study of the northern Rocky Mountains intermontane basin aquifers, Montana and Idaho: American Water Resources Association, Montana Section Meeting, Missoula, Montana, September 24-25, 1991 [handout].

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Table 1. Surface-water gaging stations in operation in Montana, October 1994

Station number

Stations are listed in downstream order by standard drainage-basin number: Part 05 (Hudson Bay basin), Part 06 (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 principal-reservoir gaging stations is shown in figure 6. All stations are in Montana, except as indicated.

Funding source

BIA	Bureau of Indian Affairs
BLRES	Blackfeet Nation
BPA	Bonneville Power Administration
BR	Bureau of Reclamation
CHRES	Northern Cheyenne Tribe
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FLRES	Confederated Salish and Kootenai Tribes of the Flathead Reservation
FPRES	Fort Peck Tribes
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
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSE	Wyoming State Engineer
WWT	Department of State-International Joint Commission, Waterways Treaty

Data-collection process (gage equipment)

DCP - Data-collection platform
O - Observer record, reservoir
S - Stage recorder

Type of record published

C - Continuous
M - Monthend
Se - Seasonal

Table 1. Surface-water gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Funding source	Data-collection process (gage equipment)	Type of record published
	Part 05			
05014500	Swiftcurrent Creek at Many Glacier	USGS	S	C
05015500	Lake Sherburne at Sherburne	WWT	DCP,S	C
05016000	Swiftcurrent Creek at Sherburne	WWT	S	Se
05017500	St. Mary River near Babb	WWT	S	C
05018500	St. Mary Canal at St. Mary Crossing, near Babb	WWT	DCP,S	Se
05020500	St. Mary River at International Boundary, Alberta	BR,WWT	DCP,S	C
	Part 06			
06008000	Odell Creek above Taft Ranch, near Lakeview	USFWS	S	Se
06012000	Lima Reservoir near Monida	USGS	O	M
06012500	Red Rock River below Lima, near Monida	BR	DCP,S	Se
06015300	Clark Canyon Reservoir near Grant	USGS	DCP,S	M
06016000	Beaverhead River at Barretts	BR	S	Se
06018500	Beaverhead River near Twin Bridges	BR,USGS	DCP,S	C
06019500	Ruby River above reservoir, near Alder	MDNRC	S	C
06020500	Ruby River Reservoir near Alder	MDNRC	O	M
06020600	Ruby River below reservoir, near Alder	MDNRC	S	C
06024450	Big Hole River below Big Lake Creek, at Wisdom	MDFWP	S	Se
06025500	Big Hole River near Melrose	MDFWP, MDNRC	DCP,S	C
06026500	Jefferson River near Twin Bridges	MDFWP	DCP,S	C
06033000	Boulder River near Boulder	MDNRC	S	C
06035000	Willow Creek near Harrison	MDNRC	S	Se
06036000	Willow Creek Reservoir near Harrison	MDNRC	O	M
06036650	Jefferson River near Three Forks	MDFWP, USAE	DCP,S	C
06037500	Madison River near West Yellowstone	USGS	S	C
06038000	Hebgen Lake near West Yellowstone	FERC	DCP,O	M
06038500	Madison River below Hebgen Lake, near Grayling	FERC	DCP,S	C
06038800	Madison River at Kirby Ranch, near Cameron	FERC	DCP,S	C
06040500	Ennis Lake near McAllister	FERC	O	M
06041000	Madison River below Ennis Lake, near McAllister	FERC	DCP,S	C
06043500	Gallatin River near Gallatin Gateway	MDFWP	DCP,S	C
06049500	Middle Creek Reservoir near Bozeman	MDNRC	O	M
06050000	Hyalite Creek at Hyalite Ranger Station, near Bozeman	MDNRC	S	Se
06052500	Gallatin River at Logan	USAE	DCP,S	C
06054500	Missouri River at Toston	MDFWP, MDNRC, USAE,USGS	DCP,S	C
06058500	Canyon Ferry Lake near Helena	USGS	DCP,S	M
06058600	Helena Valley Reservoir	BR	DCP,O	M
06061500	Prickly Pear Creek near Clancy	MDNRC	S	C
06064500	Lake Helena near Helena	FERC	O	M
06065000	Hauser Lake near Helena	FERC	O	M
06065500	Missouri River below Hauser Dam, near Helena	FERC	S	C
06066000	Holter Lake near Wolf Creek	FERC	O	M
06066500	Missouri River below Holter Dam, near Wolf Creek	FERC	DCP,S	C
06071300	Little Prickly Pear Creek at Wolf Creek	MDFWP	S	C
06073500	Dearborn River near Craig	MDFWP	DCP,S	C
06075000	Smith River Reservoir near White Sulphur Springs	MDNRC	O	M
06076690	Smith River near Fort Logan	MDFWP, MDHES	DCP,S	C
06078200	Missouri River near Ulm	USAE	DCP,S	C
06078230	Sand Coulee above Cottonwood Creek, at Centerville	MDSL	S	Se
06078250	Cottonwood Creek near Stockett	MDSL	S	Se
06078260	Number Five Coulee below Giffen Spring, near Stockett	MDSL	S	Se
06078270	Sand Coulee at Sand Coulee	MDSL	S	Se
06079500	Gibson Reservoir near Augusta	BR,MDNRC	DCP,O	M

Table 1. Surface-water gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Funding source	Data-collection process (gage equipment)	Type of record published
	Part 06--Continued			
06080500	Pishkun Reservoir near Augusta	MDNRC	O	M
06082000	Willow Creek Reservoir near Augusta	BR,MDNRC	DCP,O	M
06083000	Nilan Reservoir near Augusta	MDNRC	O	M
06088500	Muddy Creek at Vaughn	BR,USGS	S	C
06089000	Sun River near Vaughn	FERC,USAE, USGS	DCP,S	C
06090300	Missouri River near Great Falls	FERC	S	C
06090570	Big Otter Creek near Belt	MDHES	S	Se
06090590	Anaconda Drain at Belt	MDSL	S	Se
06090650	Lake Creek near Power	USFWS, USGS	S	Se
06090800	Missouri River at Fort Benton	USGS	S	C
06090900	Lower Two Medicine Lake near East Glacier	MDNRC	O	M
06091700	Two Medicine River below South Fork, near Browning	BLRES,BR	DCP,S	C
06093000	Four Horns Lake near Heart Butte	MDNRC	O	M
06093200	Badger Creek below Four Horns Canal, near Browning	BLRES,BR	DCP,S	C
06094000	Swift Reservoir near Dupuyer	MDNRC	O	M
06095500	Lake Frances near Valier	MDNRC	O	M
06098500	Cut Bank Creek near Browning	BLRES,BR	DCP,S	C
06099000	Cut Bank Creek at Cut Bank	BIA,BLRES	S	C
06099500	Marias River near Shelby	USGS	DCP,S	C
06101300	Lake Elwell near Chester	USGS	DCP,O	M
06101500	Marias River near Chester	BR	DCP,S	C
06108000	Teton River near Dutton	USGS	S	C
06109500	Missouri River at Virgelle	USAE	DCP,S	C
06110500	Ackley Lake near Hobson	MDNRC	O	M
06115200	Missouri River near Landusky	USAE	DCP,S	C
06116500	Bair Reservoir near Delpine	MDNRC	O	M
06119000	Martinsdale Reservoir near Martinsdale	MDNRC	O	M
06120500	Musselshell River at Harlowton	MDNRC	S	C
06122500	Deadmans Basin Reservoir near Shawmut	MDNRC	O	M
06122800	Musselshell River near Shawmut	MDNRC	DCP,S	Se
06126050	Musselshell River near Lavina	MDNRC	DCP,S	Se
06126500	Musselshell River near Roundup	MDNRC, USAE	DCP,S	C
06127500	Musselshell River at Musselshell	MDNRC	DCP,S	Se
06130500	Musselshell River at Mosby	BR,USAE	S	C
06131000	Big Dry Creek near Van Norman	USAE,USGS	DCP,S	C
06131500	Fort Peck Lake at Fort Peck	USAE	O	M
06131800	Missouri River stage station No. 1 near Fort Peck	USAE	S	C
06132000	Missouri River below Fort Peck Dam	USAE	S	C
06132200	South Fork Milk River near Babb	BIA	S	Se
06133000	Milk River at western crossing of International Boundary	BIA,WWT	DCP,S	Se
06133500	North Fork Milk River above St. Mary Canal, near Browning	BR,WWT	DCP,S	Se
06134000	North Milk River near International Boundary, Alberta	BR,WWT	DCP,S	Se
06134500	Milk River at Milk River, Alberta	WWT	S	C
06134700	Verdigris Coulee near mouth, near Milk River, Alberta	WWT	S	Se
06135000	Milk River at eastern crossing of International Boundary	BR,WWT	DCP,S	Se
06136500	Fresno Reservoir near Havre	MDNRC	O	M
06137400	Big Sandy Creek at reservation boundary, near Rocky Boy	BIA	S	C
06137570	Boxelder Creek near Rocky Boy	BIA	S	C
06139500	Big Sandy near Havre	BIA	S	Se
06140500	Milk River at Havre	USAE	S	C
06141600	Little Boxelder Creek at mouth, near Havre	MDNRC	S	Se
06142400	Clear Creek near Chinook	BR	DCP,S	Se
06144260	Altawan Reservoir near Govenlock, Saskatchewan	WWT	S	M
06144270	Spangler Ditch near Govenlock, Saskatchewan	WWT	S	Se

Table 1. Surface-water gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Funding source	Data-collection process (gage equipment)	Type of record published
	Part 06--Continued			
06144350	Middle Creek near Saskatchewan boundary, Saskatchewan	WWT	S	Se
06144360	Middle Creek Reservoir near Battle Creek, Saskatchewan	WWT	S	Se
06144395	Middle Creek below Middle Creek Reservoir, near Govenlock, Saskatchewan	WWT	S	Se
06144440	Middle Creek near Govenlock, Saskatchewan	WWT	S	Se
06144450	Middle Creek above Lodge Creek, near Govenlock, Saskatchewan	WWT	S	Se
06145500	Lodge Creek below McRae Creek, at International Boundary	WWT	DCP,S	Se
06147950	Gaff Ditch near Merryflat, Saskatchewan	WWT	S	Se
06148500	Cypress Lake west inflow canal near West Plains, Saskatchewan	WWT	S	Se
06148700	Cypress Lake west inflow canal drain near Oxarat, Saskatchewan	WWT	S	Se
06149000	Cypress Lake west outflow canal near West Plains, Saskatchewan	WWT	S	Se
06149100	Vidora Ditch near Consul, Saskatchewan	WWT	S	Se
06149200	Richardson Ditch near Consul, Saskatchewan	WWT	S	Se
06149300	McKinnon Ditch near Consul, Saskatchewan	WWT	S	Se
06149400	Nashlyn Canal near Consul, Saskatchewan	WWT	S	Se
06149500	Battle Creek at International Boundary, Saskatchewan	WWT	DCP,S	Se
06151000	Lyons Creek at International Boundary	WWT	S	Se
06151500	Battle Creek near Chinook	BIA	DCP,S	Se
06154100	Milk River near Harlem	BR,MDNRC	DCP,S	Se
06154400	Peoples Creek near Hays	BIA	DCP,S	C
06154410	Little Peoples Creek near Hays	USGS	S	C
06154430	Lodge Pole Creek at Lodge Pole	BIA	S	C
06154550	Peoples Creek below Kuhr Coulee, near Dodson	BIA	S	C
06155000	Nelson Reservoir near Saco	MDNRC	O	M
06155030	Milk River near Dodson	BR,MDNRC	DCP,S	Se
06156500	Belanger Creek diversion canal near Vidora, Saskatchewan	WWT	S	Se
06157000	Cypress Lake near Vidora, Saskatchewan	WWT	S	Se
06157500	Cypress Lake east outflow canal near Vidora, Saskatchewan	WWT	S	Se
06158500	Eastend Canal at Eastend, Saskatchewan	WWT	S	Se
06159000	Eastend Reservoir at Eastend, Saskatchewan	WWT	S	Se
06161300	Huff Lake pumping canal near Val Marie, Saskatchewan	WWT	S	Se
06161500	Huff Lake gravity canal near Val Marie, Saskatchewan	WWT	S	Se
06162000	Huff Lake near Val Marie, Saskatchewan	WWT	S	M
06162500	Newton Lake main canal near Val Marie, Saskatchewan	WWT	S	Se
06163000	Newton Lake near Val Marie, Saskatchewan	WWT	S	M
06163050	Frenchman River below Newton Lake, near Val Marie, Saskatchewan	WWT	S	Se
06164000	Frenchman River at International Boundary	WWT	DCP,S	Se
06164510	Milk River at Juneberg Bridge, near Saco	BR,USGS	DCP,S	C
06169500	Rock Creek below Horse Creek, near International Boundary	USGS	S	C
06172310	Milk River at Tampico	MDNRC	S	Se
06174500	Milk River at Nashua	USAE	DCP,S	C
06175100	Missouri River stage station No. 3 at West Frazer pumping plant, near Frazer	USAE	S	C
06175510	Missouri River stage station No. 4 at East Frazer pumping plant, near Frazer	USAE	S	C
06175520	Missouri River stage station No. 5 near Oswego	USAE	S	C
06177000	Missouri River near Wolf Point	USAE	DCP,S	C
06177500	Redwater River at Circle	USGS	S	C
06178000	Poplar River at International Boundary	MDNRC, USGS	S	Se
06178500	East Poplar River at International Boundary	MDNRC	S	C
06181000	Poplar River near Poplar	FPRES	DCP,S	C
06181995	Beaver Creek at International Boundary	WWT	S	Se
06183450	Big Muddy Creek near Antelope	USGS	DCP,S	C
06183700	Big Muddy Creek diversion canal near Medicine Lake	USFWS	S	C
06185500	Missouri River near Culbertson	USAE	DCP,S	C

Table 1. Surface-water gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Funding source	Data-collection process (gage equipment)	Type of record published
	Part 06--Continued			
06186500	Yellowstone River at Yellowstone Lake outlet, Yellowstone National Park, Wyo.	USGS	S	C
06187950	Soda Butte Creek near Lamar Ranger Station, Yellowstone National Park, Wyo.	USGS	S	C
06188000	Lamar River near Tower Falls Ranger Station, Yellowstone National Park, Wyo.	USGS	S	C
06190540	Hot River at Mammoth, Yellowstone National Park, Wyo.	USGS	S	C
06191000	Gardner River near Mammoth, Yellowstone National Park	USGS	S	C
06191500	Yellowstone River at Corwin Springs	USAE	DCP,S	C
06192500	Yellowstone River near Livingston	USAE	S	C
06195600	Shields River near Livingston	MDFWP	DCP,S	C
06200000	Boulder River at Big Timber	MDNRC	S	C
06204000	Mystic Lake near Roscoe	FERC	O	M
06204050	West Rosebud Creek near Roscoe	FERC	S	C
06205000	Stillwater River near Absarokee	USAE	S	C
06207500	Clarks Fork Yellowstone River near Belfry	MDNRC	S	C
06208500	Clarks Fork Yellowstone River at Edgar	MDNRC, WSE	S	C
06211000	Red Lodge Creek above Cooney Reservoir, near Boyd	MDNRC	S	Se
06211500	Willow Creek near Boyd	MDNRC	S	Se
06212000	Cooney Reservoir near Boyd	MDNRC	O	M
06212500	Red Lodge Creek below Cooney Reservoir, near Boyd	MDNRC	S	Se
06214500	Yellowstone River at Billings	USAE	DCP,S	C
06216000	Pryor Creek at Pryor	USGS	S	C
06216900	Pryor Creek near Huntley	USGS	S	C
06286400	Bighorn Lake near St. Xavier	USGS	DCP,S	M
06286490	Bighorn Canal near St. Xavier	BR	S	Se
06287000	Bighorn River near St. Xavier	BR	DCP,S	C
06289000	Little Bighorn River at State Line, near Wyola	BIA,USGS	S	C
06290000	Pass Creek near Wyola	BIA	S	C
06290500	Little Bighorn River below Pass Creek, near Wyola	USGS	DCP,S	C
06291500	Lodge Grass Creek above Willow Creek diversion, near Wyola	BIA	S	C
06294000	Little Bighorn River near Hardin	MDNRC, WSE	S	C
06294500	Bighorn River above Tullock Creek, near Bighorn	MDNRC, USAE,WSE	DCP,S	C
06294995	Armells Creek near Forsyth	MBMG	S	C
06295000	Yellowstone River at Forsyth	BR	S	C
06295113	Rosebud Creek at reservation boundary, near Kirby	USGS	S	C
06295250	Rosebud Creek near Colstrip	CHRES	S	C
06296003	Rosebud Creek at mouth, near Rosebud	CHRES	S	C
06306300	Tongue River at State line, near Decker	MDNRC, WSE	S	C
06307000	Tongue River Reservoir near Decker	MDNRC	O	M
06307500	Tongue River at Tongue River Dam, near Decker	MBMG, MDNRC	S	C
06307600	Hanging Woman Creek near Birney	MBMG	S	C
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	S	C
06307740	Otter Creek at Ashland	MBMG	S	C
06308500	Tongue River at Miles City	MDNRC, USAE,WSE	DCP,S	C
06309000	Yellowstone River at Miles City	USAE	DCP,S	C
06324500	Powder River at Moorhead	MDNRC	S	C
06326500	Powder River near Locate	MDNRC, USAE,WSE	DCP,S	C
06329500	Yellowstone River near Sidney	USAE	DCP,S	C

Table 1. Surface-water gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Funding source	Data-collection process (gage equipment)	Type of record published
	Part 12			
12301300	Tobacco River near Eureka	USAE	S	C
12301920	Lake Koocanusa near Libby	USAE	S	C
12301933	Kootenai River below Libby Dam, near Libby	USAE	DCP,S	C
12302055	Fisher River near Libby	USAE	DCP,S	C
12303500	Lake Creek at Troy	FERC	S	C
12304040	Basin Creek near Yaak	USFS	S	C
12304500	Yaak River near Troy	USAE	DCP,S	C
12323240	Blacktail Creek at Butte	EPA	DCP,S	C
12323250	Silver Bow Creek below Blacktail Creek, at Butte	EPA	DCP,S	C
12323600	Silver Bow Creek at Opportunity	EPA	S	C
12323750	Silver Bow Creek at Warm Springs	EPA	S	C
12323770	Warm Springs Creek at Warm Springs	EPA,MDFWP	S	C
12323800	Clark Fork near Galen	EPA,MDFWP	DCP,S	C
12324200	Clark Fork at Deer Lodge	EPA,MDFWP	S	C
12324590	Little Blackfoot River near Garrison	EPA,MDNRC	S	C
12324680	Clark Fork at Goldcreek	EPA,MDFWP	S	C
12325000	Georgetown Lake near Southern Cross	FERC	O	M
12325500	Flint Creek near Southern Cross	FERC	S	C
12327090	Flint Creek above Fred Burr Creek, near Philipsburg	MDNRC	S	Se
12327100	Fred Burr Creek near Philipsburg	MDNRC	S	Se
12329500	Flint Creek at Maxville	MDNRC	S	C
12330000	Boulder Creek at Maxville	MDNRC	S	C
12331500	Flint Creek near Drummond	EPA	S	C
12331800	Clark Fork near Drummond	EPA	DCP,S	C
12332000	Middle Fork Rock Creek near Philipsburg	MDNRC	S	C
12332500	East Fork Rock Creek Reservoir near Philipsburg	MDNRC	O	M
12334510	Rock Creek near Clinton	EPA,MDNRC	DCP,S	C
12334550	Clark Fork at Turah Bridge, near Bonner	EPA,MDFWP	S	C
12335500	Nevada Creek above reservoir, near Finn	MDNRC	S	C
12336500	Nevada Lake near Finn	MDNRC	O	M
12340000	Blackfoot River near Bonner	EPA,USGS	DCP,S	C
12340500	Clark Fork above Missoula	EPA,USAE	S	C
12342000	Painted Rocks Lake near Conner	MDNRC	O	M
12342500	West Fork Bitterroot River near Conner	MDNRC	S	C
12344000	Bitterroot River near Darby	MDNRC	DCP,S	C
12344500	Lake Como near Darby	MDNRC	O	M
12350250	Bitterroot River at Bell Crossing, near Victor	MDFWP	S	Se
12352500	Bitterroot River near Missoula	MDNRC	S	C
12353000	Clark Fork below Missoula	MDHES, USGS	S	C
12354500	Clark Fork at St. Regis	BPA	DCP,S	C
12355000	Flathead River at Flathead, British Columbia	WWT	S	C
12355500	North Fork Flathead River near Columbia Falls	BPA,BR, MDFWP	DCP,S	C
12358500	Middle Fork Flathead River near West Glacier	BPA,BR	DCP,S	C
12359800	South Fork Flathead River above Twin Creek, near Hungry Horse	BR	DCP,S	Se
12362000	Hungry Horse Reservoir near Hungry Horse	BR	S	C
12362500	South Fork Flathead River near Columbia Falls	BR	DCP,S	C
12363000	Flathead River at Columbia Falls	BR,FERC, MDFWP	DCP,S	C
12365000	Stillwater River near Whitefish	MDNRC	S	C
12366000	Whitefish River near Kalispell	MDNRC	S	C
12370000	Swan River near Bigfork	FLRES, MDNRC	S	C
12371000	Turtle Lake near Polson	BIA	O	M
12371500	Flathead Lake at Somers	FERC	S	C
12372000	Flathead River near Polson	FERC	S	C

Table 1. Surface-water gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Funding source	Dete-collection process (gege equipment)	Type of record published
	Part 12--Continued			
12372500	Little Bitterroot Lake near Marion	BIA	O	M
12373500	Hubbart Reservoir near Niarada	BIA	O	M
12374250	Mill Creek above Bassoo Creek, near Niarada	FLRES	S	C
12375000	Upper Dry Fork Reservoir near Lonepine	BIA	O	M
12375500	Dry Fork Reservoir near Lonepine	BIA	O	M
12375900	South Fork Crow Creek near Ronan	FLRES	S	C
12376700	Lower Crow Reservoir near Charlo	BIA	O	M
12377150	Mission Creek above reservoir, near St. Ignatius	FLRES	S	C
12377200	Mission Reservoir near St. Ignatius	BIA	O	M
12377300	St. Marys Lake near St. Ignatius	BIA	O	M
12377900	Pablo Reservoir near Pablo	BIA	O	M
12378200	McDonald Reservoir near Charlo	BIA	O	M
12378300	Kicking Horse Reservoir near Charlo	BIA	O	M
12378400	Ninepipe Reservoir near Charlo	BIA	O	M
12380000	Upper Jocko Lake near Arlee	BIA	O	M
12380500	Lower Jocko Lake near Arlee	BIA	O	M
12381400	South Fork Jocko River near Arlee	FLRES	DCP,S	C
12383500	Big Knife Creek near Arlee	FLRES	S	C
12387450	Valley Creek near Arlee	FLRES	S	Se
12388200	Jocko River at Dixon	FLRES	S	C
12388400	Revais Creek below West Fork, near Dixon	FLRES	S	C
12388700	Flathead River at Perma	FLRES	DCP,S	C
12389000	Clark Fork near Plains	FERC	S	C
12389500	Thompson River near Thompson Falls	FERC	S	C
12390000	Thompson Falls Reservoir at Thompson Falls	FERC	O	M
12390700	Prospect Creek at Thompson Falls	FERC	S	C
12391300	Noxon Rapids Reservoir near Noxon	FERC	S	M
12391400	Clark Fork below Noxon Rapids Dam, near Noxon	FERC	O	C

Table 2. Crest-stage gaging stations in operation in Montana, October 1994

[The stations are funded cooperatively by the Montana Department of Transportation and the U.S. Geological Survey. The Federal Highway Administration of the U.S. Department of Transportation provides services related to the operation of the program]

Station number

Stations are listed in downstream order by standard drainage basin number: Part 06 (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 gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Records available
	Part 06	
06015430	Clark Canyon near Dillon	1969-
06025100	Quartz Hill Gulch near Wise River	1974-
06030300	Jefferson River tributary No. 2 near Whitehall	1958-
06031950	Cataract Creek near Basin	1973-
06038550	Cabin Creek near West Yellowstone	1974-
06043300	Logger Creek near Gallatin Gateway	1959-
06053050	Lost Creek near Ringling	1974-
06056300	Cabin Creek near Townsend	1959-
06058700	Mitchell Gulch near East Helena	1959-
06073600	Black Rock Creek near Augusta	1974-
06090550	Little Otter Creek near Raynesford	1974-
06098700	Powell Coulee near Browning	1974-
06100300	Lone Man Coulee near Valier	1959-
06101520	Favot Coulee tributary near Ledger	1974-
06105800	Bruce Coulee tributary near Choteau	1963-
06109530	Little Sandy Creek tributary near Big Sandy	1972-
06109560	Alkali Coulee tributary near Big Sandy	1974-
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	Big Coulee near Martinsdale	1972-
06123200	Sadie Creek near Harlowton	1971-
06124600	East Fork Roberts Creek tributary near Judith Gap	1974-
06125520	Swimming Woman Creek tributary near Hedgesville	1974-
06125680	Big Coulee Creek tributary near Cushman	1974-
06127505	Fishel Creek near Musselshell	1974-
06127520	Home Creek near Sumatra	1973-
06127570	Butts Coulee near Melstone	1963-
06127585	Little Wall Creek tributary near Grassrange	1974-
06128500	South Fork Bear Creek tributary near Roy	1962-
06129700	Gorman Coulee near Cat Creek	1955-73,1977,1980,1991,1993-
06129800	Gorman Coulee tributary near Cat Creek	1955-
06130610	Bair Coulee near Mosby	1974-
06130620	Blood Creek tributary near Valentine	1974-
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-
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-

Table 2. Crest-stage gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Records available
	Part 06--Continued	
06154510	Kuhr Coulee tributary near Dodson	1983-
06155300	Disjardin Coulee near Malta	1955-
06155600	Murphy Coulee tributary near Hogeland	1974-
06156100	Lush Coulee near Whitewater	1972-
06164600	Beaver Creek tributary near Zortman	1974-
06164623	Little Warm Creek tributary near Lodge Pole	1983-
06165200	Guston Coulee near Malta	1974-
06172300	Unger Creek near Vandalia	1958-
06174300	Milk River tributary No. 3 near Glasgow	1974-
06174600	Snow Coulee at Opheim	1972-
06175700	East Fork Wolf Creek near Lustre	1955-
06177020	Tule Creek tributary near Wolf Point	1974-
06177050	East Fork Duck Creek near Brockway	1955-
06177700	Cow Creek tributary near Vida	1963-
06177820	Horse Creek tributary near Richey	1974-
06179100	Butte Creek tributary near Four Buttes	1972-
06183300	Marron Creek tributary 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-
06214150	Mills Creek at Rapelje	1974-
06216200	West Wets Creek near Billings	1955-
06217300	Twelvemile Creek near Shepherd	1973-
06217700	North Fork Crooked Creek near Shepherd	1962-
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-
06295100	Rosebud Creek near Kirby	1959-
06296100	Snell Creek near Hathaway	1963-
06296115	Reservation Creek near Miles City	1973-
06306950	South Fork Leaf Rock Creek near Kirby	1958-
06307700	Cow Creek near Fort Howes Ranger Station, near Otter	1972-
06307720	Brian Creek near Ashland	1973-
06307930	Jack Creek near Volborg	1973-
06308200	Basin Creek tributary near Volborg	1955-
06308330	Deer Creek tributary near Volborg	1973-
06308340	La Grange Creek near Volborg	1973-
06309078	Tree Coulee near Kinsey	1972-
06309080	Deep Creek near Kinsey	1962-
06324995	Badger Creek at Biddle	1972-
06325700	Deep Creek near Powderville	1973-

Table 2. Crest-stage gaging stations in operation in Montana, October 1994 (Continued)

Station number	Station name	Records available
	Part 06--Continued	
06325950	Cut Coulee near Mizpah	1973-
06326580	Lame Jones Creek tributary near Willard	1974-
06326940	Spring Creek tributary near Fallon	1972-
06326950	Yellowstone River tributary No. 5 near Marsh	1962-
06326960	Timber Fork Upper Sevenmile Creek tributary near Lindsay	1974-
06327450	Cains Coulee at Glendive	1991-
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-
06329350	Alkali Creek 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	Hawksnest Creek tributary near Albion	1973-
06334625	Coal Creek tributary near Mill Iron	1974-
	Part 12	
12323300	Smith Gulch near Silver Bow	1959-
12324700	Clark Fork tributary near Drummond	1958-

Table 3. Surface-water-quality stations in operation in Montana, October 1993 through September 1995

Station number

Stations are listed in downstream order by standard drainage basin number: Part 06 (Missouri River basin) and Part 12 (upper Columbia River basin). Each station number contains either a 2-digit part number plus a 6-digit downstream order number or a 15-digit number generally representing latitude, longitude, and sequence number. All stations in Montana, except as indicated.

The location of the stations is shown in figure 8.

Funding source

BIA	Bureau of Indian Affairs
DOI	Department of the Interior
EPA	U.S. Environmental Protection Agency
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
MPC	Montana Power Company
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

Sampling frequency

CR	Continuous record
DA	Once-daily, annual
DS	Once-daily, seasonal
Numeral	Number of times scheduled per year
I	Intermittent

Table 3. Surface-water-quality stations in operation in Montana, October 1993 through September 1995 (Continued)

Station number	Station name	Funding source	Sampling frequency				
			Chemical	Sediment	Biological	Daily temperature	Daily specific conductance
	Part 06						
06024450	Big Hole River below Big Lake Creek, at Wisdom	MDFWP	-	-	-	CR	-
06025500	Big Hole River near Melrose	MDFWP	-	-	-	CR	-
06036905	Firehole River near West Yellowstone	NPS	-	-	-	CR	-
06037000	Gibbon River near West Yellowstone	NPS	-	-	-	CR	-
06037500	Madison River near West Yellowstone	USGS	7	7	-	-	-
06038500	Madison River below Hebgen Lake, near Grayling	USGS	7	7	-	-	-
06040000	Madison River near Cameron	MDNRC	7	7	-	-	-
06041000	Madison River below Ennis Lake, near McAllister	MDFWP, USGS	7	7	-	CR	-
06041300	Hot Springs Creek near Norris	MDNRC	5	5	-	-	-
06041500	Madison River near Norris	MDNRC	5	5	-	-	-
06041700	Cherry Creek near Norris	MDNRC	5	5	-	-	-
06042600	Madison River at Three Forks	MDNRC	5	5	-	-	-
06054500	Missouri River at Toston	MDFWP, USGS	7	4	4	CR	-
06075700	North Fork Smith River near mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06075800	South Fork Smith River at mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06075900	Big Birch Creek at mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06076550	Newlan Creek at mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06076600	Camas Creek at mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06076650	Benton Gulch at mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06076690	Smith River near Fort Logan	MDHES	12	12	-	-	-
06077090	Sheep Creek near mouth, near White Sulphur Springs	MDHES	12	12	-	-	-
06078230	Sand Coulee Creek above Cottonwood Creek, at Centerville	MDSL	12	-	-	-	-
06078250	Cottonwood Creek near Stockett	MDSL	12	-	-	-	-
06078260	Number Five Coulee below Giffen Spring, near Stockett	MDSL	12	-	-	-	-
06078270	Sand Coulee at Sand Coulee	MDSL	12	-	-	-	-
471851111111101	Giffen Spring near Stockett	MDSL	12	-	-	-	-
472114111095001	Cottonwood Mine #2 drain to Ladd Coulee, at Stockett	MDSL	12	-	-	-	-
472212111093301	Number Five Coulee near Stockett	MDSL	12	-	-	-	-
472306111103601	Mine drain to Mining Coulee, near Sand Coulee	MDSL	12	-	-	-	-
472313111104901	Mine drain to Sand Coulee, near Sand Coulee	MDSL	12	-	-	-	-
472330111082801	Centerville wetlands inflow at Centerville	MDSL	12	-	-	-	-
472331111083001	Centerville wetlands outflow at Centerville	MDSL	12	-	-	-	-
472334111104401	Mount Oregon Mine drain to Kates Coulee, at Sand Coulee	MDSL	12	-	-	-	-
472346111102401	Nelson Mine drain to Sand Coulee, at Sand Coulee	MDSL	12	-	-	-	-
472446111085101	Pipe Spring at Tracy	MDSL	12	-	-	-	-
472447111085301	Stock Tank Spring at Tracy	MDSL	12	-	-	-	-
472513111082901	Johnson Badwater Mine large wetlands inflow near Tracy	MDSL	12	-	-	-	-
472514111082301	Johnson Badwater Mine small wetlands outflow near Tracy	MDSL	12	-	-	-	-
472513111082501	Johnson Badwater Mine small wetlands inflow near Tracy	MDSL	12	-	-	-	-
472517111081001	Johnson Goodwater Mine small wetlands inflow near Tracy	MDSL	12	-	-	-	-
06088500	Muddy Creek at Vaughn	USGS	9	9	-	-	-
06089000	Sun River near Vaughn	USGS	9	6	6	-	DA
06090300	Missouri River near Great Falls	MPC	I	I	-	-	-

Table 3. Surface-water-quality stations in operation in Montana, October 1993 through September 1995 (Continued)

Station number	Station name	Funding source	Sampling frequency				
			Chemical	Sediment	Biological	Daily temperature	Daily specific conductance
		Part 06--Continued					
06090590	Anaconda drain at Belt	MDSL	12	-	-	-	-
472233110552601	French Coulee wetlands outflow at Belt	MDSL	12	-	-	-	-
472235110553201	French Coulee wetlands inflow at Belt	MDSL	12	-	-	-	-
472305110551701	Lewis Coulee above Castner Park, at Belt	MDSL	12	-	-	-	-
472309110551201	Lewis Coulee below mine adit, at Belt	MDSL	12	-	-	-	-
472310110550801	Lewis Coulee above mine adit, at Belt	MDSL	4	-	-	-	-
06090650	Lake Creek near Power	DOI	I	I	-	I	I
06115200	Missouri River near Landusky	USAE, USGS	5	DS	5	DA	-
06130500	Musselshell River at Mosby	USAE, USGS	4	DS	4	DA	-
06154410	Little Peoples Creek near Hays	USGS	4	4	-	-	-
06164510	Milk River at Juneberg Bridge, near Saco	USGS	9	-	-	DA	DA
06169500	Rock Creek below Horse Creek, near International Boundary	USGS	4	4	4	-	-
06174500	Milk River at Nashua	USGS	5	5	5	-	-
06178000	Poplar River at International Boundary	MDNRC	5	5	-	-	-
06178500	East Poplar River at International Boundary	MDNRC	6	6	-	DA	DA
06179000	East Fork Poplar River near Scobey	MDNRC	6	6	-	-	-
06181000	Poplar River near Poplar	USGS	6	6	6	-	-
06185500	Missouri River near Culbertson	USGS	5	-	5	-	5
06192500	Yellowstone River near Livingston	USGS	5	5	5	-	-
06289000	Little Bighorn River at State Line, near Wyola	BIA	6	6	-	-	-
06289500	Little Bighorn River near Wyola	BIA	6	6	-	-	-
06294000	Little Bighorn River near Hardin	BIA	6	6	-	-	-
06294995	Armells Creek near Forsyth	MBMG	4	4	-	-	-
06306300	Tongue River at State Line, near Decker	USGS	4	-	-	-	-
06307500	Tongue River at Tongue River Dam, near Decker	MBMG	9	9	-	-	-
06307600	Hanging Woman Creek near Birney	MBMG	4	4	-	-	-
06307740	Otter Creek at Ashland	MBMG	4	4	-	-	-
06308500	Tongue River at Miles City	USGS	4	4	4	-	-
06324500	Powder River at Moorhead	USGS	-	DS	-	-	-
06326500	Powder River near Locate	USGS	5	5	5	-	-
06326555	Cherry Creek near Terry	MBMG	-	DA	-	I	I
06329500	Yellowstone River near Sidney	USAE, USGS	5	DS	5	-	-
		Part 12					
12300110	Lake Koocanusa at International Boundary	USAE	5	-	-	-	-
12301830	Lake Koocanusa at Tenmile Creek, near Libby	USAE	6	-	6	-	-
12301919	Lake Koocanusa at Forebay, near Libby	USAE	6	-	-	-	-
12301933	Kootenai River below Libby Dam, near Libby	USAE	9	-	-	-	-
12323230	Blacktail Creek at Harrison Avenue, at Butte	EPA	10	10	-	-	-
12323250	Silver Bow Creek below Blacktail Creek, at Butte	EPA	10	10	-	-	-
12323600	Silver Bow Creek at Opportunity	EPA	10	10	1	-	-
12323750	Silver Bow Creek at Warm Springs	EPA	10	10	1	-	-
12323770	Warm Springs Creek at Warm Springs	EPA	6	6	1	-	-
12323800	Clark Fork near Galen	EPA, MDFWP	10	10	1	CR	-
12324200	Clark Fork at Deer Lodge	EPA, MDFWP	10	DA	1	CR	-
12324590	Little Blackfoot River near Garrison	EPA	6	6	1	-	-
12324680	Clark Fork at Goldcreek	EPA, MDFWP	10	10	1	CR	-
12331500	Flint Creek near Drummond	EPA	10	10	1	-	-

Table 3. Surface-water-quality stations in operation in Montana, October 1993 through September 1995 (Continued)

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Biological	Daily temperature	Daily specific conductance
	Part 12--Continued						
12331800	Clark Fork near Drummond	EPA	10	10	1	-	-
12334510	Rock Creek near Clinton	EPA	6	6	1	-	-
12334550	Clark Fork at Turah Bridge, near Bonner	EPA, MDFWP	10	DA	1	CR	-
12340000	Blackfoot River near Bonner	EPA	6	DA	1	-	-
12340500	Clark Fork above Missoula	EPA	10	DA	-	-	-
12353000	Clark Fork below Missoula	USGS	6	6	6	-	-
12355500	North Fork Flathead River near Columbia Falls	MDFWP	-	-	-	CR	-
12362500	South Fork Flathead River near Columbia Falls	MDFWP	-	-	-	CR	-
12363000	Flathead River at Columbia Falls	MDFWP, USGS	4	4	4	CR	-

Table 4. Ground-water-level observation-well network in Montana, October 1994

[The network is funded by the U.S. Geological Survey]

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 number--15-digit identification number, based on latitude-longitude location. The location of the wells is shown in figure 9.

Well depth--reported in feet below land surface.

Principal aquifer--

Czr	-	Cenozoic rocks
Qal	-	Quaternary alluvium
Qt	-	Quaternary terrace deposits
Qalp	-	Pleistocene alluvium
Qgd	-	Pleistocene glacial drift
Qgo	-	Pleistocene glacial outwash
Qgl	-	Pleistocene glaciolacustrine deposits
Qtp	-	Pleistocene terrace deposits
Ts	-	Tertiary sediments
Tfu	-	Fort Union Formation (Paleocene)
Ke	-	Eagle Sandstone (Upper Cretaceous)
Kjr	-	Judith River Formation (Upper Cretaceous)
Kp	-	Parkman Sandstone (Upper Cretaceous)
Ktm	-	Two Medicine Formation (Upper Cretaceous)
Kv	-	Virgelle Sandstone (Upper Cretaceous)
Kvm	-	Virgelle Sandstone Member of Eagle Sandstone (Upper Cretaceous)
Kc	-	Colorado Group (Upper and Lower Cretaceous)
Kk	-	Kootenai Formation (Lower Cretaceous)
Js	-	Swift Formation (Upper and Middle Jurassic)
Mm	-	Madison Group (Mississippian)
Mmc	-	Mission Canyon Limestone (Mississippian)

Begin year water level--year water-level measurement begins.

Measurement frequency--A, annual; C, continuous recorder; I, intermittent; Q, quarterly.

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

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

Analyzing agency--US, U.S. Geological Survey, Denver Colorado; MB, Montana Bureau of Mines and Geology, Butte, Montana;--, unknown.

Table 4. Ground-water-level observation-well network in Montana, October 1994 (Continued)

Local number	Site identification number	Well depth (feet)	Principal aquifer	Water level		Chemical analysis		
				Begin year	Measurement frequency	Begin year	Type	Analyzing agency
37N27W24BABB01	485746115032601	230	Czr	1977	A	1976	B	MB
37N27W27ACCB01	485634115054401	320	Qgd	1977	A	--	--	--
36N28W01ADC 01	485448115090801	206	Czr	1972	A	--	--	--
36N28W11AADB01	485411115101901	290	Qgl	1971	A	--	--	--
36N27W05DCBC01	485428115065601	168	Qgd	1966	A	--	--	--
36N09E05DBAD01	485420110345801	1,015	Ke	1978	A	1978	B	MB
35N02E27AABD01	484603111270301	250	Ke	1979	A	--	--	--
35N33E19DBA 01	484600107271001	246	Kjr	1978	A	1978	B	MB
35N58E01DBDD01	484848104031601	39	Qgo	1983	I	--	--	--
35N58E24AAAA01	484648104025301	200	Qgo	1982	I	1982	B	MB
35N58E24DDDD01	484557104025301	73	Qgo	1982	I	1982	B	MB
34N58E11DBAB01	485254104050501	130	Qgo	1984	I	1984	B	MB
34N58E14CBDD01	484150104053901	151	Qgo	1982	I	1982	B	US
34N58E20DAAA01	484108104083701	110	Qgo	1984	I	1984	B	MB
34N58E29CDBA01	484003104092901	81	Qgo	1982	I	1982	B	US
33N06W12AAA 02	483812112191202	400	Kv	1965	A	--	--	--
33N06W12AAA 03	483812112191203	250	Ktm	1965	A	--	--	--
33N58E17ADDD01	483650104084001	130	Qgo	1984	I	1984	B	MB
33N58E23CBCA02	483553104055702	150	Qgo	1984	I	1984	B	MB
33N58E28CBBA01	483503104083401	130	Qgo	1984	I	1984	B	MB
33N58E29ADDB01	483509104084501	98	Qgo	1984	I	1984	B	MB
33N58E29ADDB02	483509104084502	330	Tfu	1984	I	1984	B	MB
33N58E32CCAA01	483358104093701	91	Qgo	1982	I	1982	B	US
32N15E17DDDC01	483138109481001	180	Qal	1947	A	1947	B	--
32N57E26CBBB02	482951104165002	247	Qalp	1984	I	1984	B	MB
32N57E26CBBB03	482951104165003	150	Qgo	1984	I	1984	B	MB
32N58E04DBBD01	483318104105401	318	Tfu	1984	I	1984	B	MB
32N58E04DBBD02	483318104105402	143	Qgo	1984	I	1984	B	MB
31N57E01BACA01	482824104150401	125	Qgo	1983	I	1984	B	MB
30N33W05ABAB01	482357115503801	187	Qgl	1980	A	1980	C	MB
30N33W30DAAD01	481958115513601	43	Qgl	1980	A	1980	C	MB
30N33W30DAAD02	481958115513602	23	Qgl	1980	A	1980	C	MB
30N05W33DDB 01	481839112151501	122	Kvm	1968	A	--	--	--
29N22W14BBDD01	481652114220501	220	Qgl	1964	A	--	--	--
29N22W28ACCC01	481458114240901	200	Qgl	1965	A	--	--	--
29N22W36BCBD01	481407114205601	452	Qgl	1976	A	--	--	--
29N21W20CCCC01	481519114182501	278	Qgl	1963	A	--	--	--
29N13E21AABA02	481542110023501	210	Qalp	1947	A	--	--	--
23N24W34ADAA01	474251114385201	377	Qal	1943	C	1983	B,C	MB
22N03W15BAAD01	474005111583801	92	Kc	1991	A	1992	B,C	US
22N03W15BAAD02	474005111583802	62	Kc	1991	I	1992	B,C	US
22N03W15BAAD03	474005111583803	47	Qtp	1991	I	1992	B,C	US
22N03W15BAAD04	474005111583804	30	Qtp	1991	I	1992	B,C	US
22N03W28AAAA01	473823111591201	81	Kc	1991	I	1992	B,C	US
22N03W28AAAA02	473823111591202	37	Kc	1991	I	1992	B,C	US
22N03W28AAAA03	473823111591203	17	Qgl	1991	I	1992	B,C	US
22N03W28ABBB01	473824111595001	80	Kc	1991	I	1992	B,C	US
22N03W28ABBB02	473824111595002	37	Kc	1991	I	1992	B,C	US
22N03W28ABBB03	473824111595003	16	Qgl	1991	I	1992	B,C	US
22N03W29AABA01	473826112004501	75	Kc	1991	I	1992	B,C	US

Table 4. Ground-water-level observation-well network in Montana, October 1994 (Continued)

Local number	Site identification number	Well depth (feet)	Principal aquifer	Water level		Chemical analysis		
				Begin year	Measurement frequency	Begin year	Type	Analyzing agency
22N03W29AABA02	473826112004502	45	Kc	1991	I	1992	B,C	US
22N03W29AABA03	473826112004503	23	Kc	1991	I	1992	B,C	US
22N03W29AABA04	473826112004504	14	Qgl	1991	I	1992	B,C	US
22N03E22ADBB11	473902111194611	49	Kc	1991	C	1991	B,C	US
21N23E13CBBB01	473456108430601	1,630	Ke	1980	A	1980	B	MB
19N03E01AABA01	472606111171201	65	Kk	1979	A	--	--	--
19N06E23BADA01	472403110553701	75	Js	1979	A	--	--	--
19N06E26ACAD01	472303110552101	435	Mm	1982	A	--	--	--
16N19W08ACBD01	470946114013201	307	Qalp	1990	C	--	--	--
15N12W36BCDD01	470049113035401	206	Czr	1975	A	--	--	--
12N20W22ADAC01	464712114051801	53	Qal	1992	C	--	--	--
12N20W22ADAC02	464711114051901	48	Qal	1992	C	--	--	--
12N20W22ADAC03	464710114052001	52	Qal	1992	C	--	--	--
11N03W30DADA01	464009112011601	44	Qal	1978	A	1978	B	MB
10N20W13BBA 01	463750114033001	50	Qalp	1959	Q	--	--	--
10N04W10DDDA01	463754112050601	23	Qal	1978	I	1979	B	MB
10N03W03BACB01	463931111581801	65	Qal	1978	I	1979	B	MB
10N03W05CCDD01	463844112005701	23	Qal	1978	A	1978	B	MB
10N03W09ACCC01	463823111591801	64	Qal	1978	I	1978	B	MB
10N03W11DDCC01	463754111562201	40	Qal	1978	I	1978	B	MB
10N03W17ACAD01	463735112001701	28	Qal	1978	I	1978	B	MB
10N03W22AAAA01	463700111572501	23	Qal	1978	I	1979	B	MB
10N02W18DDCD01	463707111534701	70	Ts	1981	I	1981	C	MB
06N20W19CCCC02	461518114090802	40	Qal	1970	C	--	--	--
01N04E25DCDD01	454809111095401	101	Qal	1951	A	--	--	--
01N54E18DDAC01	455001105024301	8,422	Mmc	1977	I	1977	C	US
01S33E19DAA 01	454350107410001	25	Qtp	1957	A	1957	B	--
01S33E24BCBC02	454401107360302	26	Qal	1960	A	--	--	--
02S41E08CDAB03	454034106415403	68	Qal	1993	A	1993	B,C	MB
03S33E09DCC 01	453441107385501	74	Qtp	1966	I	--	--	--
03S33E16BBBB01	453419107393701	19	Qal	1965	I	--	--	--
03S33E16BBBB02	453419107393702	46	Qal	1965	I	--	--	--
03S35E18DABD01	453413107260201	400	Kp	1977	A	1977	B	MB
03S39E31BDDD01	453209106575801	51	Qal	1993	A	1993	B,C	MB
04S32E35AAAA01	452647107431501	39	Qal	1965	I	--	--	--
04S38E13ABBC01	452953106591101	18	Qal	1993	I	1993	B,C	MB
04S38E36BCBB01	452706106595201	91	Qal	1993	I	1993	B,C	MB
04S38E36BCBD01	452703106594301	80	Qal	1993	I	1993	B,C	MB
04S45E04BDDB01	453107106110601	68	Qal	1980	C	1980	C	MB
06S43E19DDBA02	451746106301101	67	Qal	1987	C	1987	B,C	MB
08S09W01CCCC01	450937112393701	47	Ts	1966	C	--	--	--

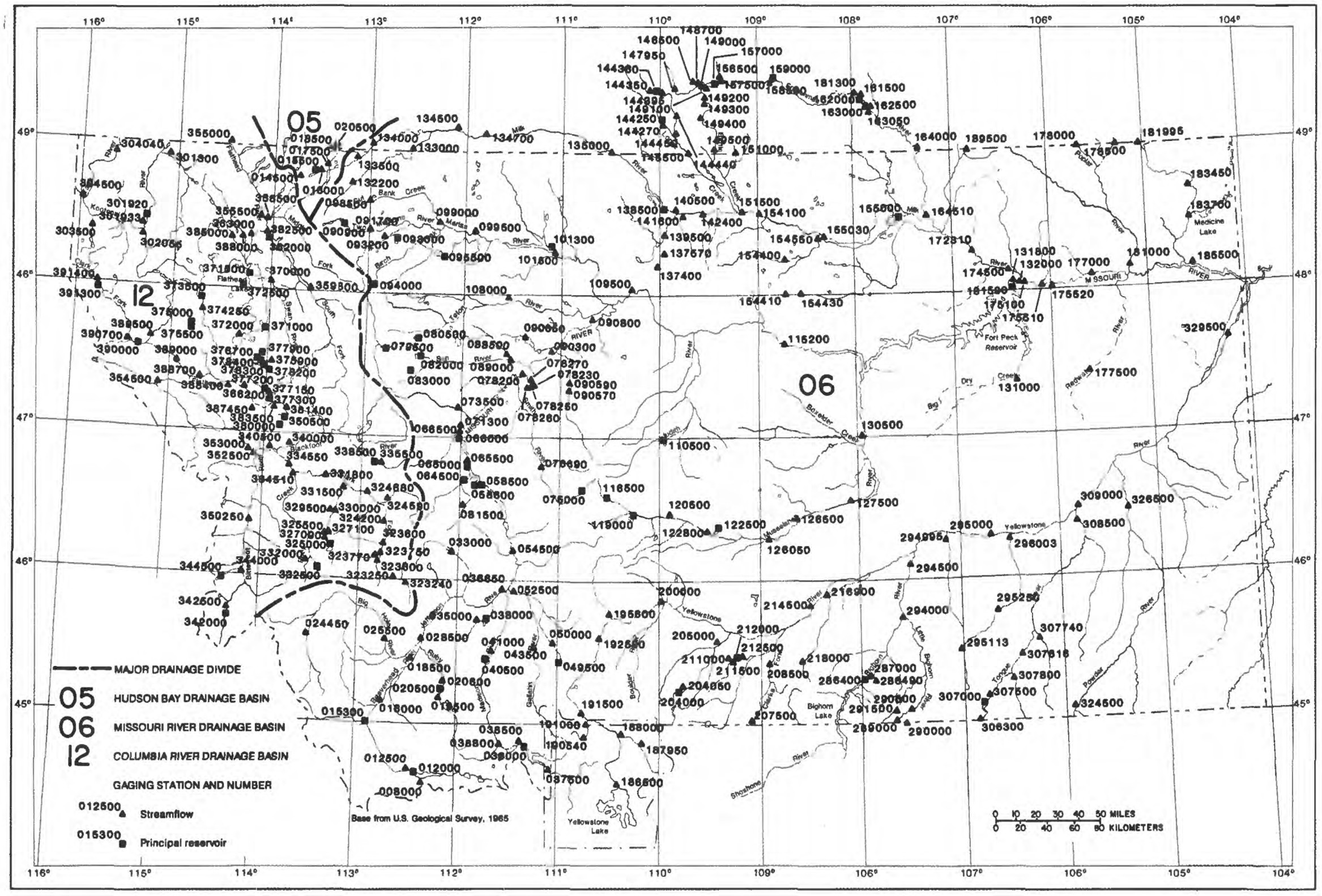

Figure 6. Surface-water gaging stations in operation in Montana, October 1994.

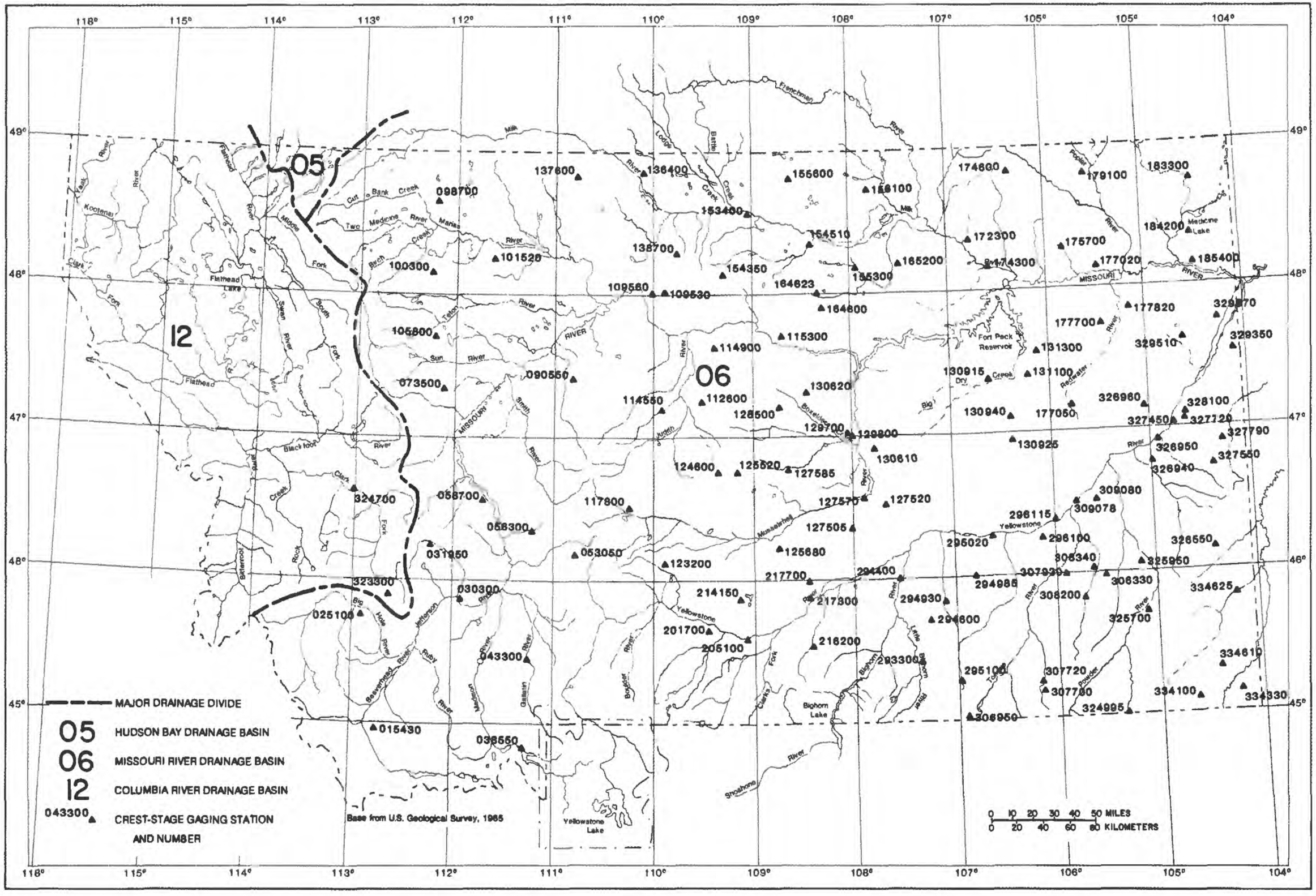

Figure 7. Crest-stage gaging stations in operation in Montana, October 1994.

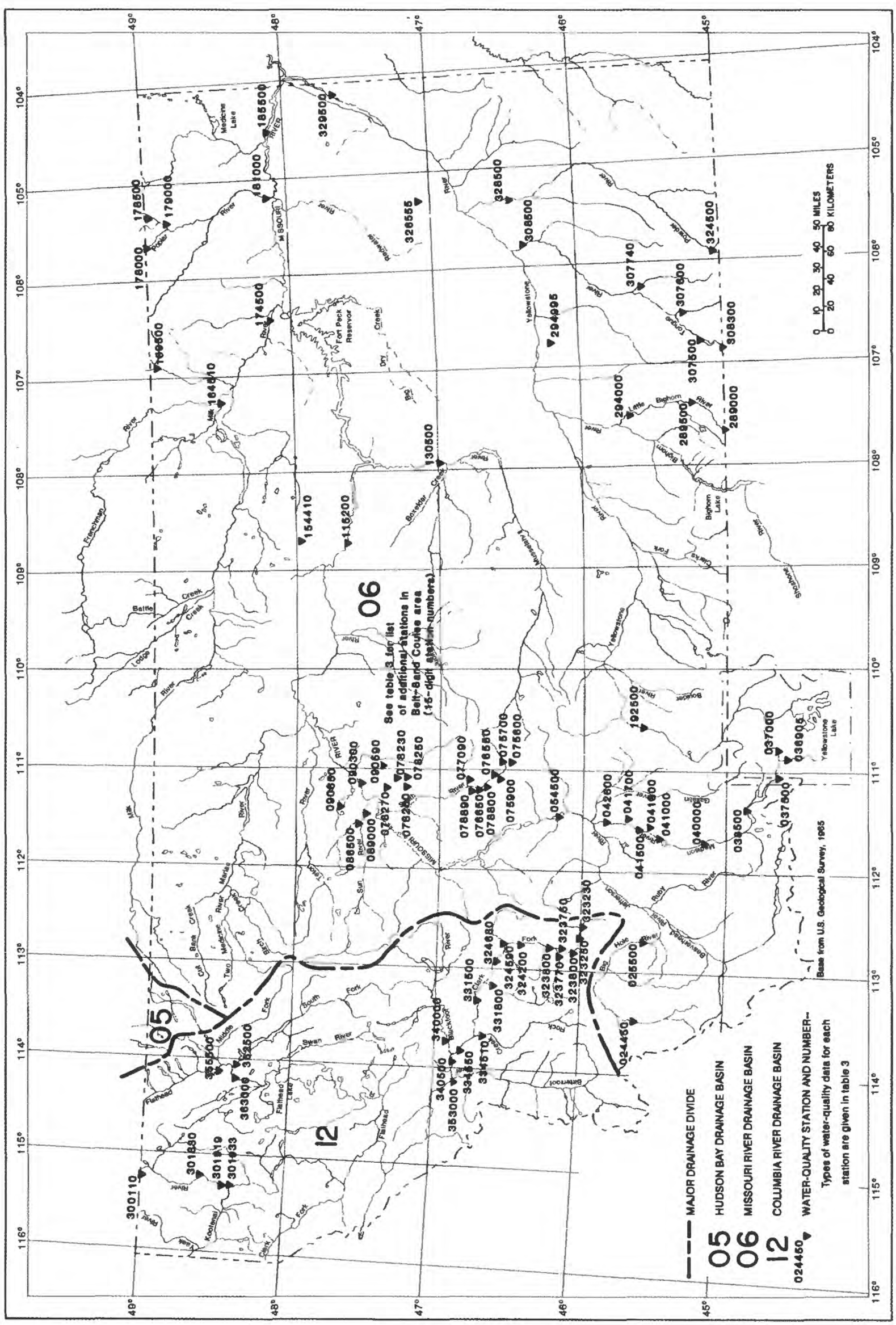

Figure 8. Surface-water quality stations in operation in Montana, October 1993 through September 1995.

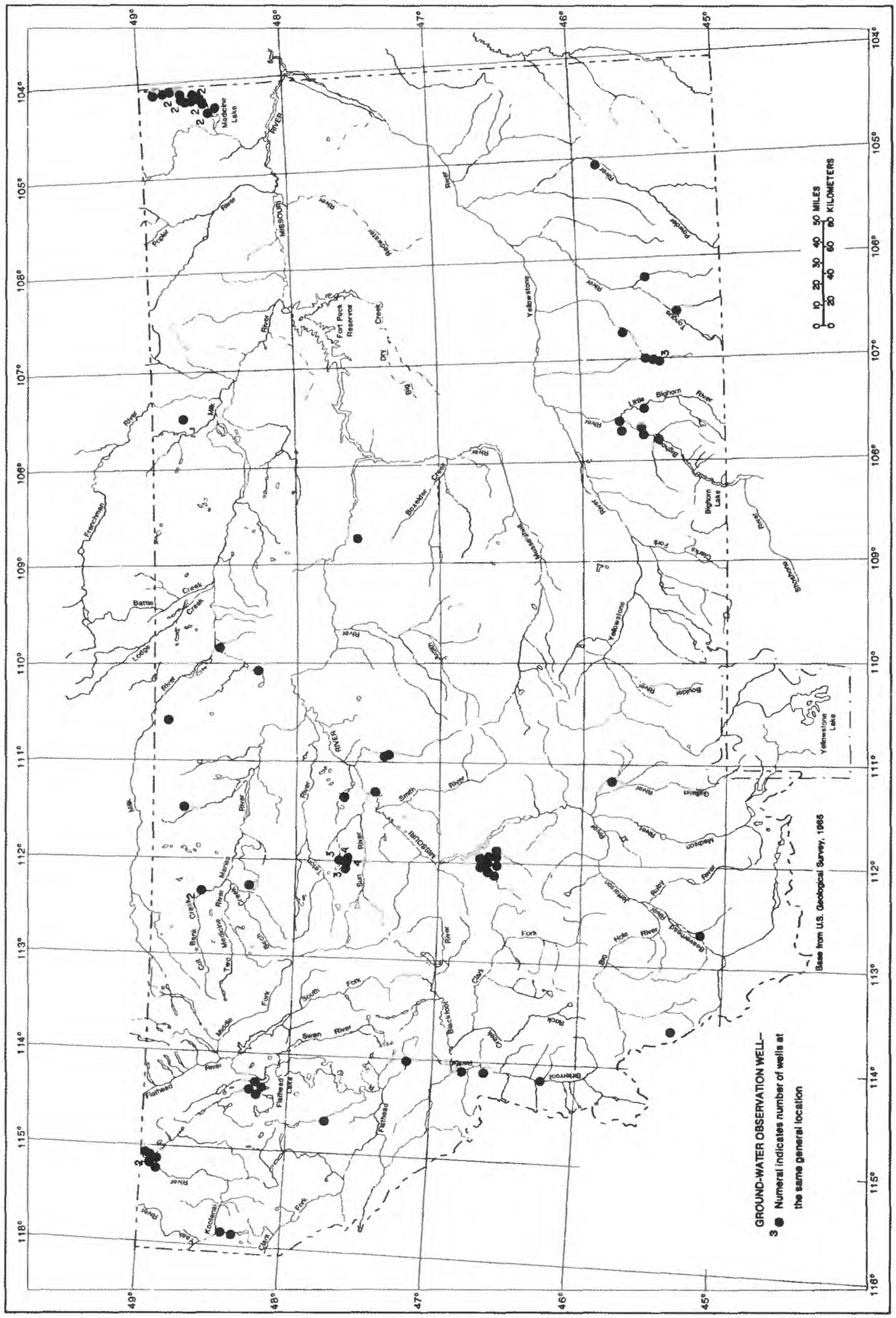

Figure 9. Ground-water-level observation wells in Montana, October 1994.

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