WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSOURI, FISCAL YEAR 1989

Compiled by Katherine L. Jenkins

U.S. GEOLOGICAL SURVEY

Open-File Report 89-621

Rolla, Missouri
1989

DEPARTMENT OF THE INTERIOR
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Message from the District Chief

For approximately 68 years, the U.S. Geological Survey (USGS), Water Resources Division (WRD), has cooperated with State, local, and Federal agencies to provide water information for the benefit of the citizens of Missouri and the Nation. I have enjoyed being District Chief of the Missouri District since June 1982, and I am pleased with the continued close interaction between our agencies in supplying critical water information. Significant water-resources problems will continue to confront our agencies in the future, which will require us all to continue to work together for their solution.

Our last Activities Report was completed in 1987. Since that time, many of the studies described in that report have been completed. Currently, several new studies have been initiated by the District. Some examples of these new efforts include the definition of sinkholes and related karst features for a water-resources study in the Springfield area utilizing a Geographical Information System for storage and analysis of the collected information. A second major cooperative project includes the evaluation of geomorphic changes and impacts on aquatic resources in streams in the Ozark region of our State. This project resulted primarily from the strong perception that Ozark streams are becoming choked with gravel and have lost much of their depth and cover with resulting consequences to the aquatic system. The Missouri District also was recently selected to coordinate a 10-State Missouri River basin water-use study that will produce an accurate, complete, and transportable water-use data file for the entire basin. The District continues to collect extensive quantities of surface- and water-quality data with much of the information being gathered by data collection platforms and GOES satellite systems for new realtime uses. Recently, the Missouri Division of Geology and Land Survey and our office reached an agreement to work jointly on the operation and maintenance of the entire Missouri Ground Water (GW) monitoring network. This joint involvement is a major step forward to help provide more complete and accurate GW data for the general public.

The publication of timely, complete, and accurate reports will continue as a major goal of our District. In addition, a new challenge to us will be to make these documents more easily understood and to make them aesthetically pleasing to the general public. Our District will diligently strive to meet all these objectives within the reports product area. This definitely is a major challenge, but I am confident that our Missouri District is ready to accept it.

Daniel P. Bauer

ORIGIN AND MISSION 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, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

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

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

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the 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 AND PROGRAM 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 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 the physical, chemical, and biological

characteristics of surface and ground water.

- 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 Department of State.

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ILLUSTRATIONS

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CONVERSION FACTORS

For readers who prefer to use metric (SI) units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
inch	25.40	millimeter
mile	1.609	kilometer
square mile	2.590	square kilometer
cubic yard	0.7646	cubic meter
acre	0.4047	hectare
gallon	3.785	liter
foot	0.3048	meter

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSOURI, FISCAL YEAR 1989

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Katherine L. Jenkins

ABSTRACT

Water-resources activities of the U.S. Geological Survey in Missouri consist of collecting hydrologic data and making interpretive studies. Hydrologic studies in Missouri are made through three basic types of projects: hydrologic data-collection programs; local or areal hydrologic investigations; and statewide or regional studies. These projects are funded through cooperative joint-funding agreements with State and local agencies, transfer of funds from other Federal agencies, and direct Federal funds. The data and the results of the investigations are published or released by either the U.S. Geological Survey or by cooperating agencies. This report describes the hydrologic data-collection programs and local or areal hydrologic investigations in Missouri for fiscal year 1989 and provides a list of selected water-resources references for Missouri.

MISSOURI DISTRICT

A District office of the U.S. Geological Survey was established in Rolla, Missouri, during 1921, when a cooperative program was begun with the Missouri Bureau of Geology and Mines (now the Missouri Department of Natural Resources, Division of Geology and Land Survey). The Missouri District, with field headquarters in Rolla, Independence, and Olivette, and a project office in Independence (fig. 1), investigates the occurrence, quantity, quality, distribution, and movement of surface and ground water in Missouri.

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

Operating Sections

The Hydrologic Surveillance and Analysis Section designs, constructs, operates, and maintains all hydrologic-data networks in the State. The Section manages the collection and analysis of the hydrologic data for the State network, processes and reviews data for the publication, prepares water-resources data for the annual water-data report, and provides quality control of results for field and office methods. The Hydrologic Studies Section plans, executes, and reports on water-resources projects, including multidiscipline appraisal studies, and conducts hydrologic and hydraulic investigations. These investigations include ground-water hydraulics and mathematical modeling of aquifer systems, environmental concerns, hydraulics affected by manmade structures, magnitude and frequency of floods and droughts, hydrology of urban areas, analysis of the effects and assessment of hazardous waste and historical and ongoing mineral mining on the hydrologic system, and traveltime and dispersion studies.

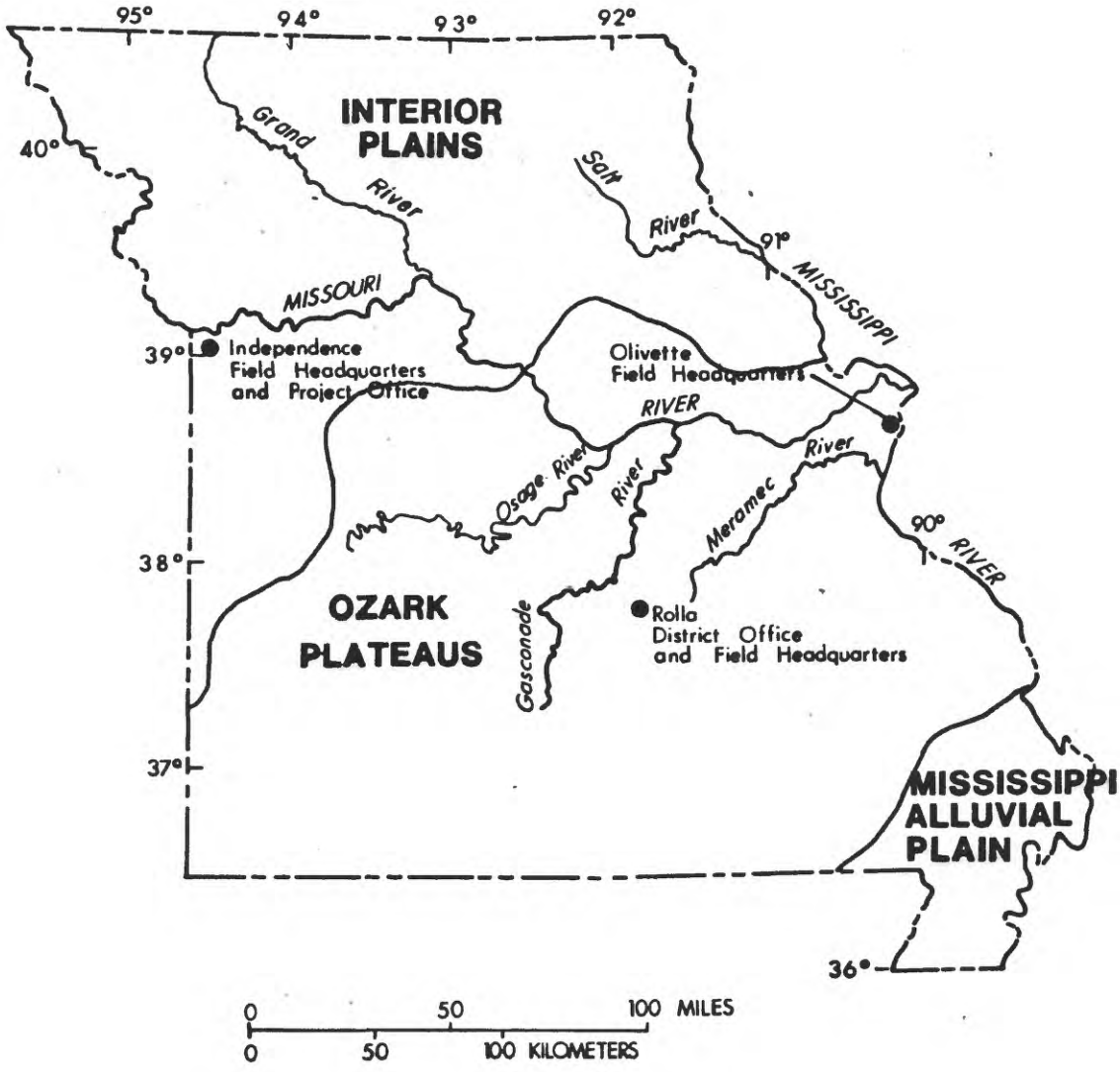
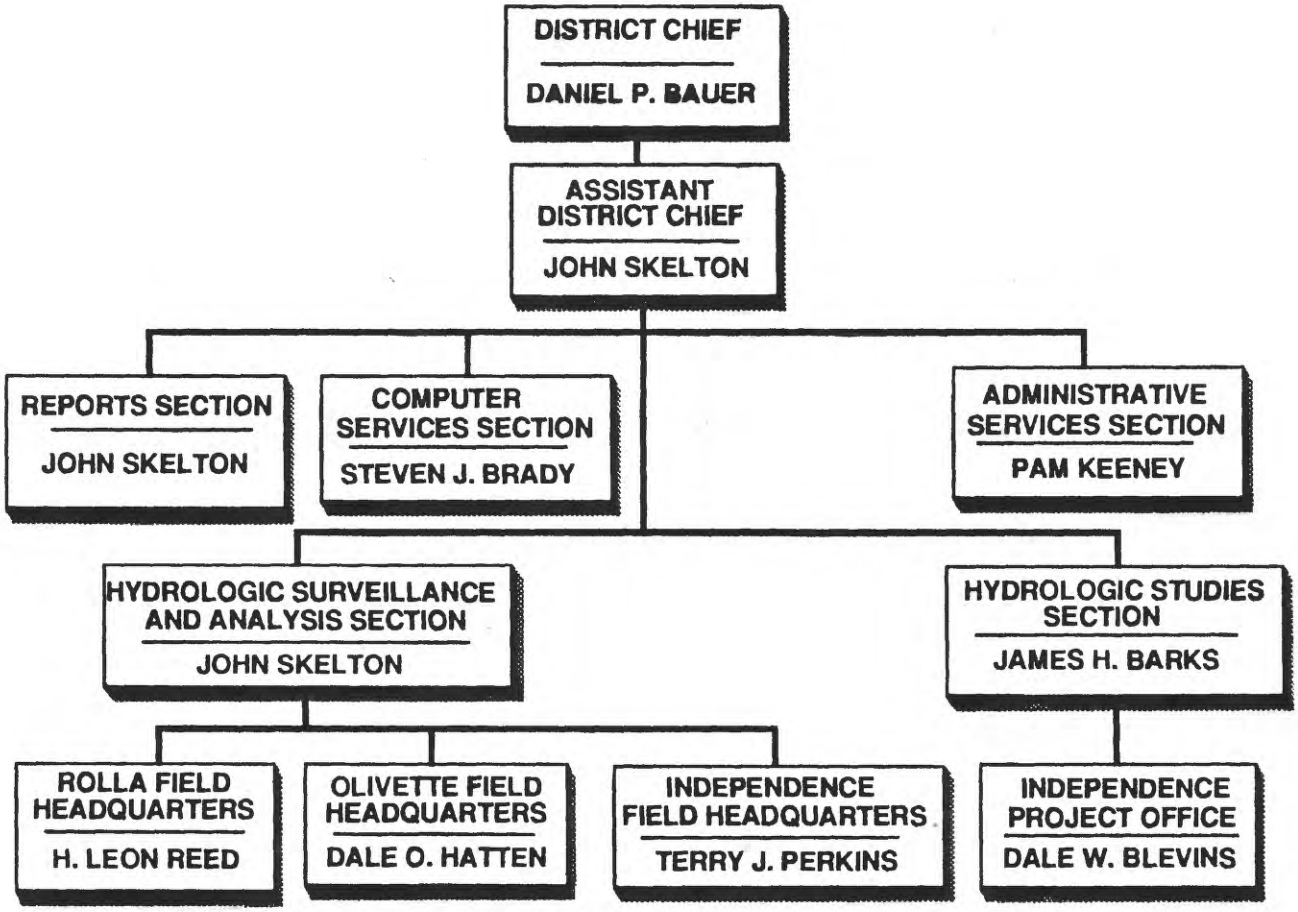


Figure 1.--Location of offices of the U.S. Geological Survey in Missouri.



Rolla Field Headquarters
H. L. Reed, SupvHydrolTech
(314) 341-0843
1210 Homelife Plaza
Rolla, MO 65401

DISTRICT OFFICE
(314) 341-0824
1400 Independence Road
Mail Stop 200
Rolla, MO 65401

Olivette Field Headquarters
D. O. Hatten, SupvHydrolTech
(314) 567-7077
Dielman Industrial Center
9351 Dielman Industrial Drive
Olivette, MO 63132

Independence Field Headquarters
T. J. Perkins, Lead HydrolTech
(816) 254-7272
Room 223, Federal Building
301 West Lexington
Independence, MO 64050

Independence Project Office
D. W. Blevins, Hydrologist
(816) 254-5824
Room 219, Federal Building
301 West Lexington
Independence, MO 64050

Figure 2.--Missouri District organization and office addresses and telephone numbers.

Support Sections

The Reports Section maintains records of technical and hydrologic-data reports; reviews project annotated outlines; and edits, types, assembles, verifies, and prepares manuscripts and illustrations for publication. The Section advises and updates District personnel on current report-writing procedures.

The Computer Services Section manages and maintains the District's computer system, and coordinates processing, storage, and retrieval of data for the District and National Computer files. The Section helps design, implement, and maintain the computer program software necessary for District operation.

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

COOPERATION AND PROGRAM FUNDING

The Missouri District and agencies of the State of Missouri have had cooperative agreements for the systematic collection of streamflow records since 1921. About 90 percent of the hydrologic data collected by the U.S. Geological Survey in Missouri is in cooperation with local, State, or other Federal agencies.

Collection of surface-water data was begun at a few selected sites during 1903; collection of ground-water data in cooperation with the Missouri Department of Natural Resources, Division of Geology and Land Survey was begun during 1963; and collection of water-quality data was begun during 1962 in cooperation with the Missouri Water Pollution Control Program (now a part of the Missouri Department of Natural Resources, Division of Environmental Quality). Surface-water data primarily are collected cooperatively with other Federal agencies, whereas the ground-water and water-quality data primarily are collected in cooperation with selected divisions of the Missouri Department of Natural Resources. These types of data are needed for the continuing determination and evaluation of the quantity, quality, and use of Missouri's water resources.

Moneys for program operation of the U.S. Geological Survey in Missouri come from joint-funding agreements with local and State agencies, transfer of funds from other Federal agencies, and direct Federal funds. Distribution of funding for program operation during fiscal year 1989 is shown in figure 3.

WATER CONDITIONS

Sufficient water for present demands is available in many parts of Missouri during most years. Annual precipitation ranges from 34 inches in the northwest to 46 inches in the southeast, according to the National Weather Service (fig. 4), but in some years precipitation has been as much as 15 inches less than normal.

Surface-water supplies generally are adequate for most uses (fig. 5). However, variation in availability occurs within and among the State's three major physiographic regions: the Interior Plains, the Ozark Plateaus, and the Mississippi Alluvial Plain (fig. 6). Some small communities in the Plains region, for example, can have water-supply shortages during droughts because many of the public-water supply districts serve large areas and cannot meet increased demands during extreme low-flow periods. Ozark streams generally have the best-sustained low flows because of the contribution of ground water from extensive solution cavities in the carbonate aquifers. Low flows in the Mississippi Alluvial Plain region are second in magnitude to those of the Ozarks and are sustained by ground-water contributions from the extensive alluvial deposits.

More communities depend on ground water than on surface water, but larger quantities of surface water are withdrawn because most of Missouri's large cities have surface-water supplies. The southeastern two-thirds of the State is underlain by freshwater aquifers (Harris, 1979).

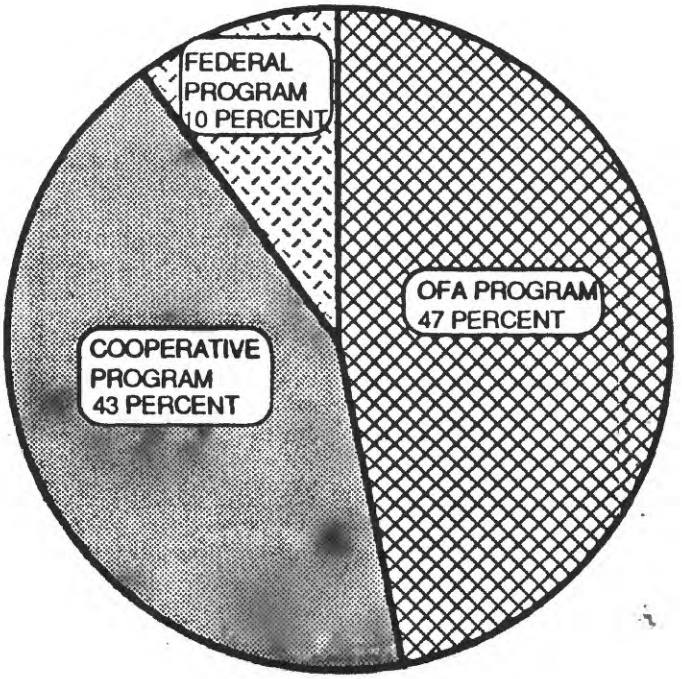


Figure 3.--Distribution of funding for water-resources programs of the U.S. Geological Survey in Missouri, fiscal year 1989.

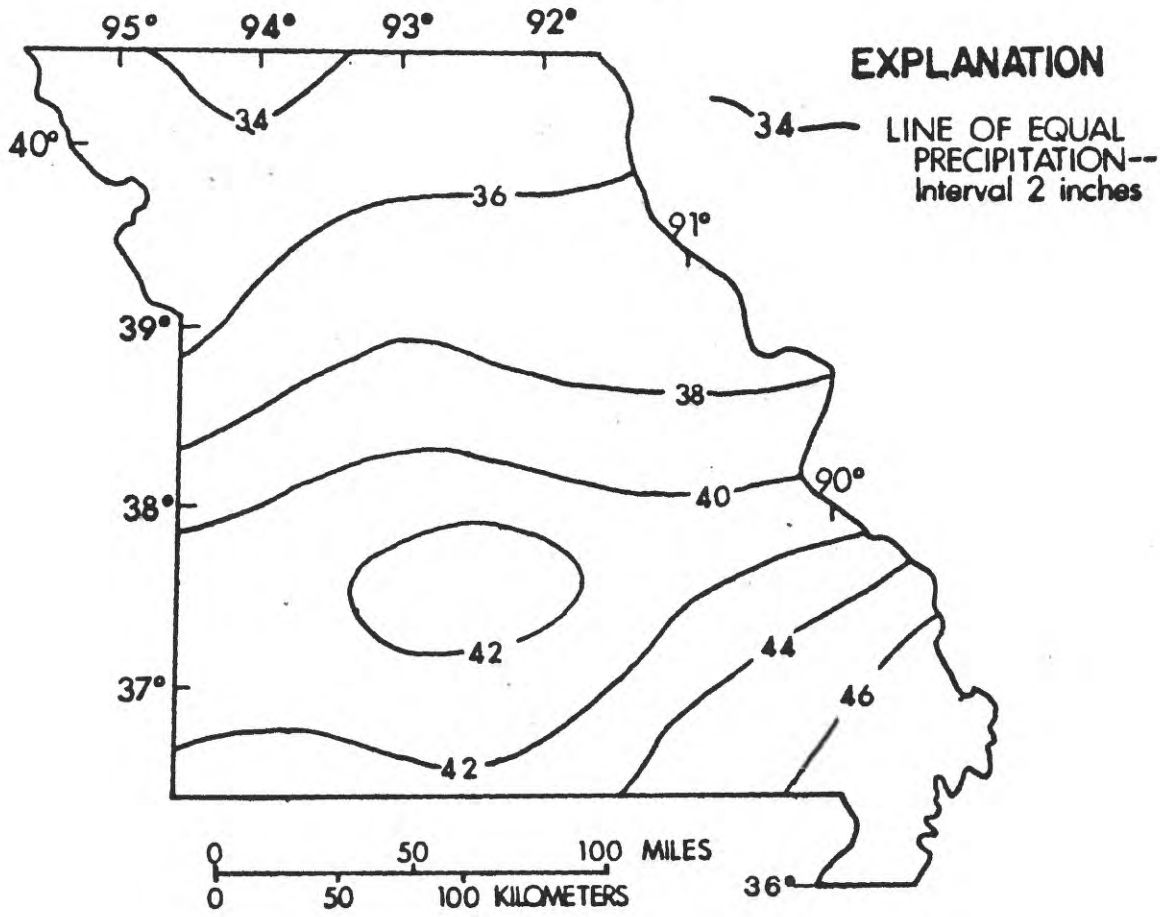


Figure 4.--Mean annual precipitation.

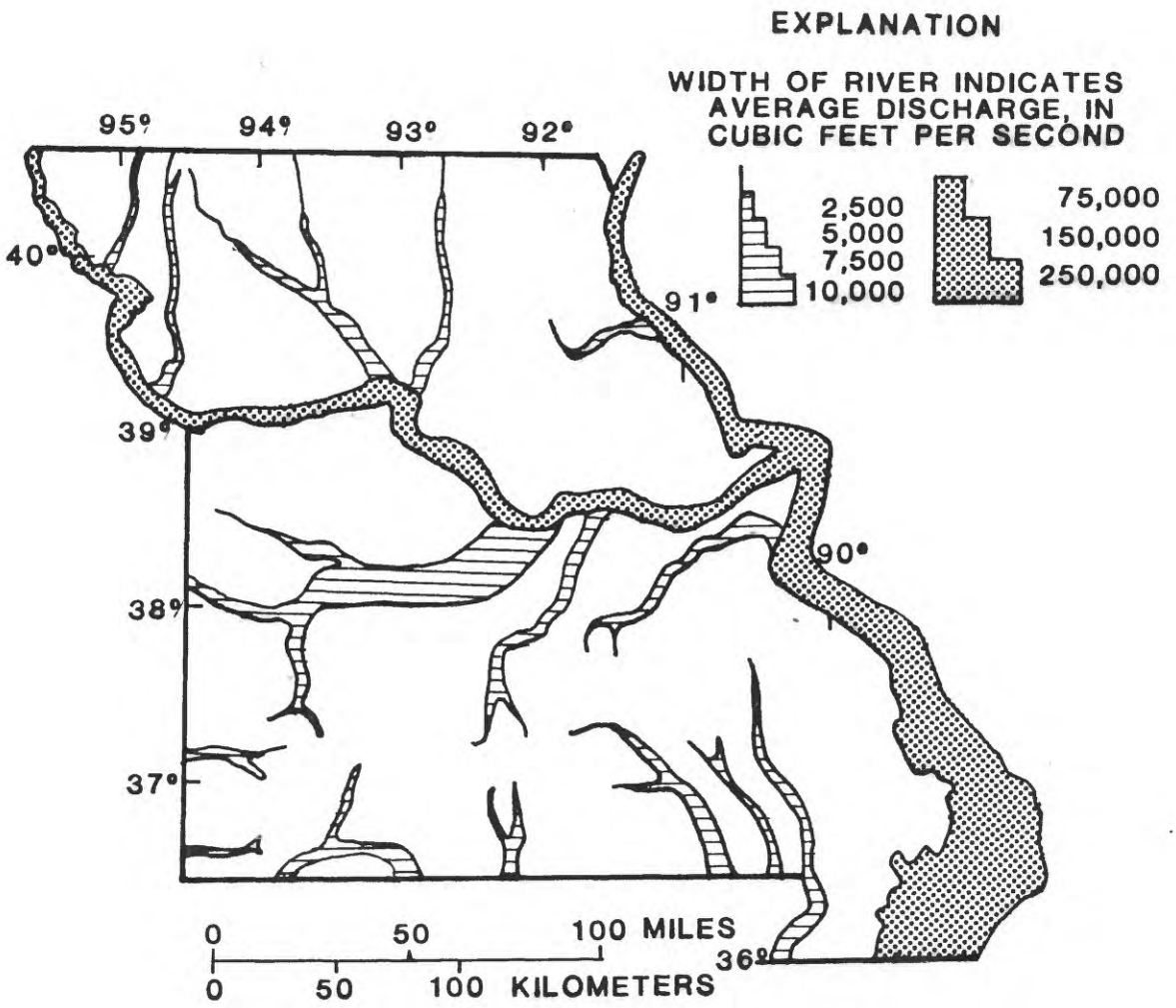


Figure 5.--Average discharge of the principal rivers.

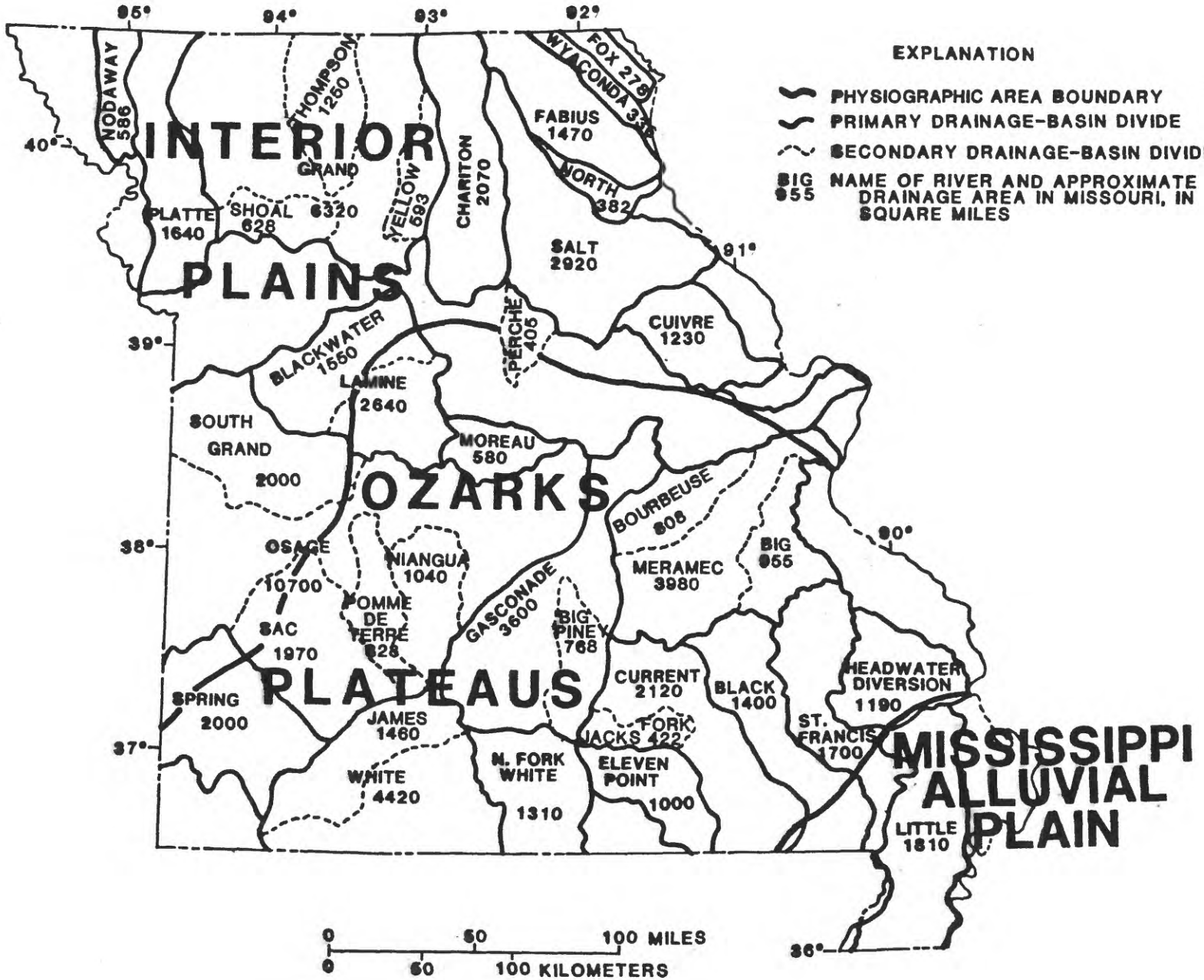


Figure 6.--Physiographic divisions and major drainge basins.

Large quantities of saline ground water are available in the northwestern one-third of Missouri (fig. 7). However, without desalination, this water is unsuitable for most purposes. In local areas of the State, the increased use of ground water for farmland irrigation has lowered ground-water levels.

Generally, water quality in Missouri streams and aquifers is adequate for most uses (Missouri Division of Geology and Land Survey, 1967). However, water-quality concerns in Missouri include stream erosion that is among the largest in the United States; carbonate rocks in the Ozarks region that contain solution-enlarged cracks and crevices allowing contaminants, such as sewage-lagoon effluent, to directly enter the shallow ground-water system; dioxin that is present in the soil and streambed sediment in several stream basins and may move through the hydrologic system in association with sediment particles; and many obsolete sewage-treatment plants in the State that adversely affect the water quality of streams.

NATIONAL HYDROLOGIC-DATA NETWORKS AND PROGRAMS

A significant quantity of stream water-quality data is collected in Missouri as part of the National Stream Quality Accounting Network (NASQAN). NASQAN is a data-collecting effort for obtaining consistent regional and nationwide overviews of the quality of streams. The primary objectives of the network are to: (1) Account for the quantity and quality of water moving within and from major river basins in the United States; (2) depict areal variability; (3) detect changes in stream quality; and (4) provide data for future assessments of changes in stream quality. Ten NASQAN stations are included in the Missouri District's hydrologic data-collection program.

The National Water-Use Information Program of the U.S. Geological Survey is a Federal-State cooperative program designed to collect, store, and disseminate water-use information both nationally and locally. The program was begun during 1978 to develop a single source of uniform information on water use. The water-use information from this program complements long-term U.S. Geological Survey data on the availability and quality of the Nation's water resources. Information on the National Water-Use Information Program and its data bases can be obtained from the District office in Rolla.

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Water Resources Division
1400 Independence Road, Mail Stop 200
Rolla, Missouri 65401

As part of the U.S. Geological Survey's program of releasing water data to the public, a large-scale computerized system is used for the storage and retrieval of water data. At the present (1989), all primary U.S. Geological Survey water-resources data are maintained on the National Water Data Storage and Retrieval System (WATSTORE) at the central computer facilities in Reston, Virginia. These data also are stored and are available on District minicomputer files using the Distributed Information System (DIS). The DIS configuration provides easier dissemination and access of data that pertain to a given state. These data are available for water planning and management in machine-readable form, computer-printed tables or graphs, statistical tabulations, and digital plots. Information about the availability of specific types of data, the acquisition of data or products, and user charges can be obtained from the District office in Rolla.

A Master Water Data Index (MWDI) was developed by the Office of Water Data Coordination (OWDC) and is managed by the National Water Data Exchange (NAWDEX) Program Office to assistusers of water data to identify, locate, and acquire needed data. The U.S. Geological Survey through OWDC coordinates the water-data-acquisition activities of the U.S. Geological Survey and other Federal agencies. This information is made available to all users of water data by means of a national network of assistance centers. In Missouri, NAWDEX services can be obtained from the District Chief, Rolla, Missouri.

The U.S. Geological Survey outlines flood-prone areas on topographic maps as part of a nationwide Federal program for managing flood losses. Studies of the frequency and extent of flooding in Missouri have resulted in delineation of the 100-year flood boundary on selected topographic quadrangle maps (fig. 8). These maps are available on request from the Missouri District office in Rolla.

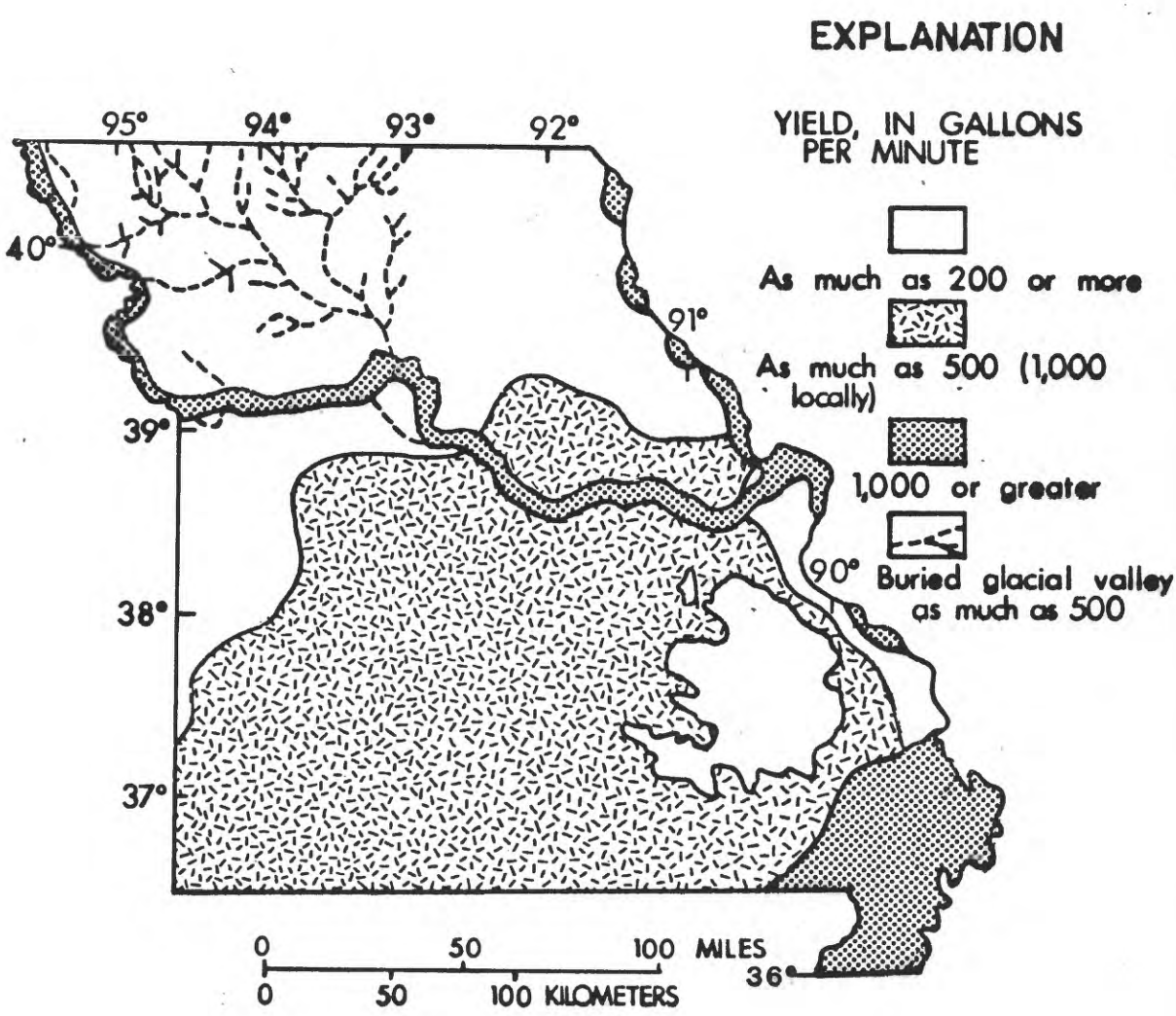

Figure 7.--Availability of ground water.

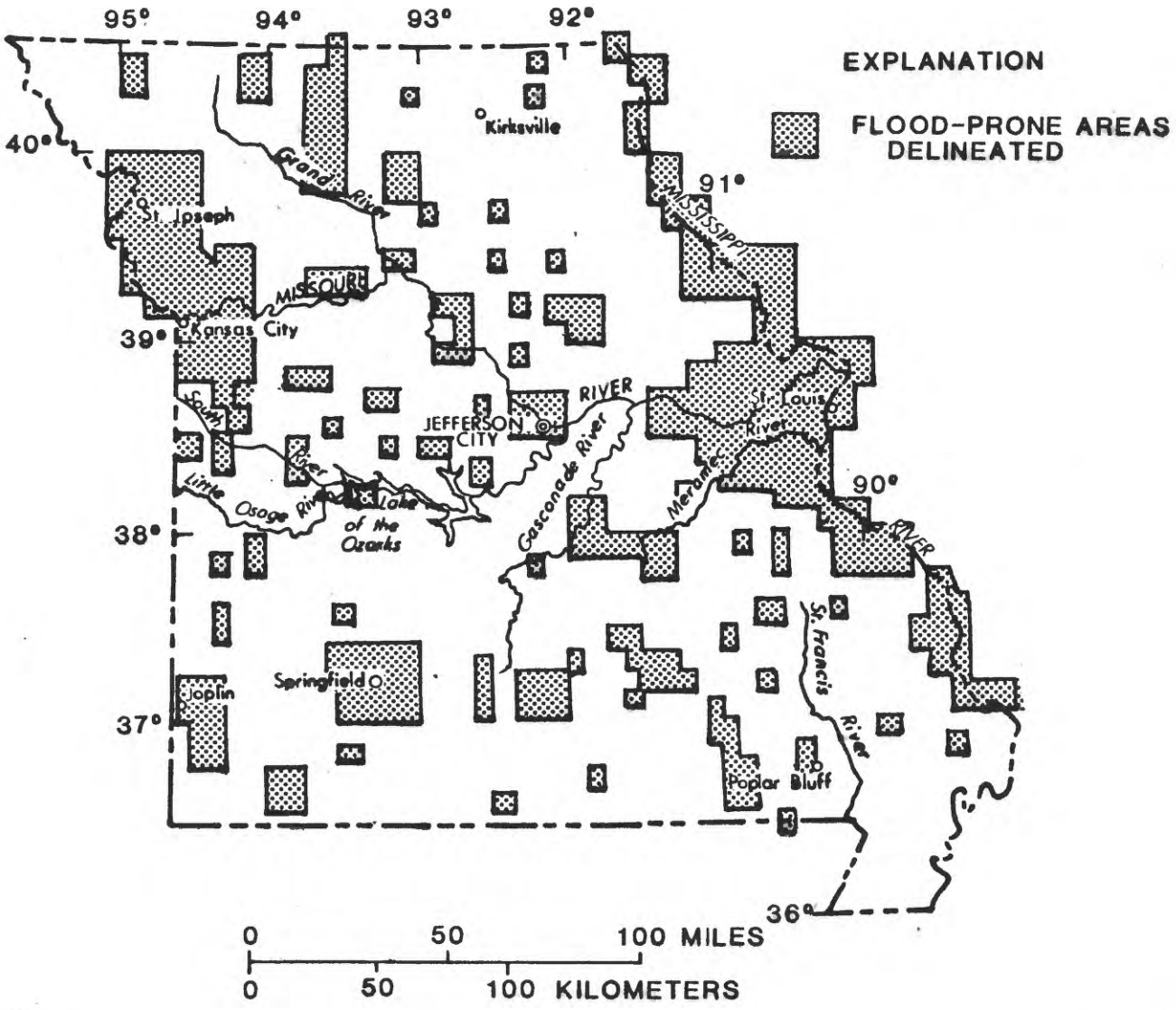

Figure 8.--Flood-prone area maps completed in Missouri.

HYDROLOGIC DATA-COLLECTION PROGRAMS

Hydrologic data-collection stations are maintained by the U.S. Geological Survey throughout Missouri to obtain records of stream discharge or stage, lake and reservoir storage, spring discharge, ground-water levels, and the quality of surface and ground water. Major drainage basins in Missouri and approximate areas in square miles are shown in figure 6. Daily discharge and surface-water quality data-collection stations in operation during fiscal year 1989 are listed in downstream order in table 1, which also includes the cooperating agency and type of data collected. In addition to these stations, the Missouri District, in cooperation with the Missouri Division of Geology and Land Survey, collects data from 137 low-flow partial-record sites, 17 peak-flow partial-record sites, and about 346 observation wells throughout the State.

Hydrologic data collected in Missouri as part of the data-collection network are published annually in a report entitled "Water Resources Data, Missouri, Water Year 19__" (the water year is from October 1 of each year to September 30 of the following year). These data represent the majority of water resources data collected in Missouri in cooperation with local, State, and other Federal agencies. Reports for each year are released the following year. Water-data reports are available for inspection at the U.S. Geological Survey in Rolla, Missouri, or may be purchased from the U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia 22161.

Table 1.--Daily discharge, stage, and surface-water quality stations in operation during fiscal year 1989

Station number	Station name	Cooperation[1]	Type of data[1]
05490600	Des Moines River at St. Francisville	CE RI	C, S
05495000	Fox River at Wayland	CE RI	D
05496000	Wyaconda River above Canton	CE RI	D
05497000	North Fabius River at Monticello	CE RI	D
05498000	Middle Fabius River near Monticello	CE RI	D
05500000	South Fabius River near Taylor	CE RI	D
05501000	North River at Palmyra	CE RI	D
05501600	Mississippi River at Hannibal	DEQ	C
05502000	Bear Creek at Hannibal	CE RI	D
05502300	North Fork Salt River at Hagers Grove	CE STL	D
05502500	North Fork Salt River near Shelbina	CE STL	D, S
05503800	Crooked Creek near Paris	CE STL	D
05504800	South Fork Salt River above Santa Fe	CE STL	D
05506500	Middle Fork Salt River at Paris	CE STL	D, S
05506800	Elk Fork Salt River near Madison	CE STL	D
05507600	Lick Creek at Perry	CE STL	D
05507795	Salt River below Cannon Dam	CE STL	St
05507800	Salt River near Center	CE STL	D
05508000	Salt River near New London	CE STL	D, S
05508805	Spencer Creek below Plum Creek near Frankford	CE STL	D
05509300	Salt River near Ashburn	CE STL	St
05514500	Cuivre River near Troy	CE STL, DEQ	C, D
05587450	Mississippi River at Grafton, Illinois	CE STL	D
05587500	Mississippi River at Alton, Illinois	NONE	St, S
05587550	Mississippi River below Alton, Illinois	NONE	C
05587795	Mississippi River at Hartford	CE STL	St
06813000	Tarkio River at Fairfax	DGLS	D
06817700	Nodaway River near Graham	CE KC	D
06817800	Nodaway River near Oregon	DEQ	C
06818000	Missouri River at St. Joseph	CE KC, DEQ	D, C
06819500	One Hundred and Two River at Maryville	DGLS	D
06820500	Platte River near Agency	CE KC	D
06821140	Smithville Reservoir near Smithville	CE KC	R
06821150	Little Platte River at Smithville	CE KC	D
06821190	Platte River at Sharps Station	CE KC	D, C

Table 1.--Daily discharge, stage, and surface-water quality stations in operation during fiscal year 1989--Continued

Station number	Station name	Cooperation[1]	Type of data[1]
06893000	Missouri River at Kansas City	CE KC	D
06893500	Blue River near Kansas City	CE KC	D
06893590	Blue River at 12th Street in Kansas City	CE KC	St
06893791	Longview Reservoir at Kansas City	CE KC	R
06893793	Little Blue River below Longview damsite in Kansas City	CE KC	D
06893880	East Fork Little Blue River at Lake Jacomo	CE KC	St
06893885	East Fork Little Blue River at Blue Springs Lake	CE KC	St
06893890	East Fork Little Blue River near Blue Springs	CE KC	D
06894000	Little Blue River near Lake City	CE KC	D
06895500	Missouri River at Waverly	CE KC	D
06897500	Grand River near Gallatin	CE KC	D
06899500	Thompson River at Trenton	CE KC	D
06899680	Grand River at Chillicothe	CE KC	St
06900000	Medicine Creek near Galt	DGLS	D
06902000	Grand River near Sumner	CE KC, DEQ	D, C
06904050	Chariton River at Livonia	CE KC	D
06904500	Chariton River at Novinger	CE KC	D
06905500	Chariton River near Prairie Hill	CE KC	D
06906000	Mussel Fork near Musselfork	CE KC	D
06906190	Long Branch Lake near Macon	CE KC	R
06906200	East Fork Little Chariton River near Macon	CE KC	D
06906300	East Fork Little Chariton River near Huntsville	CE KC, DEQ	D, C
06906500	Missouri River at Glasgow	CE KC	St
06906800	Lamine River near Otterville	DGLS	D
06908000	Blackwater River at Blue Lick	CE KC	D
06909000	Missouri River at Boonville	CE KC	D
06910230	Hinkson Creek near Columbia	DC	D, T
06910410	Cedar Creek near Columbia	LRC	D, C, T
06910414	Cedar Creek near Ashland	DEQ	C
06910450	Missouri River at Jefferson City	UE	St
06916664	Marais des Cygnes River at Rich Hill	CE KC	St
06916670	Miami Creek near Butler	CE KC	St
06917060	Little Osage River near Horton	CE KC	St
06918065	Marmaton River near Nevada	CE KC	St
06918070	Osage River above Schell City	CE KC	D, C

Table 1.--Daily discharge, stage, and surface-water quality stations in operation during fiscal year 1989--Continued

Station number	Station name	Cooperation[1]	Type of data[1]
06918330	Clear Creek near Eldorado Springs	CE KC	St
06918335	Big Monegaw Creek at Appleton City	CE KC	St
06918440	Sac River near Dadeville	CE KC	D
06918460	Turnback Creek above Greenfield	CE KC	D
06918600	Little Sac River near Walnut Grove	DEQ	C
06918740	Little Sac River near Morrisville	CE KC	D
06918990	Stockton Lake near Stockton	CE KC	R
06919000	Sac River near Stockton	CE KC	D
06919020	Sac River below Stockton	CE KC	D
06919500	Cedar Creek near Pleasant View	CE KC	D
06919900	Sac River near Caplinger Mills	CE KC	D
06920500	Osage River at Osceola	CE KC	St
06921070	Pomme de Terre River near Polk	CE KC, DGLS	D
06921200	Lindley Creek near Polk	CE KC	D
06921325	Pomme de Terre Lake near Hermitage	CE KC	R
06921350	Pomme de Terre River near Hermitage	CE KC	D
06921760	South Grand River near Clinton	CE KC	D
06922070	Elm Branch near Winsor	DEQ	C
06922190	West Fork Tebo Creek near Lewis	CE KC	C
06922440	Harry S. Truman Lake at Warsaw	CE KC	R
06922450	Osage River below Harry S. Truman Dam	CE KC	D
06922500	Osage River at Warsaw	CE KC	St
06922550	Osage River below Warsaw	CE KC	St
06922560	Lake of the Ozarks at Oar House Marina	CE KC	St
06922790	Lake of the Ozarks above Buffalo Creek	CE KC	St
06922900	Lake of the Ozarks at Rainy Creek	CE KC	St
06923500	Bennett Spring at Bennett Springs	DGLS	D
06925500	Lake of the Ozarks near Bagnell	DGLS	R
06926000	Osage River near Bagnell	UE	D
06926500	Osage River near St. Thomas	UE	D
06926510	Osage River below St. Thomas	NONE	C
06930450	Big Piney River at Devils Elbow	DEQ	C
06930800	Gasconade River above Jerome	DEQ	C
06932000	Little Piney Creek at Newburg	DGLS	D
06933500	Gasconade River at Jerome	DGLS	D
06934000	Gasconade River at Rich Fountain	CE KC	D
06934500	Missouri River at Hermann	CE KC, DEQ	D, C, T
06935965	Missouri River at St. Charles	CE STL	St
07010000	Mississippi River at St. Louis	CE STL	D, S, T
07013000	Meramec River near Steelville	CE STL	D

Table 1.--Daily discharge, stage, and surface-water quality stations in operation during fiscal year 1989--Continued

Station number	Station name	Cooperation[1]	Type of data[1]
07014500	Meramec River near Sullivan	CE STL, DEQ	D, C
07015720	Bourbeuse River near Highgate	CE STL	D
07016500	Bourbeuse River at Union	CE STL	D
07017020	Meramec River at Pacific	CE STL	St
07017200	Big River at Irondale	CE STL	D
07018100	Big River near Richwoods	CE STL, DEQ	D
07018500	Big River near Byrnesville	CE STL	D
07019000	Meramec River near Eureka	CE STL	D, C
07019280	Meramec River at Paulina Hills	DEQ	C
07019300	Meramec River at Arnold	CE STL	St
07020500	Mississippi River at Chester, Illinois	CE STL	D, S
07020850	Mississippi River at Cape Girardeau	CE STL	St
07021000	Castor River at Zalma	DGLS	D
07022000	Mississippi River at Thebes, Illinois	CE STL, DEQ	D, C, S
07034000	St. Francis River near Roselle	CE STL	D
07035000	Little St. Francis River near Fredericktown	CE STL	D
07035800	St. Francis River near Mill Creek	CE STL	D
07036100	St. Francis River near Saco	CE STL, DEQ	D, C, S
07036940	Big Creek at Chloride	DEQ	C
07037000	Big Creek at Des Arc	CE STL	D
07037500	St. Francis River near Patterson	CE STL	D
07039000	Wappapello Lake at Wappapello	CE STL	R
07039500	St. Francis River at Wappapello	CE STL	D
07042500	Little River Ditch 251 near Lilbourn	DGLS	D
07043500	Little River Ditch 1 near Morehouse	DGLS	D
07046001	Little River Ditches near Kennett	DEQ	C
07050700	James River near Springfield	CU	D
07052500	James River at Galena	CE LR	D
07053400	Table Rock Lake near Branson	CE LR	R
07053450	White River below Table Rock Dam near Branson	CE LR	C, T
07053500	White River near Branson	CE LR	D
07053600	Lake Taneycomo at School of the Ozarks	CE LR	St, C, T
07053700	Lake Taneycomo at Branson	DEQ	C
07053820	Lake Taneycomo at Powersite Dam	CE LR	St
07057500	North Fork River near Tecumseh	CE LR	D

Table 1.--Daily discharge, stage, and surface-water quality stations in operation during fiscal year 1989--Continued

Station number	Station name	Cooperation[1]	Type of data[1]
07061300	East Fork Black River at Lesterville	DGLS	D
07061500	Black River near Annapolis	CE LR	D
07062000	Clearwater Lake near Piedmont	CE LR	R
07062500	Black River at Leeper	CE LR	D
07063000	Black River at Poplar Bluff	CE LR	D
07063500	Cane Creek at Harvielle	CE LR	St
07064400	Montauk Springs at Montauk	NPS	C
07064440	Current River below Montauk State Park	NPS	C
07064530	Welch Spring near Akers	NPS	C
07064555	Pulltite Spring near Round Spring	NPS	C
07065000	Round Spring at Round Spring	NPS	C
07065500	Alley Spring at Alley	NPS	C
07066000	Jacks Fork at Eminence	DGLS	D
07066110	Jacks Fork above Two Rivers	NPS	C
07066510	Current River above Powder Mill	NPS	C
07066550	Blue Spring near Eminence	NPS	C
07067000	Current River at Van Buren	CE LR, DGLS	D
07067500	Big Spring near Van Buren	DGLS, NPS	D, C
07067800	Current River below Hawes Campground	NPS	C
07068000	Current River at Doniphan	CE LR, DEQ	D, C
07071000	Greer Spring at Greer	DGLS	D
07071500	Eleven Point River near Bardley	CE LR, DGLS	D
07186000	Spring River near Waco	CE TU	D
07186400	Center Creek near Carterville	DGLS, DEQ	D, C
07186480	Center Creek near Smithfield	DEQ	C
07187000	Shoal Creek above Joplin	CE TU	D
07189000	Elk River at Tiff City	DEQ	C

[1]Explanation of abbreviations:

Cooperation

CE KC	U.S. Army, Corps of Engineers, Kansas City
CE LR	U.S. Army, Corps of Engineers, Little Rock
CE RI	U.S. Army, Corps of Engineers, Rock Island
CE STL	U.S. Army, Corps of Engineers, St. Louis
CE TU	U.S. Army, Corps of Engineers, Tulsa
CU	City Utilities of Springfield
DEQ	Missouri Division of Environmental Quality
DGLS	Missouri Division of Geology and Land Survey
UE	Union Electric Company of Missouri
NPS	National Park Service
LRC	Missouri Land Reclamation Commission
DC	Missouri Department of Conservation

Type of Data

C	Chemical
D	Discharge--continuous record of stage and discharge
R	Reservoir content
S	Sediment
St	Stage only
T	Temperature

Collection of Surface-Water Data (MO-001)

in cooperation with

Union Electric Company of Missouri
Missouri Highway and Transportation Commission
Missouri Department of Natural Resources, Division of Geology and Land Survey
Missouri Department of Conservation
Little River Drainage District
National Park Service
City Utilities of Springfield
U.S. Army, Corps of Engineers
City of Cape Girardeau

Loyd A. Waite, Project Chief

Statewide study area

NEED FOR STUDY

Surface-water information is needed for surveillance, planning, design, hazard warning, and operation and management in water-related fields, such as water supply, hydroeletric power, flood control, irrigation, bridge and culvert design, wildlife management, contamination abatement, flood-plain management, waste disposal, and water resources development.

OBJECTIVES

(1) Collect surface-water data sufficient to satisfy needs for current-purpose uses, such as assessment of water resources; operation of reservoirs or industries; forecasting, disposal of wastes, both common and nuclear; contamination controls; discharge data to accompany water-quality measurements; compact and legal requirements; and research or special studies. (2) Collect data necessary for analytical studies and define the trends and statistical properties of streamflow.

APPROACH

Standard methods of data collection will be used as described in the series *Techniques of Water-Resources Investigations of the U.S. Geological Survey.*

ACTIVITIES DURING FISCAL YEAR 1989

The 1988 annual water-data report was completed and submitted to the U.S. Government Printing Office in May 1988; printed copies were distributed to cooperators and other Federal agencies.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Data collection will continue, and a date of April 1990 is anticipated for completion of the 1989 water-data report.

Collection of Surface-Water Data--Continued

REPORT

Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1989, Water-resources data for Missouri, water year 1988: U.S. Geological Survey Water-Data Report MO-89-1, 290 p. (published annually).

Collection of Ground-Water Data (MO-002)

in cooperation with

Missouri Department of Natural Resources, Division of Geology and Land Survey

Jeffrey L. Imes,
Project Chief

Statewide study area

NEED FOR STUDY

Ground-water information is needed to evaluate the effects of climatic variations on recharge to and discharge from the aquifer systems, to provide a data base for measuring the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resources.

OBJECTIVES

(1) Collect sufficient data to provide a long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known to allow for proper planning and management of potential concerns in the state. (2) Provide a data base from which the short-term records acquired in areal studies can be analyzed.

APPROACH

Evaluation of regional geology allows broad, general definition of aquifer systems and their boundary conditions. Within this framework, data will be collected to help define stresses on the system and the hydrologic properties of the aquifers. The data-collection network will be refined as records accumulate and detailed areal studies of the ground-water system more closely define the aquifers, their properties, and the stresses to which they are subjected.

ACTIVITIES DURING FISCAL YEAR 1989

Measurements of streamflow and ground-water levels were made for Greene County in April 1989 and September 1989 to obtain an accurate understanding of the ground-water table and the location of losing and gaining stream reaches. A ground-water level network of 15 wells was established for Greene County during fiscal year 1989. Nine of these wells were instrumented with continuous ground-water-level recorders. Continuous ground-water-level records were processed for about 50 wells maintained by the Missouri Division of Geology and Land Survey. Ground-water-level data for 36 wells maintained during 1985 and 1986 were published, and a mass water-level measurement was completed for Audrain County.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Mass water-level measurements will be made for several areas of the State. Water levels will be monitored continuously for about 50 wells, and the records will be processed and data published in the annual data report.

Collection of Ground-Water Data--Continued

REPORT

Berkas, W.R., Endicott, Cynthia, and Cross, P.W., 1989, Groundwater level data for Missouri 1985-1986: Rolla, Missouri Division of Geology and Land Survey, Water Resources Report 37, 79 p.

Collection of Quality-Water Data (MO-003)

in cooperation with

Missouri Department of Natural Resources, Division of Geology and Land Survey, Land Reclamation Commission

National Park Service

U.S. Army, Corps of Engineers

Statewide study area

Jerri V. Davis, Project Chief

NEED FOR STUDY

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

OBJECTIVES

(1) Collect sufficient data to provide a long-term data base so that the general water quality of the hydrologic system is known to allow for proper planning and management of potential concerns in the State. (2) Collect data necessary for analytical studies and define the trends and statistical properties of water-quality conditions.

APPROACH

A network of quality-water stations will be operated to measure chemical concentrations, loads, and time trends as required by planning and management agencies.

ACTIVITIES DURING FISCAL YEAR 1989

The Missouri District water-quality network included 10 National Stream Quality Accounting Network (NASQAN) stations. Seven were sampled bimonthly and three were sampled quarterly for common inorganics, nutrients, and trace elements; one was sampled daily for temperature and specific conductance. Samples for common inorganics, nutrients, and trace elements were collected at stations operated in cooperation with the Missouri Department of Natural Resources, which included 20 monthly, 1 bimonthly, 2 sites where samples were collected 8 times, and 1 site where samples were collected twice. Samples for common inorganics, nutrients, and trace elements were collected monthly at 1 station and 8 times at another station for the U.S. Army, Corps of Engineers, and biannually at 11 stations for the National Park Service. Continuous water-quality monitors that measure temperature, temperature and dissolved oxygen, or pH and specific conductance were operated at four stations, two for the Corps of Engineers, one for the Missouri Department of Natural Resources, and one for the Missouri Department of Conservation.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

National Stream Quality Accounting Network (NASQAN) samples for common inorganics, nutrients, and trace elements will be collected at seven stations bimonthly and three stations quarterly; one station will be sampled daily for temperature and specific conductance. Stations operated in cooperation with the Missouri Department of Natural Resources will include 10 where samples will be collected monthly and 1 where samples will be collected 8 times for common inorganics, nutrients, and trace elements. Samples for common inorganics, nutrients, and trace elements will be collected monthly at 1 station and 8 times at another for the U.S. Army, Corps of Engineers, and biannually at 11 stations for the National Park Service. Continuous water-quality monitors measuring temperature, temperature and dissolved oxygen, or pH and specific conductance will be operated at four stations.

REPORT

Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1989, Water resources data, Missouri, water year 1988: U.S. Geological Survey Water-Data Report MO-89-1, 290 p. (published annually).

Sediment Processes in Natural Streams (MO-004)

in cooperation with

U.S. Army, Corps of Engineers

Robert R. Holmes, Jr.

Project Chief

Statewide study area

NEED FOR STUDY

Water-resources planning and water-quality assessment require a nationwide base level of relatively standardized information. Sediment concentrations and discharges in Missouri's rivers and streams need to be defined and monitored.

OBJECTIVE

Provide sediment data for use in broad State and Federal planning and action programs, including State and Federal management of interstate and international waters.

APPROACH

A network of sediment stations will be established and operated to provide spatial and temporal averages and trends of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

ACTIVITIES DURING FISCAL YEAR 1989

The operation of nine sediment-sampling stations continued, and the data were published in "Water Resources Data, Missouri." (published annually.) Suspended sediment and bedload data also were collected at one event-based periodic site. A literature and data search was conducted for phase one of a study entitled "Sediment characteristics of Missouri tributaries into the Mississippi River main stem." Mudflow research continued using a mud flume wheel. A M.S. thesis on mudflow research sponsored by the U.S. Geological Survey was completed.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

The operation of eight daily suspended-sediment data sites, two periodic suspended-sediment data sites, and one bedload data site will continue. A data base will be implemented to study sediment transport for phase two of the study "Sediment characteristics of Missouri tributaries into the Mississippi River main stem." Mudflow research also will continue. Preparation of a U.S. Geological Survey Water-Resources Investigations Report on mudflow research is expected.

REPORT

Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1989, Water resources data, Missouri, water year 1988: U.S. Geological Survey Water-Data Report MO-89-1, 290 p. (published annually).

Water-Use Data-Collection and Reporting Program (MO-007)

in cooperation with

Missouri Department of Natural Resources,

Division of Geology and Land Survey

Loyd A. Waite,

Project Chief

Statewide study area

NEED FOR STUDY

As population increases and industry expands to meet the needs of that population, demand for and use of water will increase. This places a two-fold stress on the water supply. The increased demand may exceed the supply, and increased use accelerates the potential for degradation of the water quality.

OBJECTIVES

(1) Systematically collect data for the estimation of the withdrawal and return of water for all types of water uses. (2) Provide a broad data base from which many types of analyses can be made. (3) Provide a greater knowledge of the general hydrologic effects of increased withdrawals from the water system. (4) Provide data to the national water-use data base to assist in the national water-resources assessment.

APPROACH

Water-use data will be collected by categories on a statewide basis. Existing data will be compiled from State files, stored in the U.S. Geological Survey Prime computer system, and entered into the U.S. Geological Survey aggregated data base. Data-collection methods and sampling strategies will be devised to acquire additional data. A report will be planned to describe data-collection methods and sampling strategies. Stastical summaries will be included in the annual water-data report.

ACTIVITIES DURING FISCAL YEAR 1989

Water-use data by major users during 1987 were edited and entered into the Missouri Department of Natural Resources (DNR) computer system. Water-use data for 1988 were collected by a mail survey. The DNR and New State Water-Use Data System (NEWSWUDS) data systems have been made compatible, and transfer of the data to NEWSWUDS is expected by the end of the fiscal year. Director's approval was obtained for a U.S. Geological Survey Water-Resources Investigations Report on water use in Missouri during 1985.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Missouri District will coordinate the newly initiated 10 state Missouri River Basin water-use study. A major emphasis of the study in fiscal year 1990 will be to develop a published study work plan. Water-use data by major users during 1989 will be collected. Water-use data for 1988 will be edited, entered into the DNR computer, and transferred into NEWSWUDS.

Water-Use Data-Collection and Reporting Program--Continued

REPORTS

Hall, D.C., and Steelman. S.H., in press, Missouri water supply and demand, in National Water Summary 1987--Hydrologic events and water supply and demand: U.S. Geological Survey Water-Supply Paper 2350.

Hall, D.C., in press, Estimated water use in Missouri during 1985: U.S. Geological Survey Water-Resources Investigations Report 89-4038, p.

Hydrology of Abandoned Strip Mines and Effects of Reclamation at the Power Mine in Western Missouri (MO 85-062)

in cooperation with

Missouri Department of Natural Resources, Division of Environmental Quality, Land Reclamation Commission

Western Missouri study area

Dale W. Blevins, Project Chief

NEED FOR STUDY

About 2,750 acres of abandoned strip mines in western Missouri are characterized by barren spoil and acid water. The Land Reclamation Commission is considering revegetating the area, but there is insufficient information about the factors that control water quality to determine whether revegetation efforts will improve the acidic condition of the lakes and streams in the area.

OBJECTIVES

To determine the movement and quality of surface and ground water; determine the interchange between the surface- and ground-water systems; and determine the effects of revegetation activities on the quantity and quality of surface discharge from the strip-mined area.

APPROACH

Existing information will be compiled with reconnaissance data to develop a conceptual hydrologic model of the basin. Continuous rainfall-runoff and surface-water-quality data will be collected to determine runoff quality and the origin of acidic water in the lakes. Ground-water and spoil samples (including isotope data) will be collected to determine the geochemistry and contribution of ground water to acidic lakes. Ground-water levels will be used to determine the direction of ground-water flow in the spoil. A water-quality computer model will be used to broaden the results and evaluate details of the hydrologic system where they are missing. Two long-term streamflow-gaging stations and two water-quality monitors will be operated to monitor the effects of revegetation on water quality.

ACTIVITIES DURING FISCAL YEAR 1989

Two lakes were determined to have been acidic before reclamation. After reclamation, one of these lakes has continued to have a near neutral pH, whereas the other lake has become acidic again. Flow offsite has remained above pH 7.0, except during late summer. Runoff still is acidic, though slightly more neutral. Base flow sampling shows no significant chemical changes between before and after reclamation. Presently, it seems lake water chemistry at the bottoms of the lakes is controlled by saturation with respect to siderite. Comparison of total metals to dissolved metals in the lakes indicates that nearly all metal concentrations are in the dissolved phase.

Hydrology of Abandoned Strip Mines and Effects of Reclamation at the Power Mine in Western Missouri--Continued

PLANNED ACTIVITIES DURING FISCAN YEAR 1990

Sampling of surface- and ground-water sites during base-flow conditions will continue. Sampling of study lakes at maximum stratification and soon after will be done. The draft of the final interpretive report will be completed by June, 1990.

Extent and Magnitude of Contamination of the Water Resources in the Vicinity of the Weldon Spring Radioactive Waste-Disposal Sites, St. Charles County, Missouri (MO 87-071)

in cooperation with

U.S. Department of Energy

Eastern Missouri study area

Michael J. Kleeschulte, Project Chief

NEED FOR STUDY

Chemical analyses indicate that water in the shallow bedrock aquifer contains large concentrations of calcium, lithium, magnesium, nitrate, sodium, strontium, sulfate, and uranium in the vicinity of four low-level radioactive waste-disposal pits near Weldon Spring, Missouri. A spring 1.5 miles north of the site also has increased lithium, nitrate, and uranium concentrations, but monitoring wells between the pits and spring do not indicate a contamination plume. The areal and vertical extent and magnitude of contamination and the transport routes for the contaminants in this karst environment need to be defined.

OBJECTIVE

To define the extent, magnitude, and transport routes of contamination near the Weldon Spring radioactive waste-disposal sites.

APPROACH

Gross water budget, infiltration tubes, and monitoring of precipitation will aid in the development of a ground-water flow model. Continuous water-level recorders on wells will monitor ground-water fluctuations with changes in climatic conditions and the possible movement of the ground-water divide. Water-quality minimonitors at one contaminated spring and at the outflow from two contaminated ponds that drain into losing streams will record water-quality variations with climate and time. Selected monitoring wells will be sampled, and water levels will be measured quarterly. Geochemical models will be used to evaluate geochemical controls. An interpretative report will be completed in the third year of the project. Water-quality conditions during remedial action will be monitored during the last 6 years of the project.

ACTIVITIES DURING FISCAL YEAR 1989

Quarterly water-level measurements indicate the ground-water altitude is higher to the west of the chemical plant than it is at the plant. Radiological contamination has been detected in springs to the north, east, and south of the site. Calibration of the ground-water flow model is in progress, and the data needed for the geochemical model have been collected. Thermodynamic equilibrium and mass balance modeling also are in progress.

Extent and Magnitude of Contamination of the Water Resources in the Vicinity of the Weldon Spring Radioactive Waste-Disposal Sites, St. Charles County, Missouri--continued

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

The operation of two continuous stream-gaging stations, two minimonitors, rain gages, and soil infiltration tubes will be discontinued. Water-quality data collection will change from a reconnaissance status to a monitoring status. Number of sites sampled and chemical constituents analyzed for will decrease. A data report will be prepared by December 1989, and the final interpretive report will be completed by June 1990.

Effects of Lead and Zinc Mining on the Quality of Surface Water and Recent Alluvium in the Old Lead Belt of Southern Missouri (MO 87-072)

in cooperation with

Missouri Department of Natural Resources, Division of Environmental Quality, Land Reclamation Commission

Southeastern Missouri study area

Brenda J. Smith, Project Chief

NEED FOR STUDY

Tailings from mining operations were placed directly on the land surface and often close to streams. The Big River basin is estimated to contain 3,000 acres underlain by tailings. Six major tailings piles contain unremoved particles of ore minerals that contribute lead, zinc, cadmium, iron, and copper to the environment. Mechanisms of contamination are dispersal of particles by wind, washing of particles by runoff into ponds and streams and subsequent transport of sediment downstream, slumping of tailings into streams, and leaching of metals by percolation of precipitation through tailings and subsequent movement of the dissolved metals or metals complexes into the ground- and surface-water systems.

OBJECTIVES

(1) Determine the quality of surface water in the area, including tailings ponds, the Big River, the Flat River, and tributaries, at high and low stages. (2) Determine the physical and chemical processes that govern water quality. (3) Determine the metal content of various size fractions of suspended and bottom sediment.

APPROACH

A sampling network of 20 to 25 surface-water sites will be established at tailings ponds and streams. About 12 to 15 of the sites will be selected for suspended and bottom sediment sampling. Sampling and measuring will be done several times during the water year and will include both high and low stream discharge. Field parameters, common inorganics, total organic carbon, trace metals, and sulfur-34 and strontium 87/86 isotopes will be determined.

ACTIVITIES DURING FISCAL YEAR 1989

Water and sediment samples were collected quarterly. Flood samples were collected in February, March, and July. A seepage study will be done in September 1989. Results from chemical analyses, particle-size analyses, and scanning electron microscope have been received. Project personnel have received training in solid-phase data interpretation and water-quality modeling.

Effects of Lead and Zinc Mining on the Quality of Surface Water and Recent Alluvium in the Old Lead Belt of Southern Missouri--continued

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Quarterly water and sediment sampling will be completed. A U.S. Geological Survey Open-File data report will be completed, and a draft of the final report, which will be published in the U.S. Geological Survey Water-Supply Series, will be prepared.

REPORT

Smith, B.J., 1988, Assessment of water quality in non-coal mining areas of Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4286, 50 p.

Mine Drainage and Subsidence Problems from Abandoned Underground Coal Mines at Huntsville, Missouri (MO 87-073)

in cooperation with

Missouri Department of Natural Resources, Division of Environmental Quality, Land Reclamation Commission

Randolph County study area

Dale W. Blevins, Project Chief

NEED FOR STUDY

Shallow underground coal mining has caused concerns at Huntsville, Missouri. Degradation of the quality of water flowing through and emerging from the mines has occurred. Subsidence of the land surface has caused significant damage to manmade structures.

OBJECTIVES

(1) Determine the location, seasonal variation, and effects of underground mine water on receiving streams and nearby ground water. (2) Determine areas susceptible to surface subsidence from mine collapse. (3) Identify potential reclamation actions that could alleviate or minimize water-quality and subsidence concerns.

APPROACH

Mine workings will be located from existing maps, geophysical techniques, subsidence features, entry locations, and wells drilled as part of this study. Geologic information will be obtained from surface mapping, drillers' logs, and literature. Water samples will be obtained from underground mines, and water levels, pH, and specific conductance will be continuously monitored. Existing wells will be inventoried to determine water levels and general ground-water quality in the area. Mine drainage sources will be identified, and flow from all significant sources will be sampled twice. Conceptual models of the ground-water flow and hydrogeochemical systems will be postulated.

ACTIVITIES DURING FISCAL YEAR 1989

Underground mine water has little or no potential for contaminating other aquifers. Mine water pH is between 6 and 7. Eighty percent of mine drainage in the area emerges at two sites. Mine recharge averages 0.4 inch per year. Mine drainage acidifies after entering a stream; however, sewage effluent neutralizes acidic streamflow. Subsidence is limited to abandoned shafts and areas where cover is thin.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

A report will be published in the U.S. Geological Survey Water-Resources Investigations Report series.

Ground-Water Resources and Lithologic Controls on Ground-Water Leakage in the Ozark Aquifer near Branson, Missouri (MO 88-074)

in cooperation with

Missouri Department of Natural Resources

City of Branson, Missouri

Jeffrey L. Imes,
Project Chief

Branson, Missouri
study area

NEED FOR STUDY

Branson, Missouri receives a large influx of tourists during the summer months. Seasonal ground-water use varies greatly; water levels decrease rapidly in early summer and recover during the winter. It is not known whether water levels are fully recovering each season. Also, no continuous confining layer separates land surface from the underlying aquifers, thus contamination is a constant threat to the aquifer.

OBJECTIVES

(1) Determine seasonal and long-term effect of ground-water withdrawals; (2) assess interaction of near-surface geologic formations in impeding vertical movement of water; and (3) provide an indication of water quality in the Ozark aquifer near Branson.

APPROACH

Existing data bases will be inventoried for well location and construction information. A monitoring network will be designed, and water levels in shallow and deep wells will be monitored for 2 years, including 2 seasons. Water-quality analysis will be done for selected wells near Branson. A ground-water flow model will be developed for the Branson area to verify flow concepts and quantify hydraulic properties of the aquifer.

ACTIVITIES DURING FISCAL YEAR 1989

Mass water-level measurements were made during March and June 1989 for the Branson area. Water levels increased by a maximum of about 110 feet from water levels during the previous summer. Monthly water-use data were collected from the larger users throughout the year. Geologic and hydrologic data are being prepared for incorporation into a 3-dimensional ground-water flow model. A reconnaissance survey of ground-water quality in selected wells indicated no organic compounds, and only small concentrations of selected inorganic compounds were present.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

The ground-water flow model will be completed, calibrated, and used to estimate the probable results of continued ground-water pumpage at the present rates in the Branson area. The final report will be prepared and published as a U.S. Geological Survey Water-Resources Investigations Report.

Ground-Water Resources and Lithologic Controls on Ground-Water Leakage in the Ozark Aquifer near Branson, Missouri--Continued

REPORT

Imes, J. L., 1989, Compilation of geohydrologic data collected as part of the areal appraisal of ground-water resources near Branson, Missouri: U.S. Geological Survey Open-File Report 89-401, 24 p.

Geomorphic Changes in Stream Channels and their Impacts on Fisheries Habitat in the Ozark Region of Missouri (MO 88-075)

in cooperation with

U.S. Department of Conservation

Missouri Ozarks study area

James H. Barks, Project Chief

NEED FOR STUDY

During the past 100 years, Missouri's Ozark streams have become choked with gravel, thus becoming wider, shallower, and braided. There is little documentation of this problem, or of associated impacts on aquatic ecosystems. To effectively design management programs for stream systems that will improve and restore aquatic habitat, the sources, magnitude, scope, and rate of change of the flow, fluvial sediment, and channel behavior need to be understood.

OBJECTIVES

Determine the magnitude of the stream channel problem; the scale or scope of change; the rate of change; and specific basin, corridor, or channel activities that will cause geomorphic changes that will result in habitat improvement.

APPROACH

Four Ozark streams will be selected based on stream geometry, geology, availability of long-term records, land use, bed material, and stream origin. Information gathered from existing literature; historic aerial photos, maps, and cross sections; stream data analysis; mean bed elevation changes; bed material and dendrochronology data will be used to identify recent geomorphic changes and their causes. This knowledge will be combined with knowledge of aquatic habitat to determine what physical changes in basins, corridors, and channels would be required to improve aquatic habitat.

ACTIVITIES DURING FISCAL YEAR 1989

A literature review was completed and historical maps were obtained for the pilot stream. The planning phase, including testing of investigative techniques, was completed. Changes in streambed elevations were calculated from discharge measurement notes at long-term gaging stations. Little Piney Creek and the Current River were selected for detailed study.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Two additional streams will be selected for detailed study. Historical maps will be obtained for each stream to be studied and photogrammetric interpretation will begin. Geomorphology, dendrochronology, and suspended and bedload data will be collected from selected stream reaches.

Investigation of Bridge-Scour Processes Occurring at Selected Sites on Missouri Streams (MO 88-076)

in cooperation with

Missouri Highway and Transportation Commission

Lawrence D. Becker,
Project Chief

Statewide study area

NEED FOR STUDY

Adequate definition of potential scour at bridge piers is essential to proper design, construction, and maintenance of hydraulic structures. Reasonably accurate estimates of scour depth are needed for safe, cost-effective bridge design. Although many scour estimating equations have been developed based on laboratory work, site-specific data have not been collected to verify the accuracy of these equations and techniques and their applicability to Missouri streams.

OBJECTIVES

To investigate bridge-pier-scour processes at selected sites on Missouri streams, collect data relative to bridge-pier scour during floods, evaluate existing scour prediction techniques and equations, and possibly develop depth-of-scour estimation techniques applicable to Missouri in whole or part.

APPROACH

The scope of this study is statewide, but will be limited to regions where pier scour can be expected to be a significant consideration in bridge design. Approximately 12 sites will be selected for data collection relative to extent of scour, sediment and bed material, and flow velocities and directions during and following flood events. Collected data will be used in verification or development of methods to predict scour effects at ungaged or site-specific locations.

ACTIVITIES DURING FISCAL YEAR 1989

Literature searches and comparison of study approaches and scour measurement techniques have been accomplished. Site reconnaissance considerations and requirements and office and field reonnaissance have been determined. The study sites have been selected, and a detailed evaluation of the project has been done. Missouri is being included in the Nationwide scour study "Measuring Performance of Bridges During Floods."

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Site reconnaissance and selection of suitable sites for detailed bridge scour studies will be completed. Bridge scour data will be collected and data analysis started.

The Effect of Sinkholes and Related Karst Features on Shallow Water Flow and Ground-Water Quality in Greene County, Missouri (MO 89-077)

in cooperation with

Watershed Management Coordinating Committee of the Ozarks

Greene County, Missouri study area

Jeffrey L. Imes, Project Chief

NEED FOR STUDY

The well-developed karstic environment of Greene County, Missouri, and lack of integrity of the confining unit that separates the shallow karst aquifer used for municipal supply can allow the rapid movement of contaminants from land surface into the shallow aquifer, and subsequently into the deep aquifer. Greene County (and Springfield) is located on top of a regional ground-water divide, and all water pumped from wells in the county ultimately comes from infiltration of precipitation within the county. Many wells in the area already have been contaminated.

OBJECTIVES

(1) Develop a comprehensive GIS (Geographic Information System) database of karst features, surface-water hydrologic data, and shallow ground-water hydrologic data. (2) Analyze and interpret collected data to estimate unknown hydrologic connections between karst features. (3) Analyze sinkhole characteristics and research sinkhole growth processes.

APPROACH

Karst-feature and geologic feature data that may affect shallow ground-water flow will be collected and digitized. Data layers include sinkhole location, caves, streams, bedrock geology, water table, and seeps and springs. These data bases will be combined with selected cultural data layers to make the data base useful in emergencies, such as chemical spills. A statistical study of sinkhole characteristics and relation to other geologic features will be conducted. Dye traces will be used to assess accuracy of estimated hydrologic connections. Partial carbon dioxide content of rock and soil will be measured in two wells as part of sinkhole growth process study.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Field work will be done to locate karst features, such as sinkholes, seeps, springs, losing stream segments, and cave orientations. Cave locations, springs, urban areas, bedrock geology, faults and fractures, and lineaments will be digitized. A water table map will be prepared and digitized, and soil data will be transferred to base maps and digitized.

Uptake and Release of Contaminants by Overburden Soil Minerals in the Vicinity of the Raffinate Pits, Weldon Spring Chemical Plant, St. Charles County, Missouri (MO 89-078)

in cooperation with

U.S. Department of Energy

John G. Schumacher,
Project Chief

St. Charles County study area

NEED FOR STUDY

The Weldon Spring Chemical Plant processed uranium ore-concentrates and scrap uranium trioxide, uranium tetrafluoride, and uranium metal. During its operation from 1957 to 1966, the plant processed more than three times its design capacity. In addition, some thorium also was processed. Waste from these operations (referred to as raffinate) was pumped into four large pits. These pits were constructed by bulldozing containment dikes from unconsolidated regolith at the site. They contain various quantities of several trace elements. It has been determined that the raffinate pits are leaking, and various trace elements have been detected in surface water and ground water. Clean-up of the site is underway and onsite disposal of contaminated materials is likely, using overburden materials at the site.

OBJECTIVES

(1) Evaluate the chemical and physical properties of the raffinate materials. (2) Determine the stratigraphic relations in the vicinity of the raffinate pits. (3) Investigate the attenuation of contaminants in various overburden zones in the vicinity of the raffinate pits. (4) Determine various factors such as retardance factors and distribution coefficients required to evaluate the use of site materials in an onsite disposal facility.

APPROACH

Existing borehole data will be used to determine stratigraphic relations near the pits. Representative samples of raffinate sludge will be collected and analyzed for radionuclides, trace elements, physical properties, and mineralogy. Soil samples will be collected near the raffinate pits and transported to the University of Missouri-Rolla laboratory. Laboratory batch and column experiments will be used to evaluate uptake and release of contaminants from the overburden materials.

ACTIVITIES DURING FISCAL YEAR 1989

Mineralogy of the various overburden units has been determined. The predominant minerals are quartz (up to 90 percent), orthoclase (up to 13 perent), and calcite (up to 15 percent). Minor quantities (2-4 percent) of montmorillonite also are present. Most overburden units contain more than 3 percent iron (by weight). Much of this is thought to exist as iron oxide coatings or mineral grains and as fracture fillings associated with manganese oxides. Analysis of shallow ground-water samples collected from

Uptake and Release of Contaminants by Overburden Soil Minerals in the Vicinity of the Raffinate Pits, Weldon Spring Chemical Plant, St. Charles County, Missouri--continued

both on and offsite indicate the ground water is moderately oxidizing, with dissolved oxygen greater than 2.0 milligrams per liter and no measurable quantities of ferrous iron or hydrogen sulfide. Samples from wells completed deeper within the shallow aquifer have smaller quantities of dissolved oxygen (0.7 to 4 milligrams per liter), in addition to smaller total dissolved solids. Measurable quantities of ferrous iron were detected in one of these wells. Laboratory sorption experiments are nearly complete for the Ferrelview Clay and clay till units, and preliminary results inicate significant quantities of molybdenum are sorbed from solution at pH 4.5 but not at higher pH values. This is thought to indicate sorption taking place on iron oxide locations rather than as ion exchange on clay minerals. Most uranium is sorbed into a glacial clay locally known as the Ferrelview Clay at neutral pH, lesser quantities at pH 4.5, and only minor quantities are sorbed at pH 9.0. This is in contrast to the clay till where most uranium is sorbed at pH 4.5, moderate quantities at pH 9.0, and only minor sorption at neutral pH. Geochemical modeling of the raffinate pit-shallow ground-water system has begun. Initial studies indicate uranium solubility is controlled by sorption on iron oxides within the overburden and by uranium hydroxide and uranium carbonate minerals within the fractured bedrock. Samples collected from interstitial water samples placed at various depths with the sludge in raffinate pit 3 indicate the persistance of an oxygenated system to depths of at least 6 feet. Concentrations of most constituents increase substantially with increasing depth below the sediment-water interface. Concentrations of nitrate exceeded 40,000 milligrams per liter at depths of 4.5 feet and calcium concentrations exceeded 9,500 milligrams per liter. Values of pH decreased from 8.5 just above the sediment-water interface to 7.0 at a depth of 4 feet.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Leaching experiments will be completed for uranium contaminated soils, and sorption experiments will be completed for nitro-aromatic compounds. Interstitial water samples will be collected from raffinate-pit sludges to determine redox conditions in the pits. Geochemical controls on contaminant movement within the shallow dolomitic aquifer will be determined through the use of equilibrium, mass balance, and reaction path modeling. A data report will be published listing water-quality, mineralogic, and laboratory experimental results. An interpretive report on geochemical controls on contaminant movement through the overburden and shallow bedrock aquifer will be completed.

Comprehensive Assessment of the Potential Hydrologic and Biological Impact of Lead and Zinc Mining in the Mark Twain National Forest of Southern Missouri (MO 89-079)

in cooperation with

Missouri Department of Natural Resources, Division of Geology and Land Survey

National Park Service

Southern Missouri study area

Michael J. Kleeschulte, Project Chief

NEED FOR STUDY

The U.S. Forest Service has issued two preference right leases for exploratory drilling and road construction for lead-zinc prospecting in the Mark Twain National Forest. Lead-zinc mining could potentially affect the water resources in the area by degrading water quality or decreasing the ground-water flow, or both. Declining water levels could cause domestic wells to go dry and contribute to land subsidence in the karst terrane. Changes in water quality and quantity could adversely affect flora and fauna, including some threatened and endangered species, as well as the large tourist industry.

OBJECTIVES

The overall objective is to provide a technical basis for estimating the probable environmental effects of lead-zinc mining in the hydrologically and biologically sensitive Mark Twain National Forest.

APPROACH

The study has been divided into three phases that generally coincide with mine development. Phase 1 will include an extensive literature search, installation of monitoring equipment on wells, inventory of existing wells, sampling of ground and surface water and stream-bottom sediment for chemical analyses, water-level measurements, and stream discharge. If mineralization warrants further study, phase 2 will include continued collection of and analyses of water and sediment, preparation of a geologic map, core analyses, aquifer testing, and construction of a ground-water flow model. Phase 3 will include comparison of data collected from earlier phases and data from monitoring in this phase to determine if resources are being affected by mining.

PLANNED ACTIVITIES DURING FISCAL YEAR 1990

Water levels will be measured quarterly and water samples will be collected biannually from 12 wells and analyzed for common ions, nutrients, and trace elements. Flow will be measured at 12 spring and stream sites quarterly and water samples will be collected and analyzed for the above constituents and suspended sediment. Streambed sediment will be collected from several sites and analyzed for trace elements. Data will be entered in GIS and analyzed, and report preparation will begin.

SOURCES OF WATER RESOURCES DIVISION PUBLICATIONS AND INFORMATION

Selected references on water resources in Missouri are listed on the following pages, and many of these references are available for inspection at:

U.S. Geological Survey, WRD
Missouri District
1400 Independence Road
Mail Stop 200
Rolla, Missouri 65401

and

Missouri Division of Geology and Land Survey
Fairgrounds Road
P.O. Box 250
Rolla, Missouri 65401

Current releases are described in a monthly pamphlet, "New Publications of the Geological Survey," which may be obtained from:

Books and Open-File Reports
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Professional Papers, Bulletins, Water-Supply Papers, Techniques of Water-Resources Investigations, Earthquake Informartion Bulletins, and popular leaflets, pamphlets, and booklets may be purchased from Books and Open-File Reports, Denver, Colorado (address above); additional information is given in "A Guide to Obtaining Information from the U.S. Geological Survey, 1982," U.S. Geological Survey Circular 900, which is available without cost from Books and Open-File Reports, Denver, Colorado.

Open-File and Water-Resources Investigations Reports for Missouri are available for inspection at the Missouri District office, and may be purchased from:

Open-File Services Section
U.S. Geological Survey
Federal Center, Bldg. 810
Box 25425
Denver, Colorado 80225

To obtain information on maps, write:

U.S. Geological Survey
Map Distribution
Federal Center, Bldg. 810
Box 25286
Denver, Colorado 80225

For additional information write:

National Cartographic Information Center
Mid-Continent Mapping Center
1400 Independence Road
Mail Stop 231
Rolla, Missouri 65401

Public Inquiries Offices (PIOs) provide general information about the programs of the U.S. Geological Survey and its reports and maps. The PIOs answer inquiries made in person, by mail, or by telephone and refer requests for specific technical information to the appropriate people. Direct inquiries for Missouri to:

Public Inquiries Office
U.S. Geological Survey
1028 General Services Administration Building
19th and F Streets, NW
Washington, D.C. 20244

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