WATER RESOURCES DIVISION IN THE 1980's

A Summary of Activities and Programs
of the U.S. Geological Survey's
Water Resources Division
1986

U. S. Geological Survey Circular 1005

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By C. William Cardin, John E. Moore, and Joan M. Rubin

U. S. Geological Survey Circular 1005

DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

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CONTENTS

	Page
Abstract	1
Introduction	2
Major Water Issues of the 1980's	3
Mission of the Water Resources Division	4
Organization	5
Personnel	10
Budget and Source of Funds	12
Programs	16
Long-Term Programs	18
Federal-State Cooperative Program	18
Coordination of Federal Water-Data Acquisition	20
Assistance to Other Federal Agencies	22
Hydrologic Research	24
National Water-Data Exchange	26
Water Resources Scientific Information Center	28
National Water-Data Storage and Retrieval System	30
National Water-Use Information Program	32
Hydrologic Data-Collection Program	34
National Stream-Quality Accounting Network	36
National Hydrologic Bench-Mark Program	36
State Water Resources Research Institutes and National Water Resources Research Grants Programs	38
Topical Programs	40
Nuclear Waste Hydrology	40
High-level radioactive wastes	40
Low-level radioactive wastes	42
Toxic Substances Hydrology	44
National Water-Quality Assessment Program	46
Regional Aquifer-System Analysis Program	48
Acid Rain Program	50
Volcano-Hazards Program	52
National Water Summary Program	54
Technical-Assistance Programs	56
Instrumentation Program	56
National Water-Quality Laboratory	58
National Training Center	59
Water Resources Division Publications	60
Distributed Information System	62
Summary and Accomplishments	63
Selected References	67
Headquarters Personnel	70
Directory of Field Offices	71
Regional Hydrologist and District Chiefs	71
Northeastern Region	71
Southeastern Region	73
Central Region	74
Western Region	76
Headquarters Branch Field Locations	77
Index	78

ILLUSTRATIONS

	Page
Organization of the U.S. Department of the Interior	6
Organization of the U.S. Geological Survey	6
Organization of the Water Resources Division	7
Water Resources Division Offices	7
Authorized Employment Levels, 1970–1985	10
Water Resources Division Personnel	11
Water Resources Division Funding, Fiscal Year 1986(Enacted)	13
Funding Trends: Fiscal Years 1970–1985	14
Water Resources Research, Investigations, and Data Collection	15
Activities and Responsibilities of the Water Resources Division	17
Publications Prepared by the U.S. Geological Survey, Water Resources Division, in Cooperation with State and Local Agencies	19
Office of Water Data Coordination Advisory Committees and Technical Working Groups	21
Coal Area Hydrology Reports	23
Environmental Effects of Mining	23
Retreat of Columbia Glacier, 1974–1984	25
Aerial Photograph of Columbia Glacier, Alaska	25
NAWDEX Provides Access to Water Data	27
Block Diagram Depicting the Structure of the Master Water Data Index Data Base	27
Publications of the Water Resources Scientific Information Center	29
Hydrologic Information from WATSTORE	31
National Water-Data Storage and Retrieval System	31
U.S. Trends in Ground-Water Use, 1950–1980	33
Number of Data-Collection Sites, 1985	34
Hydrologic Data-Collection Activities of the Water Resources Division	35
NASQAN and National Hydrologic Bench-Mark Stations, November 1985	37
State Water Resources Research Institutes	39
Barriers to the Migration of Waste from Repository Sites	41
Nine Candidate Sites for Disposal of High-Level Radioactive Waste	41
Low-Level Radioactive Waste Sites and U.S. Geological Survey Studies	43
Hazardous Substances in Surface Water and Sediment	45
Toxic Substances Hydrology Studies	45
Hypothetical NAWQA Surface-Water Study Unit	47
NAWQA Ground-Water Study Cycle	47
Regional Aquifer-System Analysis Program	49
National Trends Network to Monitor Acid Precipitation	51
Trends in Sulfate Content of Precipitation, 1978–1983	51
U.S. Geological Survey Publications on the Hydrologic Effects of the Mount St. Helens Eruption	53
Effects of Reservoirs on Downstream Sediment Loads at Stations on the Mississippi and the Missouri Rivers	55
Hydrologic Data-Collection Stations Supported by GOES Telemetry as of November 1985	57
Real-Time Hydrologic Data Collection by Satellite	57
Chemical Analysts Use Specialized Equipment at the National Water-Quality Laboratory	58
Training Hydrologists	59
Number of Water Resources Division Reports Approved for Release or Publication	61
Publications of the Water Resources Division	61
Distributed Information System	62

WATER RESOURCES DIVISION IN THE 1980's

A Summary of Activities and Programs of the U.S. Geological Survey's Water Resources Division, 1986

By C. William Cardin, John E. Moore, and Joan M. Rubin

ABSTRACT

The Water Resources Division of the U.S. Geological Survey has the principal responsibility within the Federal government for providing hydrologic information and appraising the Nation's water resources. The Geological Survey is unique among government organizations because it has neither regulatory nor developmental authority. Its sole product is information that is made available equally to all interested parties.

This report describes the Water Resources Division's mission, organization, source of funds, and major programs. Three types of programs are described: *long-term programs*, which include the Federal-State cooperative program, coordination of Federal water-data acquisition, assistance to other Federal agencies, national research, the national water-data exchange, the water resources scientific information center, the national water-use information program, hydrologic-data collection, and the State water research institute and national research grants programs; *topical programs*, which include nuclear-waste hydrology, toxic substances hydrology, national water-quality assessment, regional aquifer-system analysis, acid rain, volcano hazards, and the national water summary program; and *technical-assistance programs*, which include the instrumentation program, the national water-quality laboratory, and the national training center. Emphasis is on programs that will contribute to identifying, mitigating, or solving nationwide water-resources problems in the remaining years of the 20th century. Completing the report are discussions of how the hydrologic data and information are disseminated, the Division's use of computers, a summary and list of accomplishments, a selected list of references, a directory of Division offices, and an index.

INTRODUCTION

Effective management of water resources requires an understanding of the Nation's hydrologic system and the factors that determine the availability and quality of the water. The hydrologic system does not function according to political boundaries, and thus it is necessary for hydrologic information to be collected, analyzed, summarized, and made readily available to decisionmakers at all levels—national, regional, State, and local.

Within the Federal government, the Water Resources Division of the U.S. Geological Survey has the principal responsibility for appraising water resources and for providing hydrologic information. It is the Nation's major scientific water organization, and its sole product is water information—it has neither regulatory nor developmental authority. Virtually all the information produced is multipurpose, and, after meeting the immediate need, the information becomes part of future resource evaluation and water-management decisions.

To accomplish the Division's objective of presenting impartial, accurate data and scientific analyses equally to all interested parties, the Division releases its information through Federal, State, and local publications, technical journals, and computerized data files. Users of the information include legislative bodies and associated committees; courts; other Federal agencies; State, regional, and local agencies; water-management, irrigation, drainage, and conservation districts; industry, public interest groups, universities, and consultants; and the public.

The Division provides extensive support to other Federal agencies and, through its Federal-State Cooperative Program, to State and local agencies. This cooperative program provides the bulk of water information used by the Federal government for a variety of purposes. The Division also coordinates the water-data acquisition activities of all Federal agencies. The combination of these activities together with input from advisory committees enables the Geological Survey to keep abreast of water-information needs at all levels of government and the private sector, and to develop programs responsive to those needs.

The programs of the Division are financed by direct appropriations from the Congress, cost-sharing arrangements with State and local governments, and reimbursable agreements with other Federal agencies. These financial arrangements reflect the broad interest among all governmental sectors in seeking to resolve water-resources problems, and also reflect the prominent role that the Geological Survey plays in finding solutions to those problems.

This report is an updated version of Circular 893 which was published in 1983. It summarizes the Division's programs that are expected to have major value in contributing to solutions of nationwide water-resources problems in the 1980's. A brief description of the Division's mission, organization, and source of funds is given as background to the specific programs. Specific results and accomplishments of the various programs, and additional information on the U.S. Geological Survey and the Water Resources Division, can be found in the publications listed in the "Selected References" section.

Many of the illustrations in this report are reproduced from U.S. Geological Survey exhibit panels and briefing boards. Information about exhibit panels can be obtained from the Exhibits Committee, U.S. Geological Survey, 790 National Center, Reston, VA 22092. Previous reports that summarized past Division programs are those by Chase, Moore, and Rickert (1983), Gilbert and Buchanan (1981, 1982), Hackett (1966), and McGuinness (1964).

MAJOR WATER ISSUES OF THE 1980'S

Some of the Nation's major water issues of the 1980's are highlighted below. The information derived from the programs of the Water Resources Division that are explained in this report will help decisionmakers to understand the magnitude of the issue, to determine water-policy options, and to select or implement the soundest course of action.

- **Water availability and competition for water**—Population growth, especially in the Sunbelt States, national goals to expand agricultural production and energy-resource development, and water rights of the State and Federal governments, Indian tribes, and private individuals have increased competition for available water supplies. Principal water uses are—
  - Crop irrigation,
  - Energy production (other than hydroelectric),
  - Mineral-resources development,
  - Municipal, domestic, and industrial supply, and
  - Instream-flow maintenance for hydroelectric power, fish, wildlife, and recreation.

- **Quality of water**—Water availability cannot be separated from water quality because the usability of existing supplies depends on the quality. In some areas, contamination of surface and ground water is caused by—
  - Nonpoint-source pollution, such as runoff from agricultural and urban areas,
  - Toxic wastes, for example seepage from landfills and leaking underground storage tanks,
  - Saltwater intrusion, and
  - Acid rain.

- **Management of water and land resources**—The hydrologic system does not conform to political boundaries and the development of water resources in one State can affect the availability and use of water in other States. Hydrologic information in understandable form can help managers and decisionmakers who evaluate policy options to determine the effects of prior decisions and to guide future decisions.

MISSION OF THE WATER RESOURCES DIVISION

The mission of the Water Resources Division is to appraise the Nation's water resources and to provide the hydrologic information needed for managing these resources. To accomplish its mission the Water Resources Division, in cooperation with State and local governments and other Federal agencies—

- Collects data on a systematic basis to determine the quantity, quality, and use of surface and ground water, and the quality of precipitation.
- Conducts water resources investigations and assessments at national, State, and local scales, characterizes water resources conditions, and provides the capability to predict the impact on the resource of managerial plans or actions, and the effects of natural phenomena.
- Conducts basic and problem-oriented hydrologic and related research to produce knowledge that is useful in resolving water resources problems.
- Acquires information that is useful in predicting and describing water-related natural hazards that may result from the occurrence of flooding, volcanic eruptions, mudflows, and land subsidence.
- Coordinates the activities of all Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters.
- Disseminates data and the results of investigations through reports, maps, computerized information services, and other forms of public release, and operates water information centers.
- Provides scientific and technical assistance in hydrology to other Federal agencies, to State and local agencies, to licensees of the Federal Energy Regulatory Commission, and, on behalf of the U.S. Department of State, to international agencies.
- Administers provisions of the Water Resources Research Act of 1984, including the State Water Resources Research Institute Program and the National Water Resources Research Grant Program.

Authority for carrying out the Division's mission derives from legislation of 1879, which created the Geological Survey, and legislation of 1888 and 1894, which provided for gaging the streams, determining the water supply of the Nation, and performing other functions relating to water resources. In 1964, the mission was broadened to include the role of lead agency in the coordination of the activities of all Federal agencies in the acquisition of certain water data. This responsibility, assigned to the Department of the Interior by Office of Management and Budget Circular A-67, was delegated to the Geological Survey and its Water Resources Division by the Department. The mission was broadened most recently when the Secretary of the Interior designated the Geological Survey as the administering agency for the Water Resources Research Act of 1984, providing for State water resources research institutes and national water resources research grants.

ORGANIZATION

The U.S. Geological Survey was established in 1879 as part of the U.S. Department of the Interior. Administratively, the Geological Survey reports to the Assistant Secretary for Water and Science (see organization chart on page 6). The Headquarters of the Geological Survey is in Reston, Virginia, about 25 miles west of Washington, D.C.

The Water Resources Division is one of three program Divisions within the Geological Survey. Its functions are carried out at two levels—Headquarters and field (see organization chart on page 7). The Headquarters level is responsible for the overall direction of the Division, and consists of the Chief Hydrologist, the Associate Chief Hydrologist, and four Assistant Chief Hydrologists—for Operations, Scientific Information Management, Program Coordination and Technical Support, and Research and External Coordination.

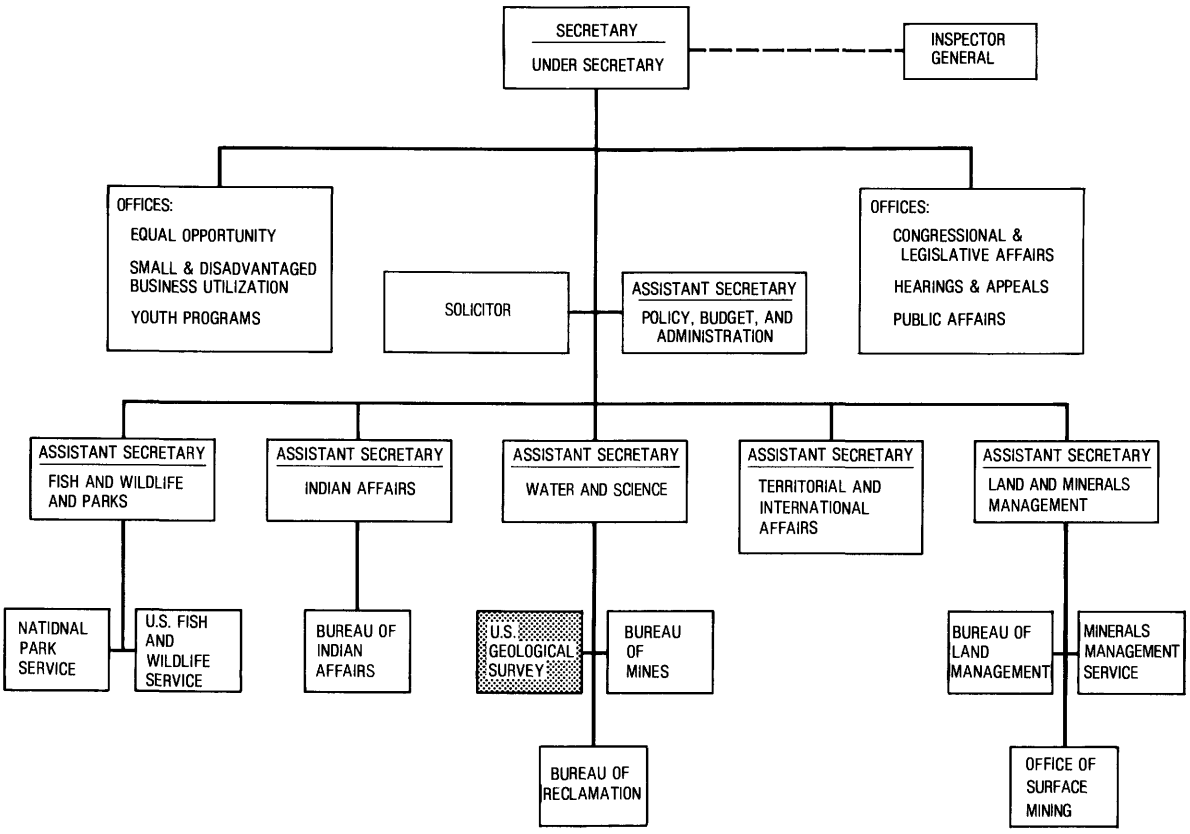
General direction of the Division's field program is through four Regional Hydrologists, each of whom is located at a regional center—Reston, Virginia (Northeastern Region); Atlanta, Georgia (Southeastern Region); Lakewood (Denver), Colorado (Central Region); and Menlo Park, California (Western Region). These Regional Hydrologists represent the Chief Hydrologist and the Director of the U.S. Geological Survey in negotiations and dealing with other organizations and committees. They also oversee the programs of the Division's 42 District offices, which carry out the water-resources investigations and data-collection programs of the Division.

The Division's hydrologic research effort is determining new methods for hydrologic-data collection and analysis, and providing new concepts in the understanding of hydrologic processes. Research staffs are located at the regional centers for the Northeastern, Central, and Western Regions, and for the Southeastern Region, at the Gulf Coast Hydroscience Center in Bay St. Louis, Mississippi. Regional activities of the research program are overseen by a Chief, Branch of Regional Research, who reports to the Chief, Office of Hydrologic Research, in the office of the Assistant Chief Hydrologist for Research and External Coordination at Headquarters.

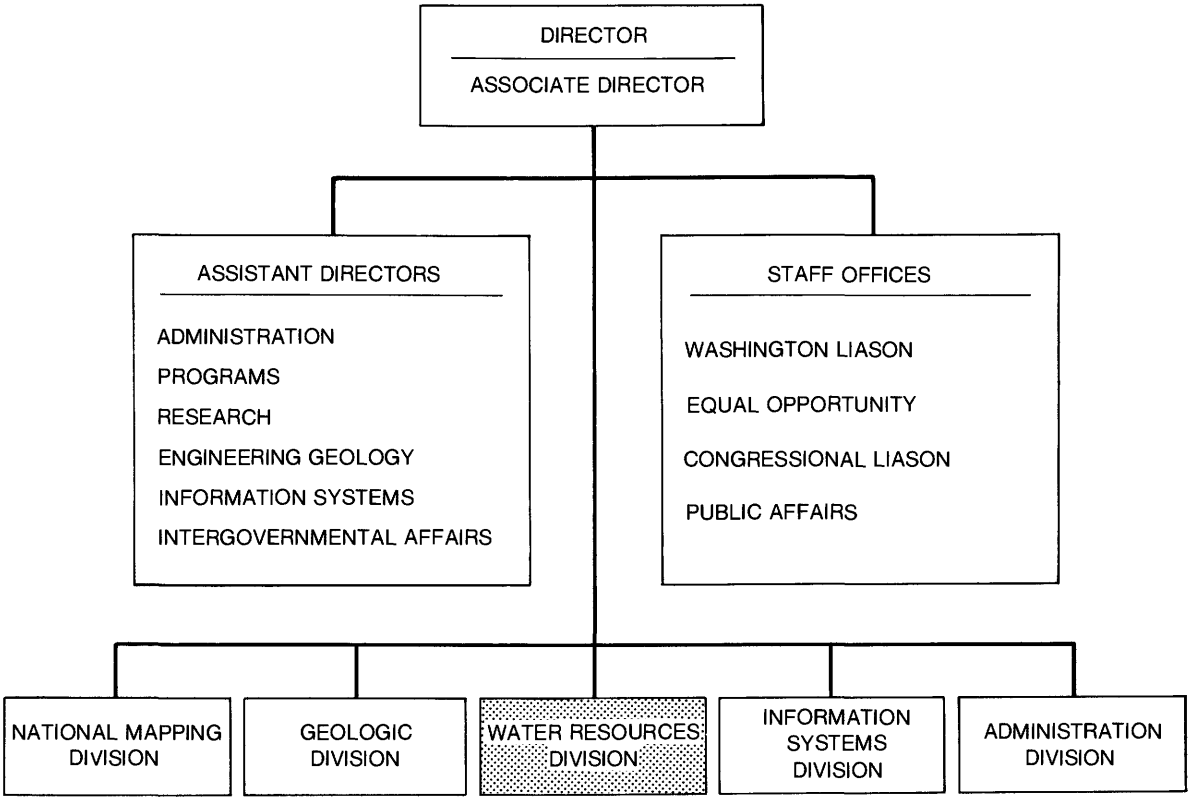
Each District office is under the guidance of a District Chief who is responsible for planning, programming, and implementing the data-collection activities and hydrologic studies within the District. Many District activities are supported by a joint-funding program, whereby the Geological Survey matches funds with tax supported State and local agencies on a 50-50 basis. Each District typically has one or more subdistrict and field offices that report to the District Chief. Three multi-State Districts also have offices that coordinate programs within each State and report to the District office.

The Division's field organization enables the Geological Survey to have close contact with State and local agencies, allows the accumulation of detailed experience and knowledge of regional and local hydrologic conditions, provides an early-warning system for the detection of emerging water problems, and reduces costs for conducting investigations and operating data-collection networks.

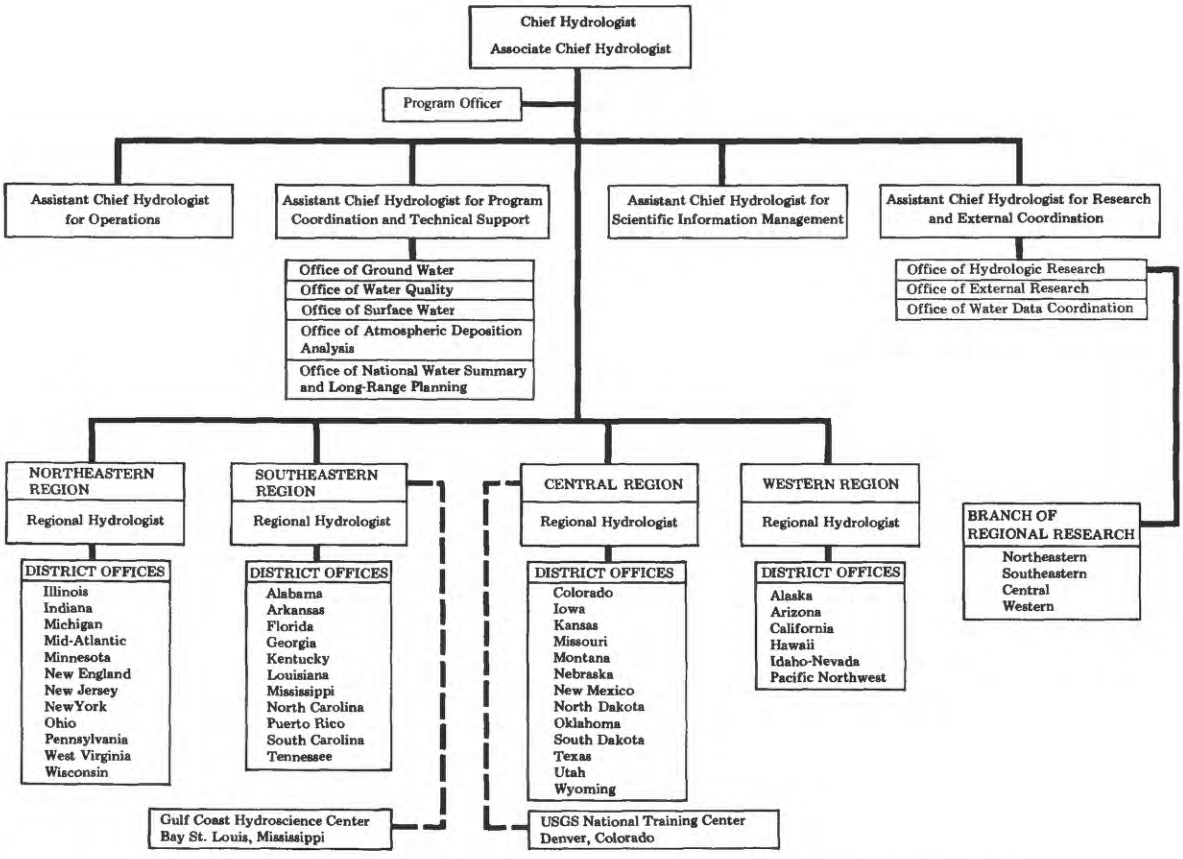
A more detailed description of the functions of each component of the Division is given on the following pages. Location of the Division's offices is shown on the map on page 7. A list of key Headquarters personnel and a directory of the field organization are given on pages 70–77.



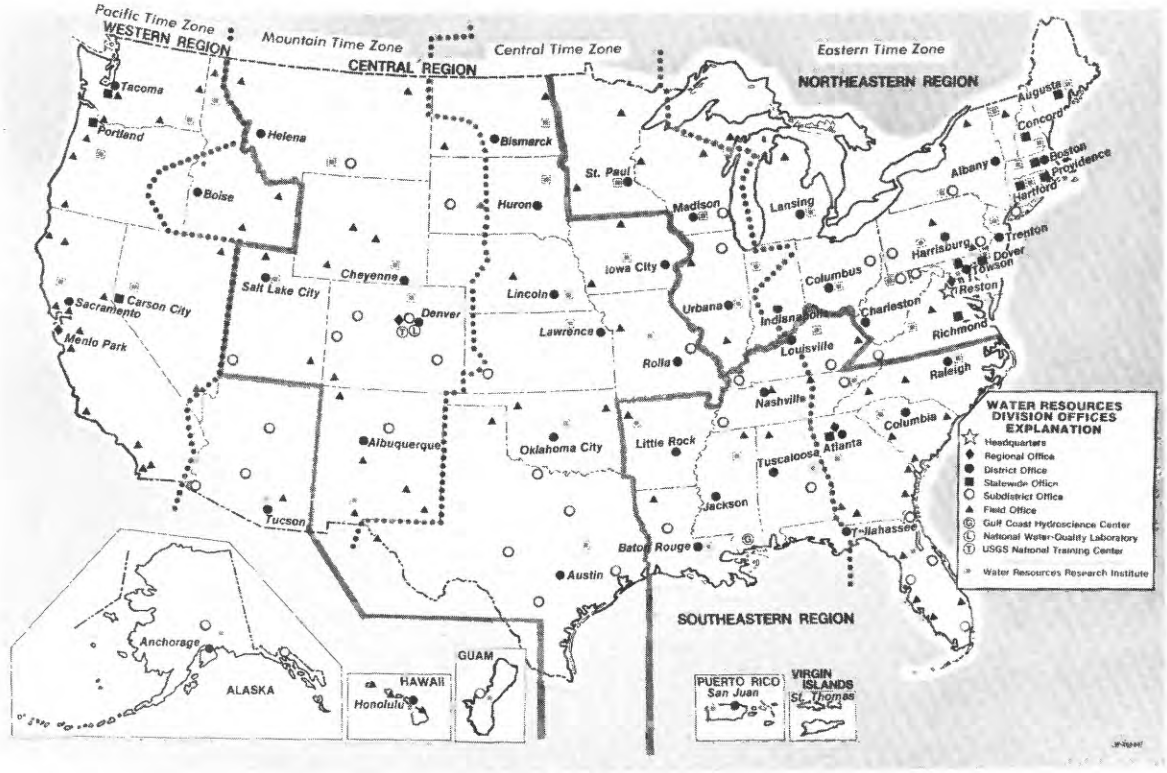
ORGANIZATION OF THE U.S. DEPARTMENT OF THE INTERIOR



ORGANIZATION OF THE U.S. GEOLOGICAL SURVEY



ORGANIZATION OF THE WATER RESOURCES DIVISION



WATER RESOURCES DIVISION OFFICES

Headquarters Organization

Chief Hydrologist and **Associate Chief Hydrologist** are responsible for overall direction of the Division, the planning, execution, and evaluation of U.S. Geological Survey hydrologic programs, and the scheduling and production of related reports and publications. All Division personnel ultimately report to these officials.

Program Officer serves as the Division focus for congressional budgets.

Assistant Chief Hydrologist for Operations assists the Chief Hydrologist in the establishment of policy on budgetary, accounting, personnel, and program support matters; in the direction of the Federal data collection program and instrumentation development; in the management of the budget of the Federal-State Cooperative Program and the technical support program; and in providing administrative and technical services to field offices.

Assistant Chief Hydrologist for Scientific Information Management assists the Chief Hydrologist in (1) the development of policy and programs related to the production and dissemination of water data and of scientific and general interest publications, and to the use of automated information-storing systems; (2) the development of methods and procedures for processing, storing, retrieving, and disseminating water data collected by the Division's field organization, and in managing the computerized Distributed Information System (DIS) and the National Water Data Storage and Retrieval system (WATSTORE); (3) the management and operation of programs which assist users in determining the availability of water data and related information from the Federal government—such as the National Water-Data Exchange (NAWDEX) and the Water Resources Scientific Information Center (WRSIC); (4) the management and operation of the program for acquisition and dissemination of information on the Nation's use of water; (5) managing, evaluating, improving, and demonstrating information transfer mechanisms, and developing new mechanisms and products; and (6) coordinating activities related to compliance with the National Environmental Policy Act of 1969 (NEPA), including review of NEPA documents prepared by other agencies, preparation of contributions to Environmental Impact Statements, and the development of environmental policy under NEPA.

Assistant Chief Hydrologist for Program Coordination and Technical Support assists the Chief Hydrologist in the development of integrated national programs of investigations concerning hydrologic conditions and issues; directs efforts to assure the accuracy and timeliness of scientific and data collection activities; oversees the development of new approaches and methodologies; provides oversight of hydrologic training programs; and gives technical guidance and support to the Division's programs related to ground water, surface water, water quality, nuclear waste hydrology, acid rain, and the National Water Summary, as well as long range Division planning, systems analysis, and laboratory analysis.

Assistant Chief Hydrologist for Research and External Coordination assists the Chief Hydrologist in the development of the Division's national research programs; directs research conducted outside the Division under the Water Resources Research Act of 1984 which provides for the administration of programs of grants for research; directs the coordination of water-data acquisition activities of Federal agencies; and gives guidance and support to the international aspects of research and investigative programs.

Field Organization

The field organization of the Division is located in four geographic regions that cover the Nation, and include Puerto Rico, the U.S. Virgin Islands, Guam, and the Pacific Islands Trust Territory.

Regional Hydrologists with line authority from the Chief Hydrologist head each region, are responsible for the direction, planning, and financial management of regional programs and operations, and serve as Division representative within the region. The Regional Hydrologist's immediate staff works closely with equivalent personnel at Division Headquarters in Reston, Virginia, and includes the Assistant Regional Hydrologist, a regional administrative officer, a program officer, a computer scientist, a reports adviser, and specialists in the disciplines of surface water, ground water, and quality of water. Regional Hydrologists direct the operations of all field offices in their respective regions, including the collection of hydrologic data, the preparation of research reports, the conduct of water-resources investigations, and the management and conduct of cooperative hydrologic studies with State and local water agencies.

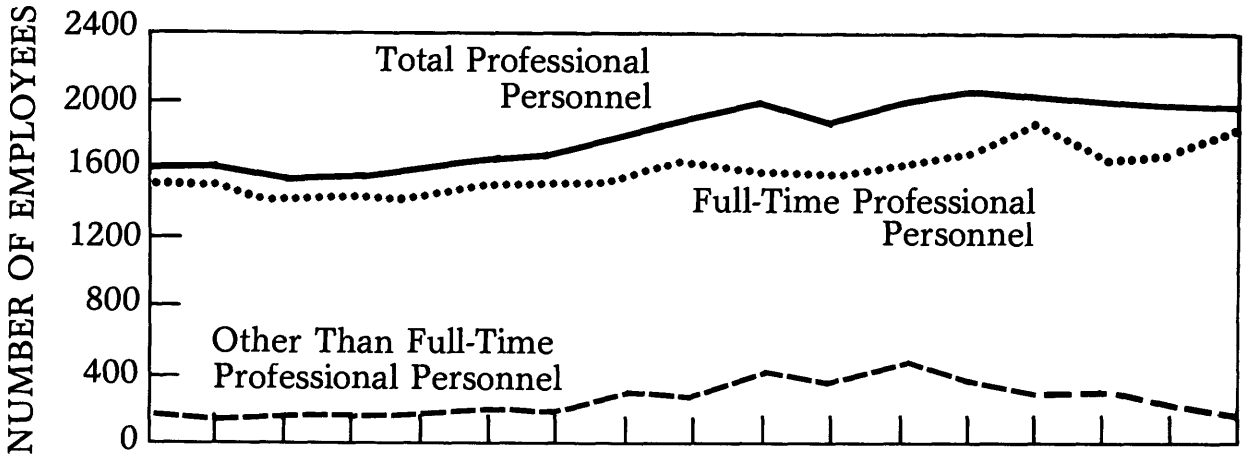
Chiefs, Branches of Regional Research, represent the Assistant Chief Hydrologist for Research and External Coordination in directing the technical aspects of mission-related research activities in the Division's geographic regions; plan, develop, and guide original and continuing research programs; provide direct supervision to mission-related research projects in the regional subunit; promote the incorporation of new findings and concepts into the general Division program; and interact closely with the Regional Hydrologist and staff to assure effective linkage between the national research programs and other programs of the Water Resources Division.

District Chiefs report to the Regional Hydrologist and are responsible for the planning, direction, and execution of data collection and hydrologic studies in their respective Districts. The District Chief maintains a staff of professional scientific and technical personnel who conduct these activities. Each district typically has one or more subdistrict and field offices that report to the District Chief. Both Headquarters and Regional offices provide support for activities in the 42 Districts.

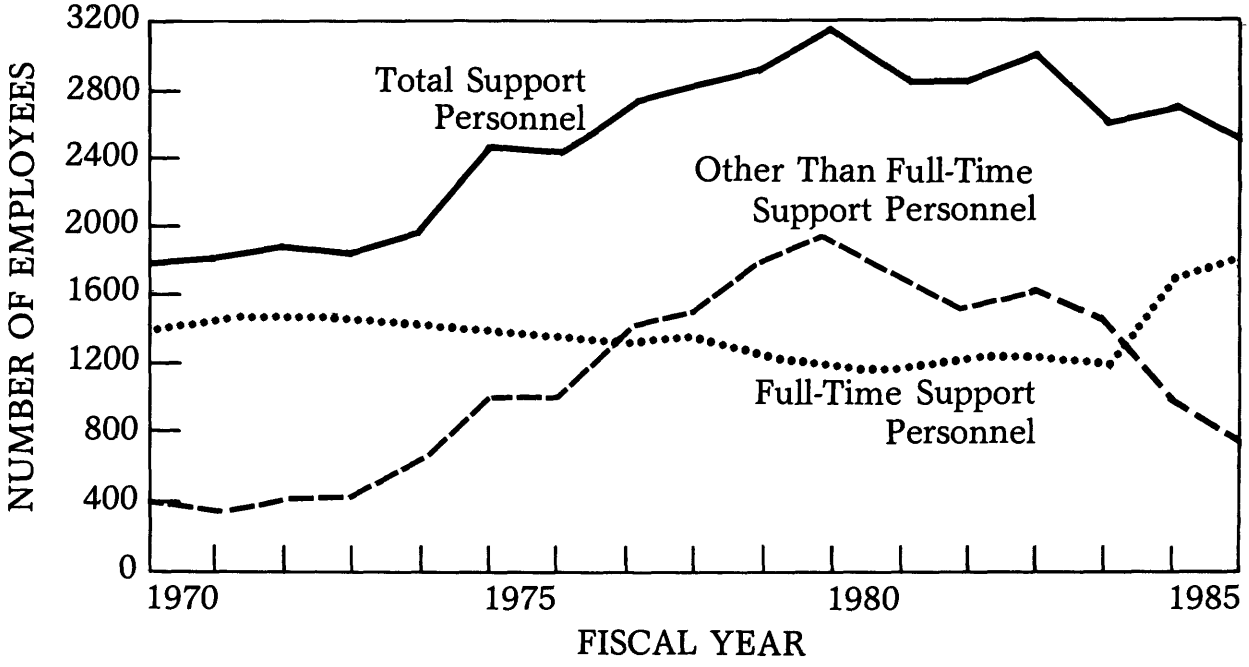
PERSONNEL

Members of the scientific staff of the Water Resources Division collectively have expertise in many phases of water and water-related activities. The scientific staff is supported by field, office, and laboratory personnel. The table below shows authorized employment levels and the illustration on the facing page shows total professional and support personnel for fiscal years 1970 to 1985.

Fiscal year	Authorized employment levels, 1970–85		
	Full time	Other than full time	Total
1970	2,888	476	3,364
1971	2,949	476	3,425
1972	2,874	542	3,416
1973	2,873	545	3,418
1974	2,866	790	3,656
1975	2,895	580	3,475
1976	2,920	707	3,627
1977	2,842	1,150	3,992
1978	2,884	1,253	4,137
1979	2,787	1,369	4,156
1980	2,837	1,391	4,228
1981	2,803	1,286	4,089
1982	2,981	1,328	4,309
1983	2,951	1,166	4,117
1984	2,922	1,162	4,084
1985	3,380	684	4,064



PROFESSIONAL PERSONNEL



SUPPORT PERSONNEL

WATER RESOURCES DIVISION PERSONNEL

BUDGET AND SOURCE OF FUNDS

Funds to support the work performed by the Water Resources Division are derived from four principal sources.

- **Federal Program**—Funds for the Federal Program are appropriated by the Congress, and are specifically identified in the annual Geological Survey budget. These funds are used to support research, data collection, high priority topical programs, the coordination of all Federal programs related to collection of water data, and internal support services. In fiscal year 1986, this funding was $72.9 million.

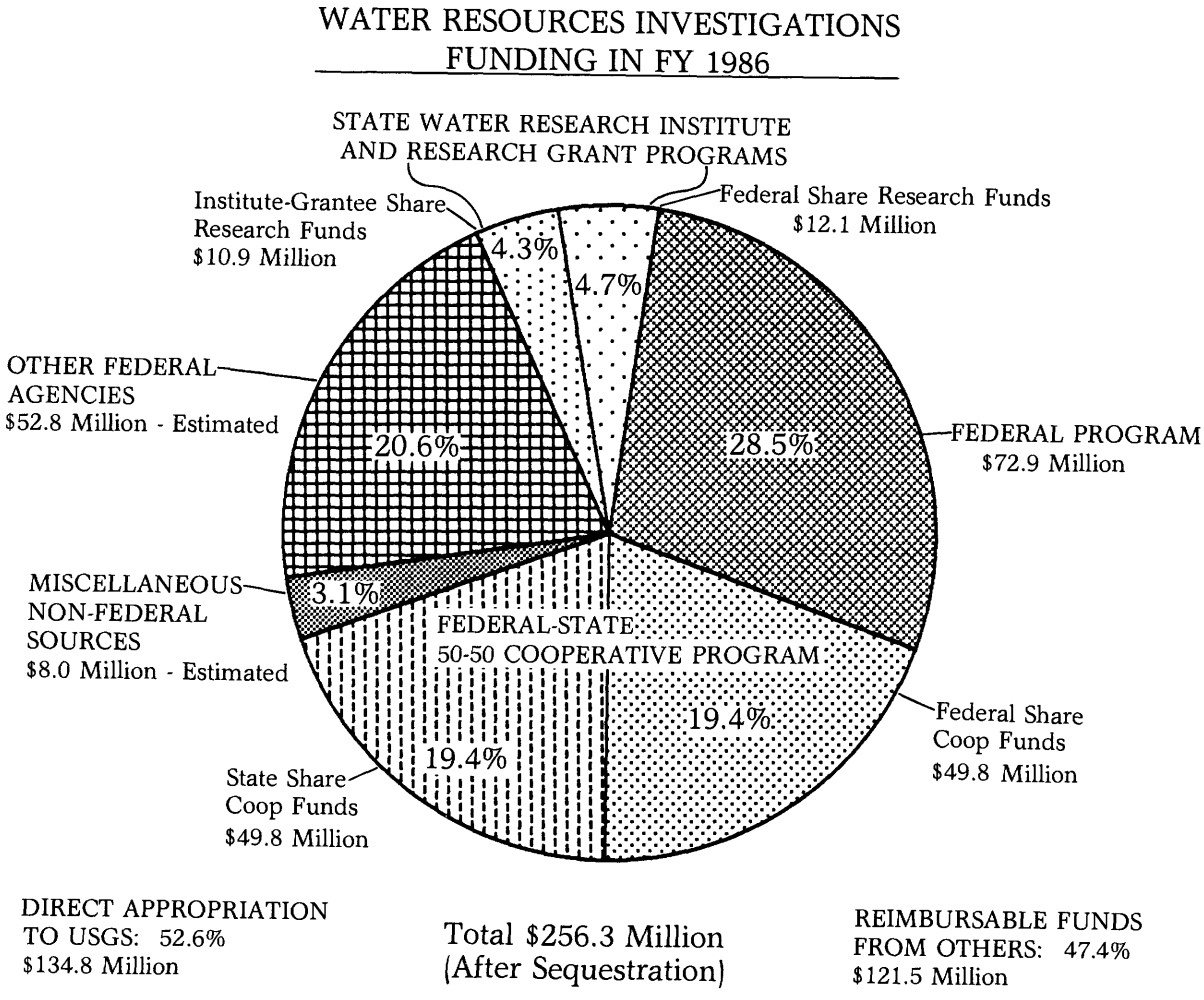
- **Federal-State Cooperative Program**—Federal funds are appropriated by the Congress and used to match those furnished by State, regional, and local agencies on a 50-50 basis. These funds are used for a variety of hydrologic data-collection activities and water-resources investigations in which the Water Resources Division represents the national responsibilities and the cooperating agencies represent State and local interests. In fiscal year 1986, these joint funds amounted to $99.6 million.

- **State Water Resources Research Institutes and National Water Resources Research Grants Programs**—Federal funds are appropriated by Congress and used to match those from 54 State Water Resources Research Institutes and research grantees on a 50-50 basis. In fiscal year 1986, the institute-grantee share of research funds was $10.9 million. The appropriated matching Federal funds, plus the cost to administer the programs, amounted to $12.1 million.

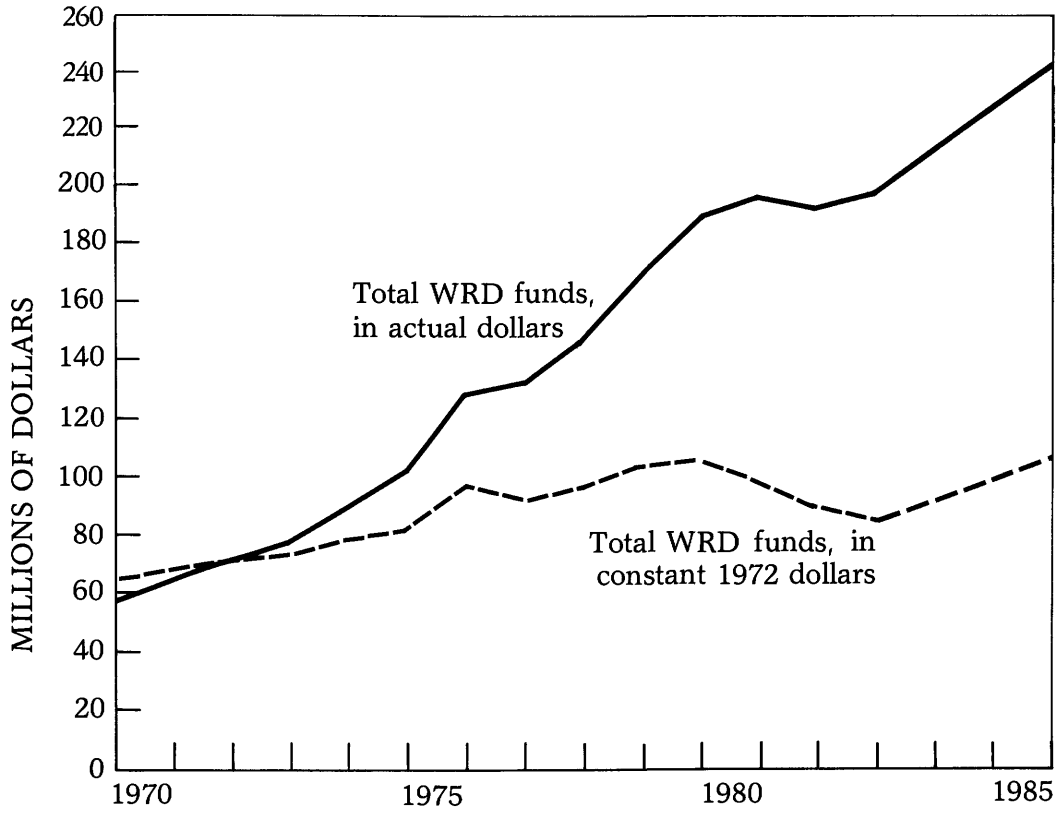
- **Other Federal Agencies (OFA) Program**—In this program, the funds are transferred to the Geological Survey as reimbursement for work performed at the request of another Federal agency. In fiscal year 1986, this funding was estimated at $52.8 million.

Other sources of Division funding are unmatched reimbursable funds from State and local government agencies, funds from Federal Energy Regulatory Commission licensees, and funds from miscellaneous non-Federal agencies. The estimated funding from these sources in fiscal year 1986 was $8.0 million.

The total Division budget in fiscal year 1986 (considering all sources of funds) was $256.3 million. From 1970 to 1986, the Division's budget, expressed in current dollars, increased substantially. However, the rate of increase was less in terms of constant 1972 dollars, as shown on page 14.



WATER RESOURCES DIVISION FUNDING, FISCAL YEAR 1986 (Enacted)



FUNDING TRENDS: FISCAL YEARS 1970–1985

WATER RESOURCES RESEARCH, INVESTIGATIONS, AND DATA COLLECTION

[In millions of dollars]

Fiscal year	1982	1983	1984	1985	[1]1986
Direct Appropriation	108.6	116.0	129.5	132.9	134.8
Federal Program	63.6	70.2	73.1	72.4	72.9
Federal-State Cooperative Program	45.0	45.8	50.0	51.7	49.8
Water Resources Research Act Programs	0	0	6.4	8.8	12.1
Reimbursable Program	78.5	86.1	100.5	113.5	121.5
Total	187.1	202.1	230.1	246.4	256.3

[1]After sequestration under the Emergency Deficit Reduction Act (Gramm-Rudman-Hollings).

Federal Program: includes data collection and analysis; National Water Data Exchange; Water Resources Scientific Information Center; coordination of Federal water-data acquisition; regional aquifer-system analysis; hydrologic research; improved instrumentation; water resources assessment; toxic substances hydrology; acid rain; scientific and technical publications; national water-quality assessment; and nuclear waste hydrology.

Federal-State Cooperative Program: includes the Federal share of joint activities in data collection and analysis, areal appraisals, and special studies; water use; and coal hydrology.

Water Resources Research Act Programs: includes the Federal shares of the State Water Resources Research Institutes Program and the National Water Resources Research Grants Program.

Reimbursable Program: includes activities performed with funding from other Federal agencies; State and local contributions under the Federal-State Cooperative Program; institute and grantee shares under the Water Resources Research Act Programs; and other miscellaneous non-Federal reimbursements (e.g., Federal Energy Regulatory Commission licensees, foreign governments).

PROGRAMS

Program development in the Water Resources Division is an evolving activity. Existing programs are reviewed regularly and future needs for water data and hydrologic investigations are projected. Water problems and data needs frequently are brought to the attention of the Division by State and local agencies and the public; thus, program development also is a grassroots effort. As data needs and water-related problems change, the programs are modified accordingly.

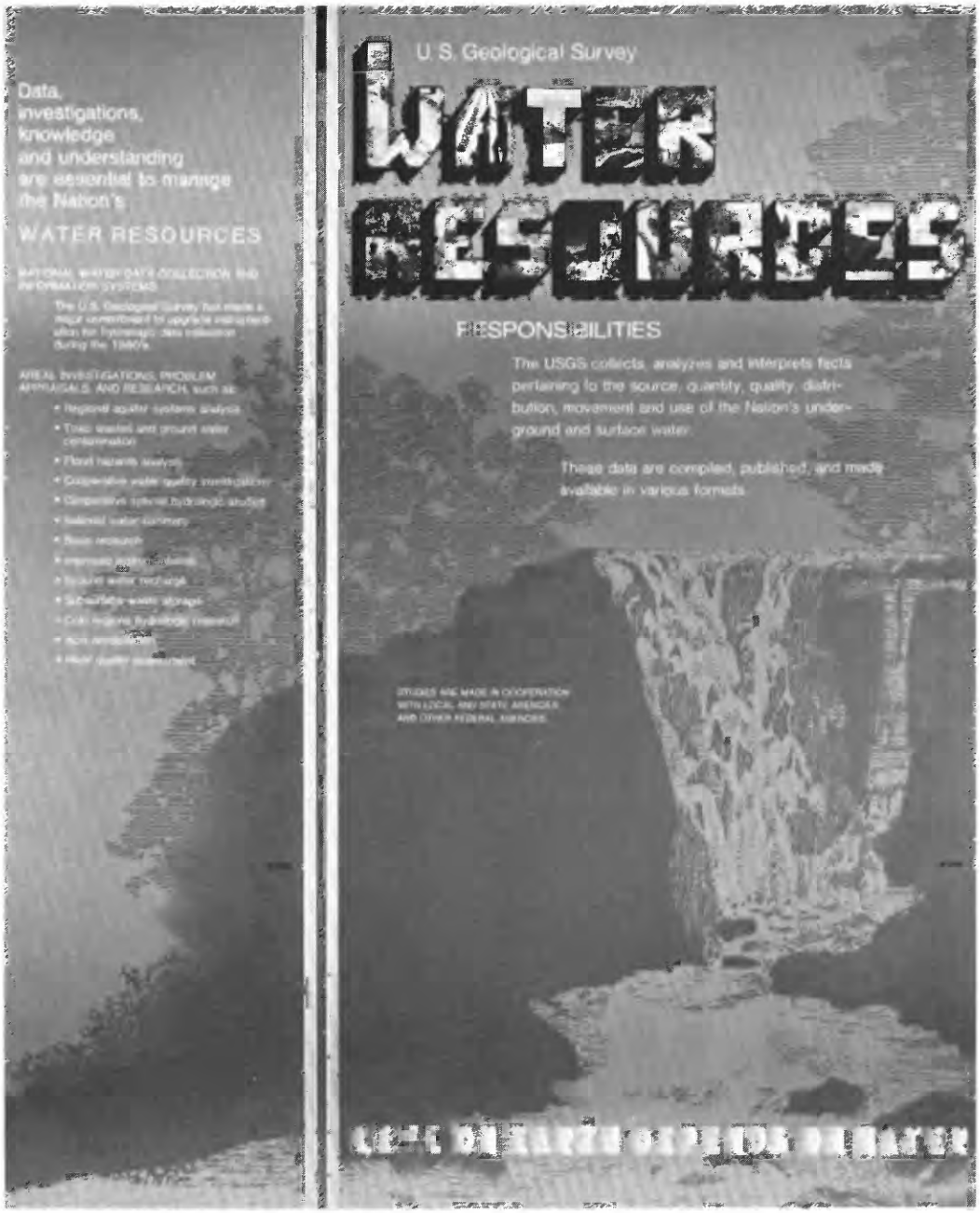
The programs of the Water Resources Division are of three major types—(a) data collection and dissemination, (b) problem-oriented water-resources appraisals, and (c) research. Budgetary documents classify the Division's activities according to source of funds: direct congressional appropriations (Federal Program); joint or shared funds (Federal-State Cooperative Program); and funds from other Federal agencies (Other Federal Agencies Program). Although this classification is helpful for budgetary and general discussion purposes, most of the programs are so interrelated that they are difficult to explain exclusively by source of funds or type of activity. For example, theories arising from research are the foundation of data collection and problem-oriented water-resources appraisals, and data collection is a major component of all water-resources appraisals and most of the research studies.

In this report, the Division's activities are discussed under three headings—long-term programs, topical programs, and technical-assistance programs. In reading the program descriptions, the reader should keep in mind that most Division programs cross scientific and budgetary boundaries.

Long-Term Programs—The long-term programs include the Federal-State Cooperative Program; coordination of Federal water-data acquisition; assistance to other Federal agencies; hydrologic research; the National Water Data Exchange; the Water Resources Scientific Information Center; the National Water-Use Information Program; the State Water Resources Research Institutes and National Water Resources Research Grants Programs; and the Hydrologic Data-Collection Program, including the National Stream-Quality Accounting Network and the National Hydrologic Bench-Mark Program. These programs provide the data and research needed for the topical programs.

Topical Programs—Topical programs are designed to provide critically needed information on issues of major and immediate concern to the Nation. The programs include toxic substances hydrology and nuclear waste hydrology (high and low-level radioactive wastes); national water-quality assessment; regional aquifer-system analysis; acid rain; volcano hazards; and appraisals of water resources conditions in the National Water Summary.

Technical-Assistance Programs—Technical-assistance programs include the instrumentation program, the National Water-Quality Laboratory, and the National Training Center. These programs, which are mostly internal to the Division (in contrast to the other programs discussed in this report that deal with other agencies and the public), contribute significantly to the success of the Division's mission.



ACTIVITIES AND RESPONSIBILITIES OF THE WATER RESOURCES DIVISION

Federal-State Cooperative Program

The Federal-State Cooperative Program is a partnership for water-resources investigations between the U.S. Geological Survey and State, regional, and local agencies. The cooperating agencies contribute at least half the funds and the Geological Survey contributes most of the work.

The program began in 1895 with a cooperative study with the State of Kansas. The Federal appropriations bill of 1929 established the 50-50 cost-sharing principle. In 1986, more than 900 agencies and the Geological Survey were working together in a balanced program that recognizes the needs, priorities, and resources of all parties. These cooperative efforts generate much of the hydrologic information needed for planning, developing, and managing the water resources of the United States.

Purpose:

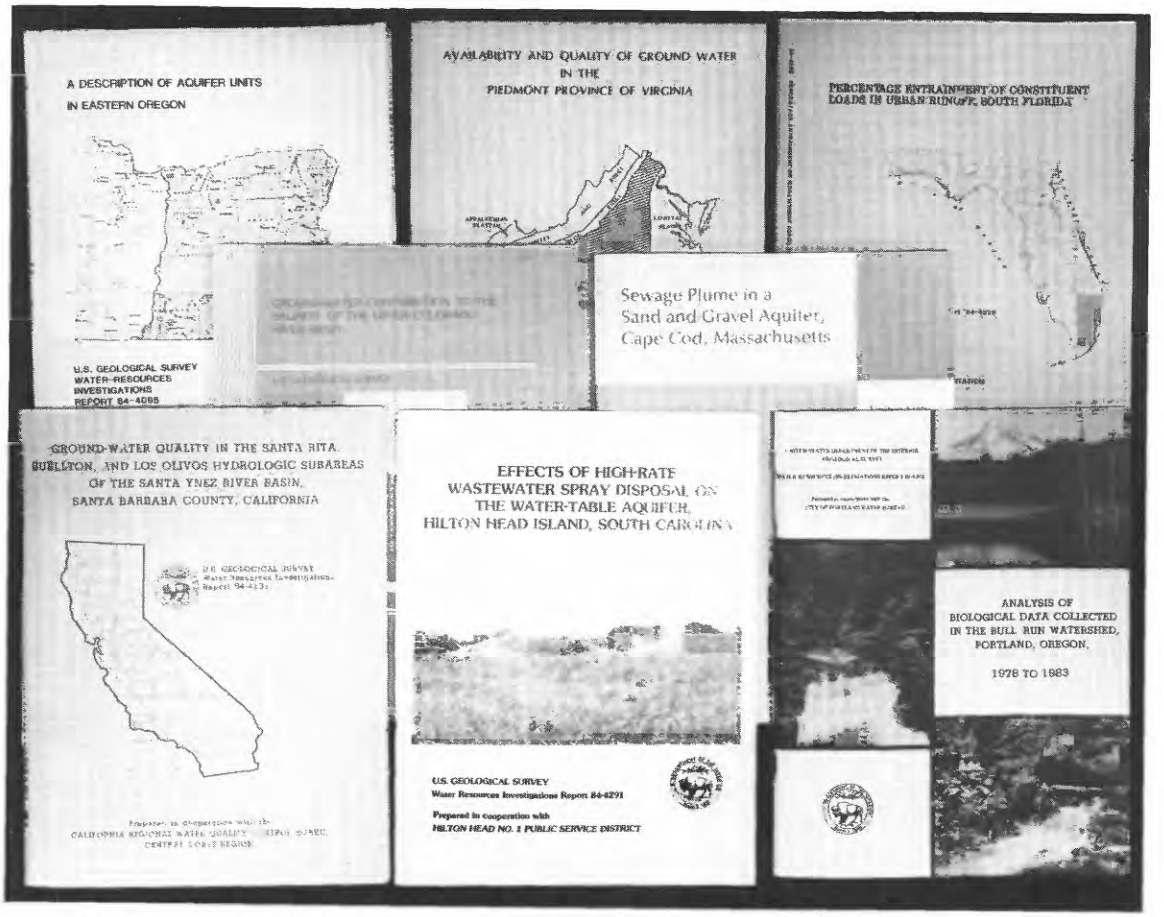
- Determine the quantity, quality, and use of surface and ground water.
- Define and evaluate the distribution and availability of water resources of drainage basins, counties, States, and hydrologic regions.
- Conduct investigations and research on current water issues such as water quality, toxic-waste disposal, erosion and sedimentation, water supply and demand, ground-water contamination, and hydrologic hazards.

Activities:

- Support the collection of hydrologic data at about two-thirds of all U.S. Geological Survey data collection sites in every State, Guam, Puerto Rico, and several territories.
- Conduct hydrologic investigations and research projects (approximately 530 in fiscal year 1985) with increasing emphasis on water-quality issues, including aquifer contamination, ground-water protection strategies, river quality assessments, storm runoff, and acid precipitation.
- Assess water-resources conditions and water-supply problems related to coal mining and land reclamation under the cooperative coal hydrology program.

Accomplishments:

- Provided the background information and scientific research that serves as an early-warning system for the detection of emerging water problems.
- Provided technical assistance to the State of Washington which helped develop an approach to mitigate the impacts of leachate on surface and ground water at more than 200 hazardous waste sites.
- Evaluated water quality in numerous streams and aquifers, and assessed existing and potential impacts of contamination from toxic wastes.
- Stimulated interest in legislation to protect aquifers which are the sole source of public water supplies, through an investigation of the Edwards Limestone Aquifer in Texas.
- Conducted investigations of the limestone formations near Brunswick, Georgia, which contributed to hydrogeologic understanding of fractured rock aquifers, and helped to refine simulation tools not only for local application but also for transfer to investigations elsewhere.
- Identified existing and potential ground-water problems in Arkansas as part of the State's ground-water protection strategy.
- Produced many publications, as part of the Federal-State Cooperative Program. See examples on facing page.



PUBLICATIONS PREPARED BY THE U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION, IN COOPERATION WITH STATE AND LOCAL AGENCIES

Coordination of Federal Water-Data Acquisition

The Office of Water Data Coordination (OWDC) coordinates the water-data acquisition activities of agencies of the Federal government. This responsibility was delegated by Office of Management and Budget Circular A-67 in 1964 to the Department of the Interior, which placed the responsibility with the U.S. Geological Survey.

Purpose:

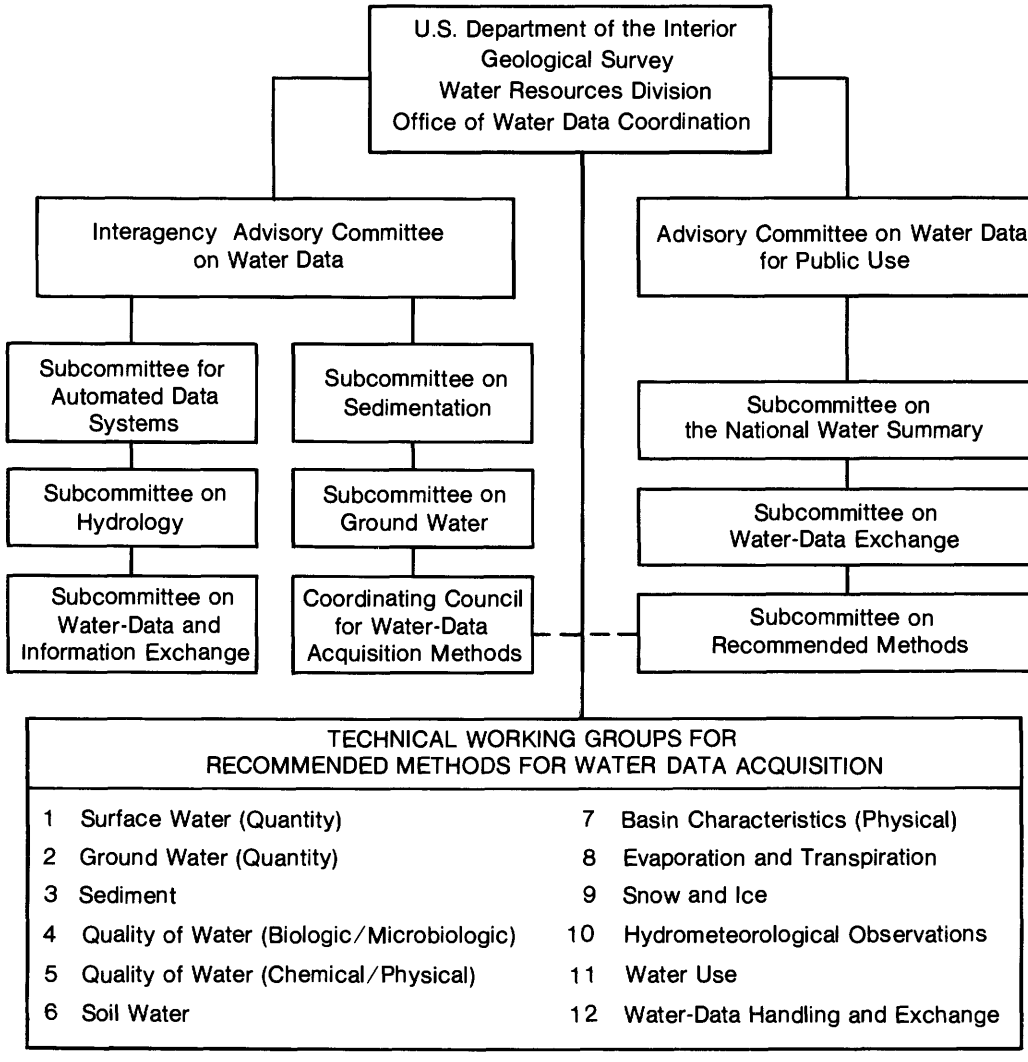
- Assure effective management of Federal programs to meet requirements for water-resources information.
- Catalog information on water data, and on planned and existing Federal programs for acquiring water data.
- Coordinate the planning, design, and documentation of water-data networks and information.

Activities:

- Conduct annual meetings of two major committees to advise the Secretary of the Interior on the status of water-data acquisition. The Interagency Advisory Committee on Water Data has representatives from 34 Federal agencies, and the Advisory Committee on Water Data for Public Use is composed of 27 members representing State and local agencies, technical societies, universities, and private enterprises. The OWDC provides staff assistance to the two advisory committees. See the organization chart on the facing page.
- Implement the recommendations of the advisory committees.
- Coordinate the preparation of the annual Federal plan for water-data acquisition.

Accomplishments:

- Helped implement the following programs of the Water Resources Division in response to recommendations from the two advisory committees:
  - National Water-Use Information
  - National Stream Quality Accounting Network
  - National Water-Data Exchange
  - River Quality Assessment
- Developed, published, and distributed about 10,000 copies of "The National Handbook of Recommended Methods for Water Data Acquisition." This 12-chapter loose-leaf manual is kept current by technical working groups staffed by representatives of the U.S. Geological Survey and other Federal agencies. The subjects of the 12 technical working groups and the manual are shown in the chart on the facing page.
- Prepared and published the catalog of information on water-data acquisition activities, which is now available through the National Water-Data Exchange (see page 26). Information in the catalog is obtained from 185 Federal liaison officials and 460 voluntary participants at State and local levels.
- Published a Hydrologic Unit Map of the United States and a Hydrologic Unit Map for each of the States.
- Prepared a digitized data base of the Hydrologic Unit Map of the United States.



OFFICE OF WATER DATA COORDINATION ADVISORY COMMITTEES AND TECHNICAL WORKING GROUPS

Assistance to Other Federal Agencies

Other Federal agencies often ask the U.S. Geological Survey to provide hydrologic information or expertise pertinent to specific needs of those agencies. The agency requesting the work reimburses the Water Resources Division for its services. The Water Resources Division also provides general assistance to other Federal agencies to assure compliance with environmental laws and regulations as required by the National Environmental Policy Act of 1969 (NEPA).

Purpose:

- To assist other Federal agencies in accomplishing their missions by providing hydrologic expertise and information.

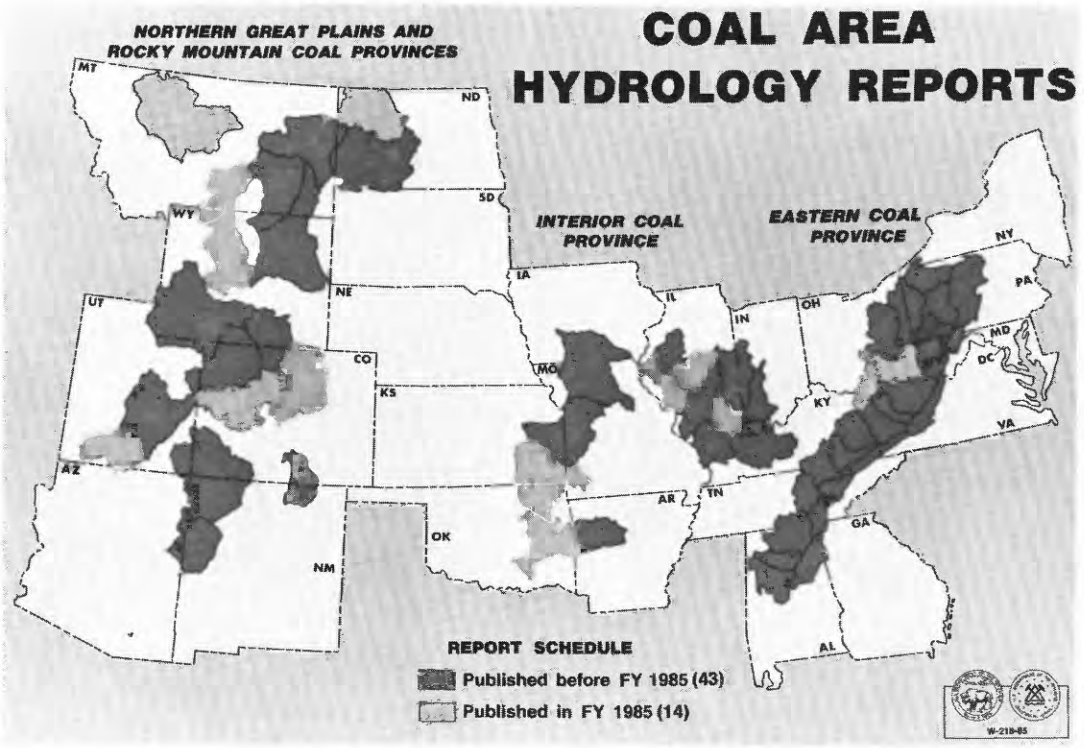
Activities:

The types of activities in this program depend on the requests for information by other Federal agencies. Examples of the assistance provided by the Water Resources Division are as follows:

- **Department of the Interior**—for most of its Bureaus, collect hydrologic data; conduct various types of investigations of the availability and characteristics of ground and surface water; evaluate the current and potential impacts of water-resources development and hazardous materials on water quality.
- **Department of Agriculture**—investigate hydrology of small watersheds by studying sediment deposits, stream discharge, and quality of water.
- **Department of Defense**—
  - *Corps of Engineers*—collect hydrologic data, and investigate tidal flows in estuaries, subsidence, streamflow, ground water, sedimentation, and water quality.
  - *Military bases*—conduct studies related to toxic waste, ground-water contamination, and water supply.
- **Department of Energy**—study hydrologic conditions and effects on the hydrologic environment of underground nuclear-explosion test sites, and of existing and potential nuclear waste disposal sites; conduct research on the interaction between radioactive materials and various geohydrologic environments.
- **Nuclear Regulatory Commission**—review interpretations of hydrologic conditions at sites being evaluated for potential high-level radioactive waste repositories.
- **Federal Emergency Management Agency**—delineate flood plains, determine flood profiles and flood frequencies for flood-insurance programs.
- **Environmental Protection Agency (EPA)**—conduct studies related to energy research and development, municipal waste-disposal sites, relationship of ground water to lakes; collect water-quality information; and provide hydrologic assistance for toxic-waste cleanup actions.

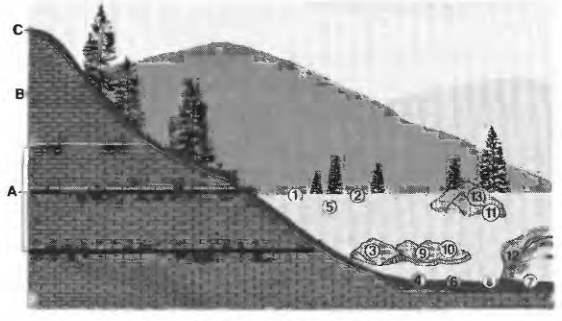
Accomplishments:

- Published a series of reports describing the hydrology of eastern and western coal areas for the Bureau of Land Management, the Bureau of Mines, and the Office of Surface Mining. (See illustration on facing page.)
- Published reports on the concentrations of selenium and other trace elements in the San Joaquin Valley, the San Luis Drain Service Area and the Kesterson National Wildlife Refuge, and Suisun Bay, as a result of studies for the Bureau of Reclamation, the Fish and Wildlife Service, and agencies of the State of California.
- Provided a synopsis of existing knowledge of ground water and surface water in North Dakota, for the use of a special congressional commission charged with recommending to the Secretary of the Interior changes to the authorized Garrison Diversion project plan.
- Implemented Memorandums of Understanding (MOU) with the EPA regarding related programs of the Geological Survey, including coordination of information on hydrologic plans, and technology transfer of data and information.
- Collaborated with the EPA in developing its national ground-water protection strategy.
- Assisted the EPA, Corps of Engineers, States, and local agencies in cleanup of toxic-waste disposal sites.
- Prepared a series of hydrologic and geologic reports on National Parks and National Monuments for the National Park Service.
- Prepared a ground-water training manual for the Office of Surface Mining.



Under the program of assistance to other Federal agencies, coal hydrology investigations have provided essential information for planning and managing mining and land reclamation.

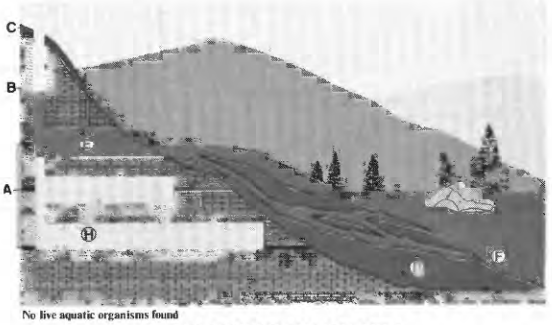
ENVIRONMENTAL EFFECTS OF MINING



A. UNDISTURBED AREA

B. CURRENTLY MINED AREA

A Coal seams
B Sandstone or limestone
C Topsoil
D Mine spoil
E Acid mine seepage
F Iron precipitate
G Mine area
H Mine area flooded
1 Riffle Beetles
2 Whirligig Beetles
3 Water Pennies
4 Midges
5 Mosquitoes
6 Black Flies
7 Craneflies - Phalacrocera
8 Craneflies - Tipula
9 Mayflies
10 Stoneflies
11 Caddisflies - Brachycentrus
12 Caddisflies - Hydropsyche
13 Alderflies
14 Pond Snails
15 Water Mites
16 Predaceous Diving Beetles
17 Spongilla Flies
18 Scuds



C. ABANDONED MINING AREA

Benthic invertebrates, dissolved sulfate, and iron concentrations related to selected mining activities. Roth, Engelke, and others, Water Resources Investigations Open-File Report 81-343.

Hydrologic Research

The Division's research focuses on increasing understanding of the fundamental hydrologic processess of the Nation's ground- and surface-water systems. Knowledge and techniques derived from the research effort are directed at solving current water-resources problems, and anticipating and thus preventing future water problems. Results of all research projects are made available to other Division programs and to the scientific community worldwide.

Purpose:

- Improve knowledge of the fundamental processes that affect or control the movement of water and chemical constituents through hydrologic systems.
- Develop an understanding of the effects of human activities on hydrologic systems.

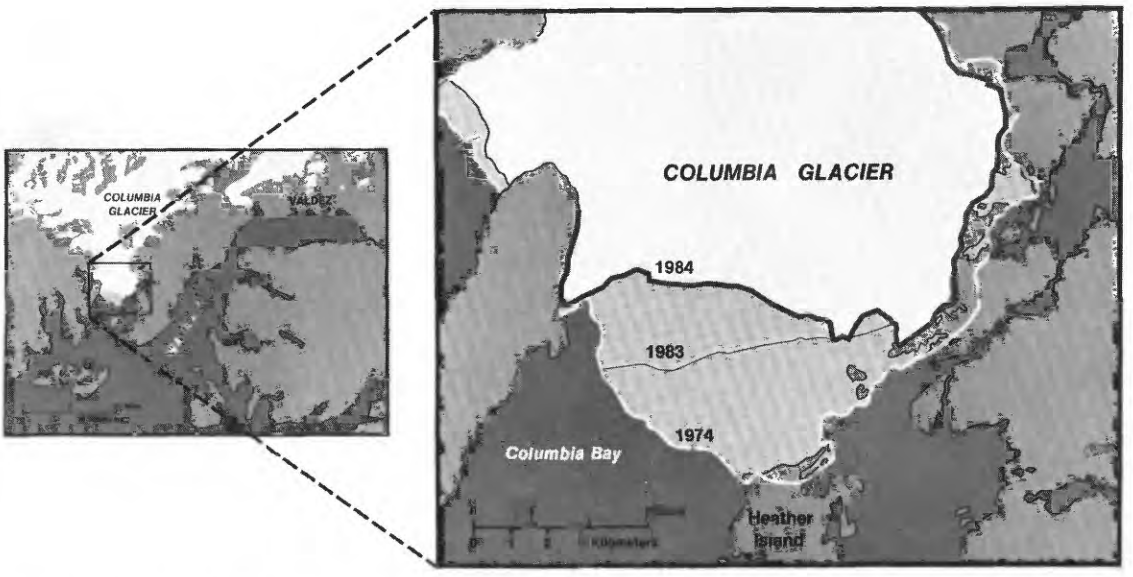
Activities:

- Conduct research in six major fields of study:
  - o Surface-water hydrology
  - o Ground-water hydrology
  - o Water chemistry
  - o Geochemistry
  - o Sediment transport and geomorphology
  - o Ecology
- Involve about 180 researchers in 110 projects in an average year. Examples of these research projects are: fate and transport of hazardous substances in surface and ground water; hydrology of lakes and estuaries; sediment transport in streams; trace element geochemistry; stream ecosystems; geophysics; transuranium elements in ground water; geochemical modeling; mechanics of mudflows; effects of acid precipitation on watershed chemistry; and glacier and snow-ice dynamics.

Accomplishments:

The results of research by the Water Resources Division are published throughout the year in approximately 250 reports and abstracts, covering a broad scientific spectrum. Some examples follow.

- Developed a mathematical model that successfully predicted the rapid retreat of the Columbia Glacier. See illustration on facing page.
- Developed a model to predict the timing of algal blooms in estuaries on the basis of tidal velocity and river-flow data.
- Developed sophisticated ground-water flow models to better understand the ground-water systems and to provide insight into the effects of the application of various ground-water management schemes.
- Initiated a new program of research and investigations regarding hazardous-substances contamination of surface water and sediments.
- Developed techniques to estimate the recurrence interval of debris and mud flows connected with activities of the Cascade Range volcanoes.
- Increased understanding of the role of lakes in the hydrologic system with respect to ground-water recharge and discharge by defining ground-water flow systems relative to lakes.
- Developed and demonstrated the usefulness of complex computer models to simulate movement of radionuclides in ground water.
- Demonstrated the importance of flow through gravel zones in river bottoms to the sorption and transport of pollutants in streams.
- Developed new borehole-geophysical methods in characterizing fractured rock zones.
- Published the first comprehensive data-set on Antarctic sea ice and interpretation of its influence on world climate, in cooperation with the National Aeronautics and Space Administration (NASA).
- Established a computer-enhanced monitoring system for Spirit Lake and other debris-dammed lakes near Mount St. Helens, utilizing satellite and radiotelemetry units to transmit real-time water-level data.
- Completed studies of long-term sediment load and channel changes in the Green River downstream of Flaming Gorge Reservoir, Utah, providing information to aquatic biologists about habitat changes in the river due to flow regulation and sediment storage by the reservoir.
- Initiated studies of humic substances and other natural organic matter, including their effect on trace metals.



Retreat of Columbia Glacier, 1974–1984, predicted by scientists of the Water Resources Division, U.S. Geological Survey. Large icebergs formed by the retreating glacier pose a potential threat to oil-tanker shipping lanes near the Alaska pipeline port of Valdez.

Aerial photograph by Austin S. Post of U.S. Geological Survey, 21,000 feet above sea level, September 26, 1981. Glacier terminus is in lower half of photograph. North is to the top.

COLUMBIA GLACIER, ALASKA

National Water-Data Exchange

The National Water-Data Exchange (NAWDEX) was established in 1976 as the outgrowth of recommendations made by the two advisory committees to the Secretary of the Interior to improve access to all federally acquired water data.

Purpose:

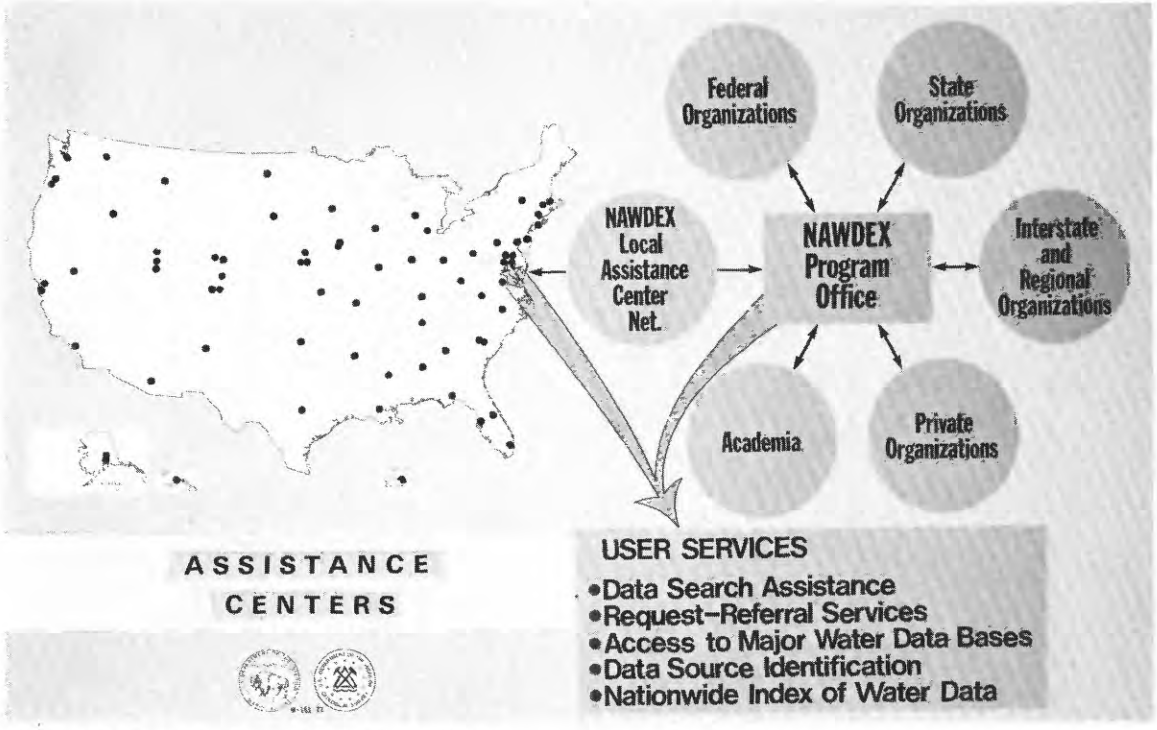
- Expand the availability of water data to all those who need and use water data, improve the exchange of such data, and serve as a focal point for obtaining the data.

Activities:

- Operate a national water-data indexing program.
- Maintain a national user-service program that includes a nationwide network of assistance centers and liaison with water-oriented organizations.
- Provide support to the Office of Water Data Coordination (OWDC) in cataloging water-data acquisition activities. See page 20 for description of OWDC.

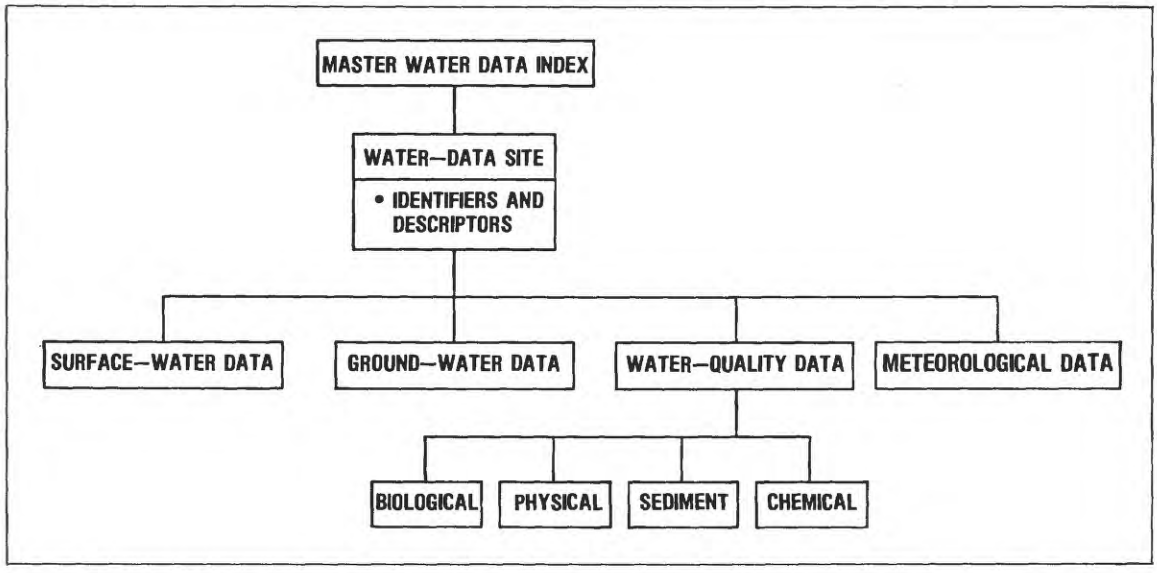
Accomplishments:

- Increased membership to nearly 270 Federal, State, and local government, academic, and private water-oriented organizations.
- Processed about 85,000 requests for hydrologic information during 1985, through a national network of 76 assistance centers in 45 States, the District of Columbia, and Puerto Rico.
- Developed and maintain the Master Water Data Index of more than 450,000 data-collection sites, operated by nearly 450 organizations. See facing page.
- Developed and maintain the Water-Data Sources Directory for more than 750 organizations that are sources of water and water-related data, and the locations within these organizations from which data may be obtained.
- Coordinated direct access to two major water-data bases: STORET, of the Environmental Protection Agency, and WATSTORE, of the U.S. Geological Survey.



Source: U.S. Geological Survey exhibit panel W-161-77.

NAWDEX PROVIDES ACCESS TO WATER DATA



Source: Perry and Williams, 1982

STRUCTURE OF THE MASTER WATER DATA INDEX DATA BASE

Water Resources Scientific Information Center

The Water Resources Scientific Information Center (WRSIC) was created in 1966 and placed in the Department of the Interior on the advice and consent of the Committee on Water Resources Research of the former Federal Council for Science and Technology, and the Office of Science and Technology in the Executive Office of the President. The objective of WRSIC was to make available information and reports on projects completed, in progress, or planned under the provisions of the Water Resources Research Act of 1964 (Public Law 88-379, as amended). WRSIC initially was located in the Office of Water Resources Research, later known as the Office of Water Research and Technology. In August 1982, the Secretary of the Interior transferred WRSIC to the U.S. Geological Survey's Water Resources Division where it complements the Division's program of disseminating water information to the public.

Purpose:

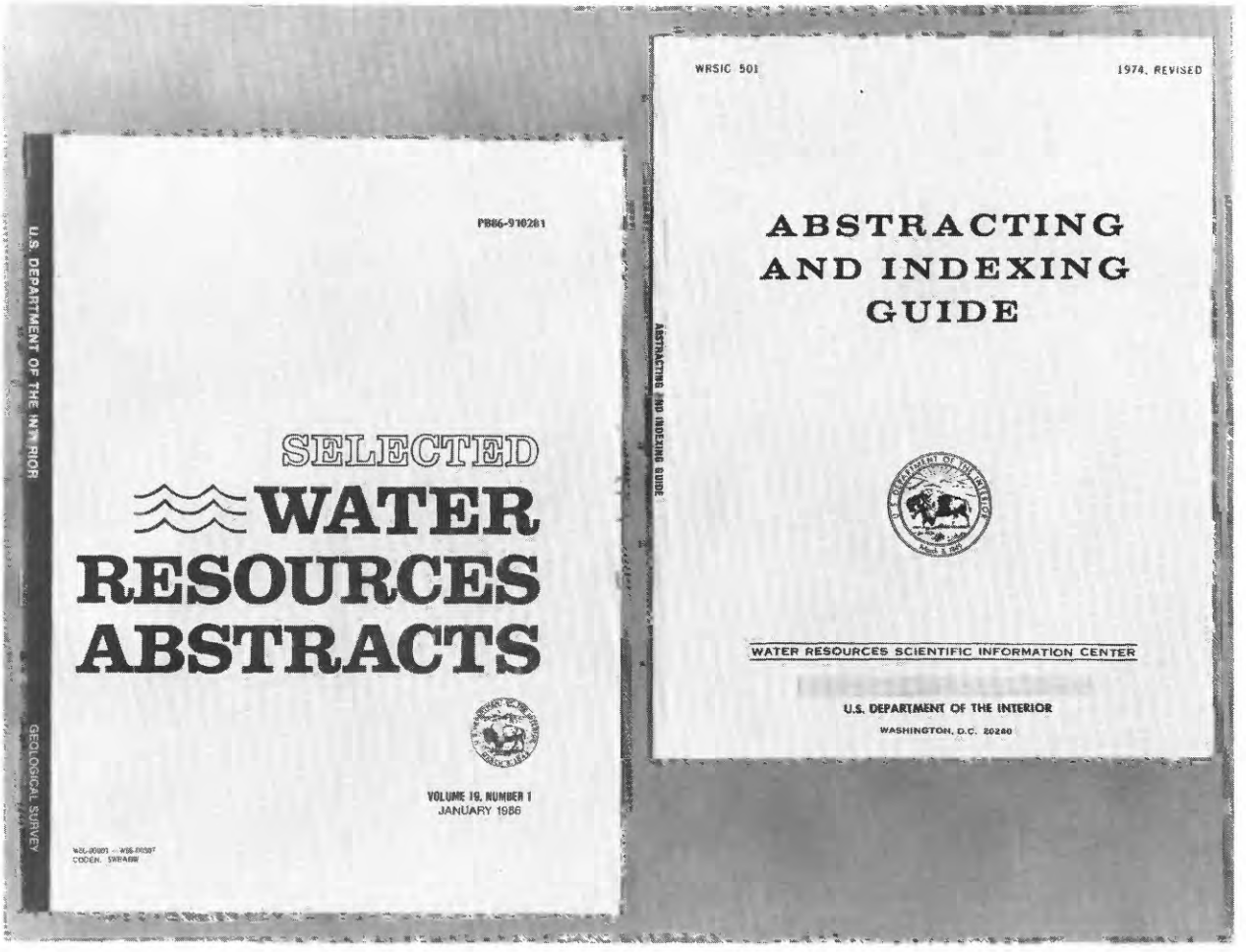
- Increase the availability and knowledge of water-related scientific and technical information by abstracting water-resources publications, and making this information promptly and readily available to the water-resources community and the public through publications and computerized bibliographic information services.

Activities:

- Acquire, abstract, and index the significant water-resources literature of the world.
- Publish "Selected Water Resources Abstracts" monthly.
- Publish cumulative annual indexes to "Selected Water Resources Abstracts" by subject, author, organization, and accession number.
- Maintain a comprehensive worldwide computerized bibliographic information base.
- Maintain a research-in-progress information base.
- Provide computer searches of the bibliographic information base for Federal agencies.
- Maintain the "Water Resources Thesaurus."

Accomplishments:

- Expanded the computerized bibliographic information base to more than 175,000 abstracts in 1985.
- Arranged for the bibliographic information base to be made available through commercial on-line services from DIALOG Information Services, Inc.



WATER RESOURCES SCIENTIFIC INFORMATION CENTER PUBLICATIONS

National Water-Data Storage and Retrieval System

The National Water-Data Storage and Retrieval System (WATSTORE) provides the data which are the basis of book and map reports that describe and analyze the Nation's water resources. These hydrologic data are used not only in determining the adequacy of water supplies, but also in designing dams, bridges, and flood-control projects; in allocating irrigation waters; in locating sources of pollution; in planning for energy development; and in predicting the potential effects on water supplies of the storage of radioactive waste. The U.S. Geological Survey began WATSTORE in 1971, to improve access to the vast amount of water data collected by the Water Resources Division.

Purpose:

- Provide computerized water data to the water-data community and maintain the national water-resources data base.

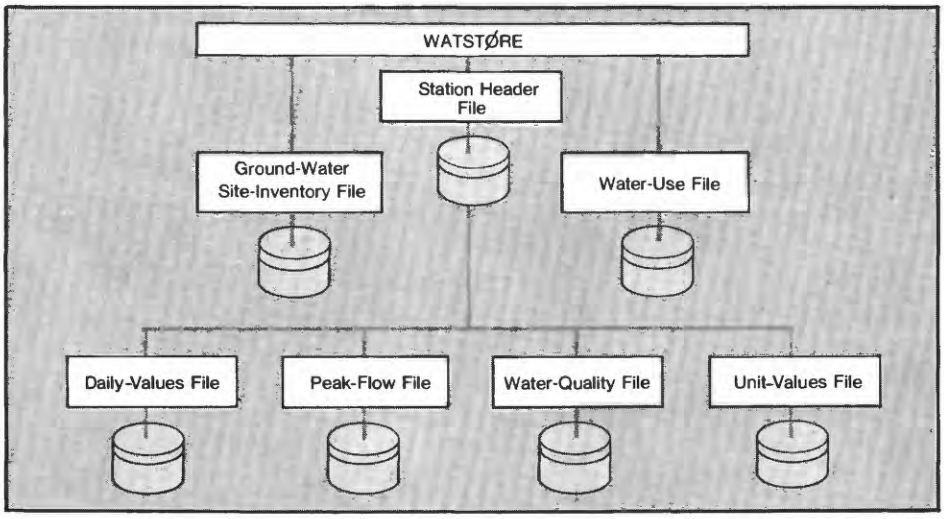
Activities:

- Maintain several computer files (see illustration on facing page) in which data are grouped and stored by common characteristics and frequency of collections. These files include—
  - Surface-water, quality-of-water, and ground-water data measured on a daily or continuous basis.
  - Annual peak (maximum) streamflow (discharge) and gage height (stage) values for surface-water stations.
  - Chemical-quality analyses for surface and ground water.
  - Water characteristics that are measured more frequently than daily.
  - Geologic and inventory data for ground-water sites.
  - Water-use information for 12 categories of use.
- Improve the dissemination of water data to water managers and planners.
- Store and retrieve data at about 50,000 locations that are part of a nationwide telecommunications network.
- Provide hydrologic data on a real-time or hourly basis, transmitted by more than 1,500 satellite data-collection platforms.
- Supply information to requestors of data in formats appropriate to their needs, such as computer-printed tables and graphs, statistical analyses, digital plots, and magnetic tape.

Accomplishments:

- Linked WATSTORE with the Environmental Protection Agency's Storage and Retrieval System (STORET). Water-quality data are transferred monthly from WATSTORE to STORET.
- Developed WATSTORE files containing—
  - 220 million daily observations of streamflow, reservoir contents, water temperature, stream sediment, and ground-water level data.
  - 2.5 million chemical, physical, biological, and radiochemical analyses from surface and ground water.
  - Hydrologic and geologic data on 900,000 inventoried wells.
- Contributed summary information to the National Water-Data Exchange (see page 26).

HYDROLOGIC INFORMATION FROM WATSTORE



NATIONAL WATER-DATA STORAGE AND RETRIEVAL SYSTEM

National Water-Use Information Program

The National Water-Use Information Program was started in response to the need for a single source for uniform information on water use. The program, which began in 1978, is part of the U.S. Geological Survey's Federal-State Cooperative Program and is designed to meet the mutual needs of State and Federal governments. The data derived by this program complement the Geological Survey's long-term data on water availability and quality.

Purpose:

- Determine nationwide how much fresh and saline surface and ground water is withdrawn, used, consumed during use, and returned for further use.
- Determine what changes in water quality are associated with the various categories of use.

Activities:

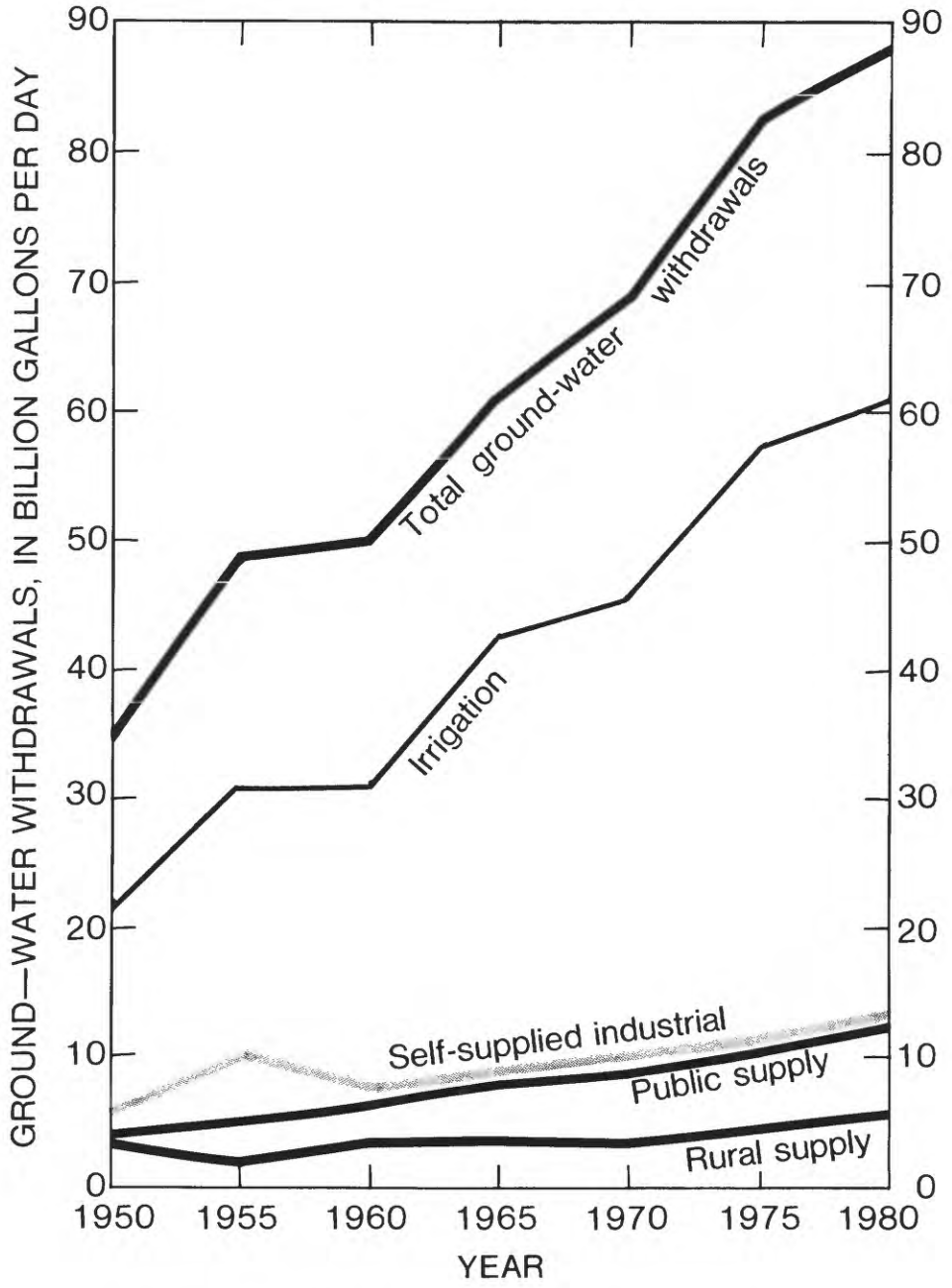
- Assist the States in the collection and compilation of water-use data.
- Develop a computerized data storage and retrieval system.
- Devise new methods and techniques to improve and standardize the collection and analysis of water-use information.
- Make the water-use information readily available and understandable.

Accomplishments:

- Established the program in 49 States and Puerto Rico.
- Developed and operated the computerized National Water-Use Data System at the Federal level, with data available through NAWDEX (see page 26) and WATSTORE (see page 30).
- Completed software programs for the State Water-Use Data System that is being used in 35 States.
- Compiled data for 12 categories of water use:

Agriculture:	*Power generation:*	*Other uses:*
o Irrigation	o Fossil Fuel	o Domestic
o Nonirrigation	o Geothermal	o Commercial
	o Hydroelectric	o Industrial
		o Nuclear
		o Mining
		o Public supply
		o Sewage treatment

- Released information in publications of the Geological Survey and State agencies.
- Published the report "Estimated use of water in the United States in 1980."



U.S. TRENDS IN GROUND-WATER USE, 1950–80

Hydrologic Data-Collection Program

The Hydrologic Data-Collection Program is the Water Resources Division's basic program for collecting and analyzing data on the Nation's surface and ground water. These data are used to support the needs of Federal, State, and local governments. Data-collection stations are maintained at selected locations to provide standardized records on stream discharge (flow) and stage (height), reservoir and lake storage, ground-water levels, well and spring discharge, and the quality of surface and ground water. The program is funded in several ways, as shown in the table below.

Purpose:

- Provide the hydrologic data needed to support the obligations and concerns of the Federal government (U.S. Geological Survey and other Federal agencies).
- Provide the hydrologic data needed to respond to the mutual needs and concerns of State, local, and Federal agencies regarding management, development, regulation, conservation, and environmental protection of the Nation's water. See Federal-State Cooperative Program, page 18.

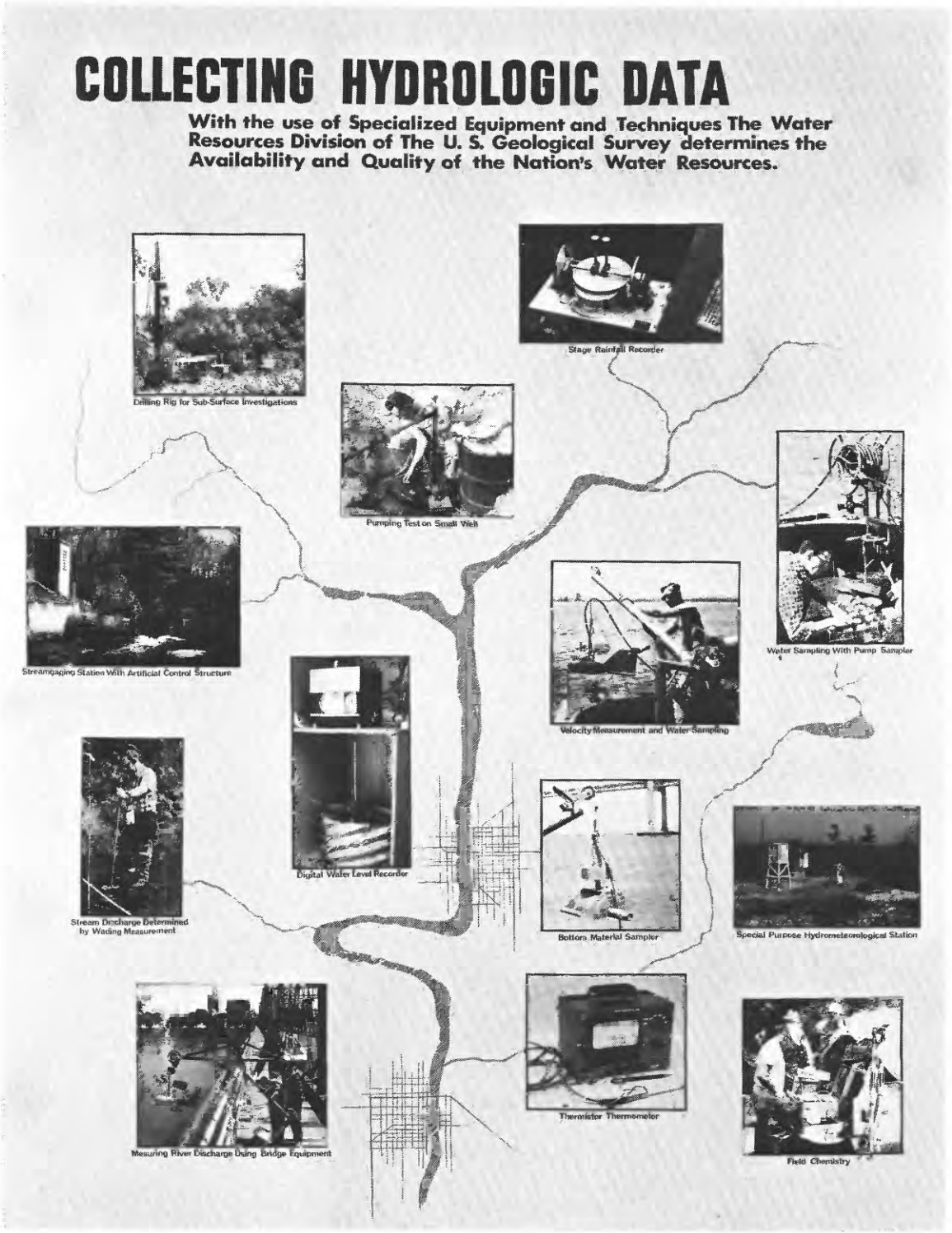
Activities:

- Collect data required by court decree, treaty, or compact.
- Provide data needed to support activities of other Federal agencies.
- Provide data needed to support national programs, such as energy studies.
- Operate stations to collect data on the quantity and quality of surface and ground water at local and State levels, with increasing attention to water-quality data describing the major surface- and ground-water resources of the Nation.
- Monitor quantity and quality of water to detect trends in stream quality. See National Stream-Quality Accounting Network (NASQAN), page 36.
- Monitor hydrologic characteristics at sites relatively unaffected by human activities. See National Hydrologic Bench-Mark Program, page 36.

NUMBER OF DATA-COLLECTION SITES, 1985

Types of stations	Number of stations, by source of funds			
	Federal Program	Federal–State cooperative program	Other Federal agencies	Total
SURFACE WATER				
Discharge				
Continuous record	554	3,223	1,607	1,635
Partial record	84	3,013	293	667
Stage only—Streams				
Continuous record	13	198	212	24
Partial record	14	418	45	30
Stage Only—Lakes/Reservoirs				
Continuous record	21	338	254	169
Partial record	11	278	67	49
Quality				
Continuous record	111	284	252	96
Scheduled, long-term	519	1,346	352	229
Short-term or project	74	718	124	61
GROUND WATER				
Water Levels				
Continuous record	94	1,783	215	192
Scheduled, long-term	814	19,487	1,501	3,221
Short-term or project	2,973	7,411	974	636
Quality				
Scheduled, long-term	52	3,796	193	293
Short-term or project	546	3,709	468	206

Source: Condes de la Torre, Alberto, 1985, U.S. Geological Survey Open-File Report 85-640.



Source: U.S. Geological Survey exhibit panel W-98.

HYDROLOGIC DATA-COLLECTION ACTIVITIES OF THE WATER RESOURCES DIVISION

Hydrologic Data-Collection Program—Continued

Accomplishments:

- Provided the basic data for water-resources appraisals, environmental impact statements, and energy-related studies. In establishing the baseline conditions of the Nation's water, the Hydrologic Data-Collection Program has become the foundation for solving emerging water issues.
- Made available hydrologic data through two computerized systems—the National Water-Data Exchange (see page 26) and National Water-Data Storage and Retrieval System (see page 30).
- Published data annually for each State, Puerto Rico, and the Trust Territories, and published special appendixes, such as data for coal-producing areas, as needed.

The U.S. Geological Survey operates two special-purpose programs to monitor surface-water quality—the National Stream Quality Accounting Network (NASQAN) and the National Hydrologic Bench-Mark Program. These programs are designed to answer the question, "What is the quality of water in the major river systems of the United States?" and "Is the quality changing?" Neither of these networks is designed to determine why the water quality might be changing. However, research is underway to improve knowledge of the processes that influence the natural and changing quality of water (see pages 24, 44, 46, and 48).

National Stream-Quality Accounting Network

Purpose:

- To obtain information on the quality and quantity of surface water moving within and from the United States through a systematic and uniform process of data collection, summarization, analysis and reporting so that the data may be used to—
  - Describe the variability of water-quality in the nation's streams.
  - Detect changes or trends in water-quality characteristics.
  - Provide a nationally consistent data base useful for water-quality assessment and hydrologic research.

Activities:

- Monitor a comprehensive set of physical and chemical characteristics of surface water at stations throughout the country to detect changes in stream quality and to determine long-term trends.
- Assess water quality from a regional and national perspective, through interpretive projects in the Districts of the Water Resources Division.

Accomplishments:

- Established more than 550 NASQAN stations in 1973–1985. NASQAN stations are generally located at or near the downstream end of hydrologic accounting units or at representative sites along coastal areas and the Great Lakes.
- Established within NASQAN a radiochemical surveillance subnetwork of 52 sampling sites.
- Developed and refined a statistical procedure for determining trends in water-quality constituents.
- Developed a computer-based station information file for use in preparing information reports, answering requests for information, and program operation and planning needs.

National Hydrologic Bench-Mark Program

Purpose:

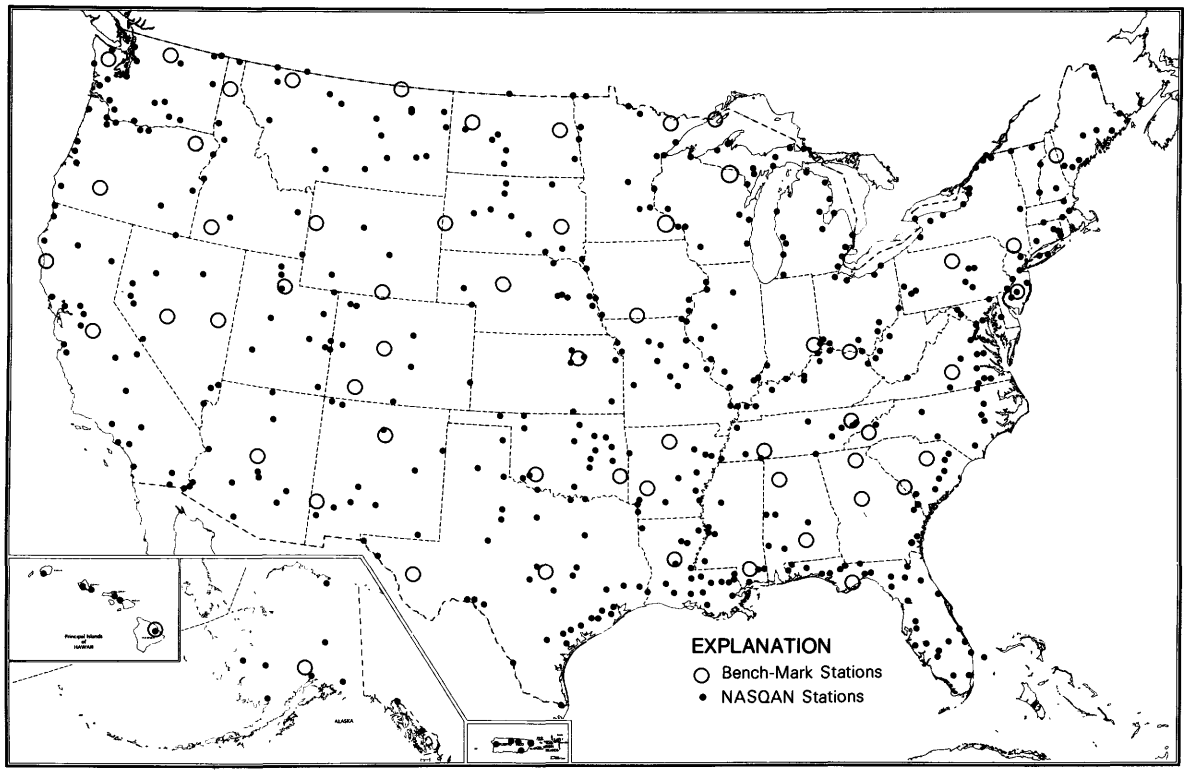
- Provide consistent hydrologic data (including water quality and related factors) in representative undeveloped watersheds nationwide, and provide analyses on a continuing basis to compare and contrast conditions observed in basins more obviously affected by human activity.

Activities:

- Monitor streamflow and physical and chemical characteristics at selected "natural" sites throughout the country.
- Provide summary, analysis, and interpretation of the data.

Accomplishments:

- Established 58 monitoring stations.
- Utilized data from the program in a search for evidence of effects of acid precipitation on stream waters.
- Published reports that describe the environment and the natural water quality of remote watersheds not "influenced" by human activities. Compared these data with data on the water quality of major streams that drain the same regions.
- Started studies to summarize all streamflow quantity and quality data and to analyze trends in quantity and quality characteristics.



NASQAN AND NATIONAL HYDROLOGIC BENCH-MARK STATIONS
NOVEMBER 1985

State Water Resources Research Institutes and National Water Resources Research Grants Programs

The Water Resources Research Act of 1984 (Public Law 98-242) directed the Secretary of the Interior to administer programs of grants and contracts for research, technology development, and information transfer that will aid the Nation and the States in solving water resources problems. Responsibility for administration of these programs has been delegated to the Director, U.S. Geological Survey.

Purpose:

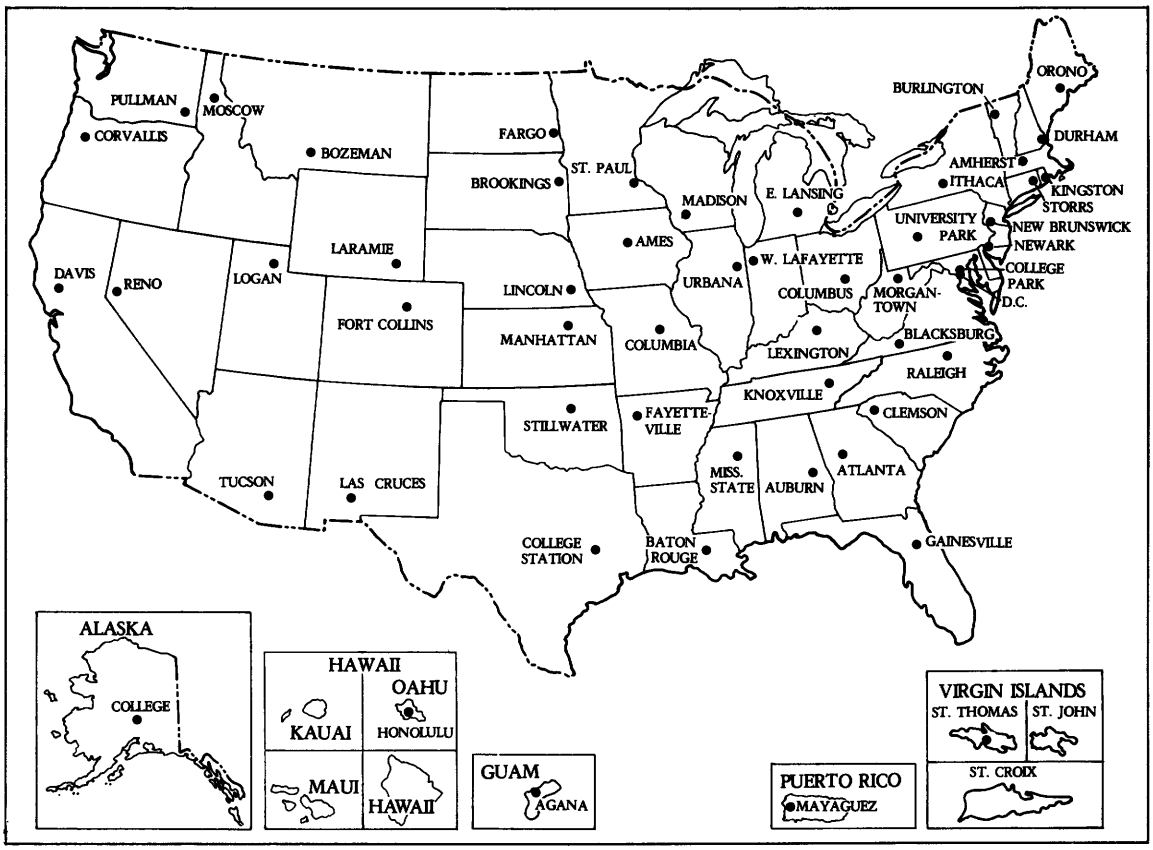
- Provide matching grants to finance annually part of the operation of up to 57 State Water Resources Research Institutes.
- Provide matching grants for research concerning any aspect of a water-resource-related problem deemed to be in the national interest.
- Provide grants and contracts for technology development concerning any aspect of water-related technology deemed to be of State, regional, and national importance, including technology associated with improvement of waters of impaired quality.

Activities:

- Evaluate the Institutes at least once in each 4-year period to determine eligibility to receive future grants.
- Define priority areas of research and technology development for funding under the Water-Resources Research and Technology Development programs.
- Solicit, evaluate, and select proposals for funding under the programs.
- Monitor progress of research and development projects funded under the Water Resources Research Act.

Accomplishments:

- Prepared instructions for Institutes on preparation of fiscal year 1984 report and fiscal year 1986 program proposal.
- Completed in July 1986, 28 of the 54 Institute evaluations scheduled between September 1985 and June 1987.
- Conducted technical reviews and evaluations on 368 research proposals submitted under the fiscal year 1985 matching grant program, and awarded 24 matching grants.
- Evaluated proposals and awarded equal matching grants to 54 State Water Resources Research Institutes in the 50 States, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. The grants provided partial funding for research, information transfer, training, and management of programs that aid in the solution of critical State water problems.



STATE WATER RESOURCES RESEARCH INSTITUTES

Nuclear Waste Hydrology

High-Level Radioactive Wastes

The disposition of high-level radioactive wastes and irradiated nuclear fuels in ways that avoid severe potential environmental and health hazards poses complex technical problems. High-level radioactive wastes are defined as spent nuclear reactor fuel or the radioactives wastes produced during the reprocessing of spent reactor fuel, and any transuranic wastes emitting radiation in excess of 100 nanocuries per gram. For many years the U.S. Geological Survey has conducted geohydrologic studies related to a variety of nuclear facilities and activities. The Geological Survey's effort is aimed at assisting the U.S. Department of Energy, which is responsible under the Nuclear Waste Policy Act of 1982 for selecting, building, and operating civilian radioactive-waste repositories.

Purpose:

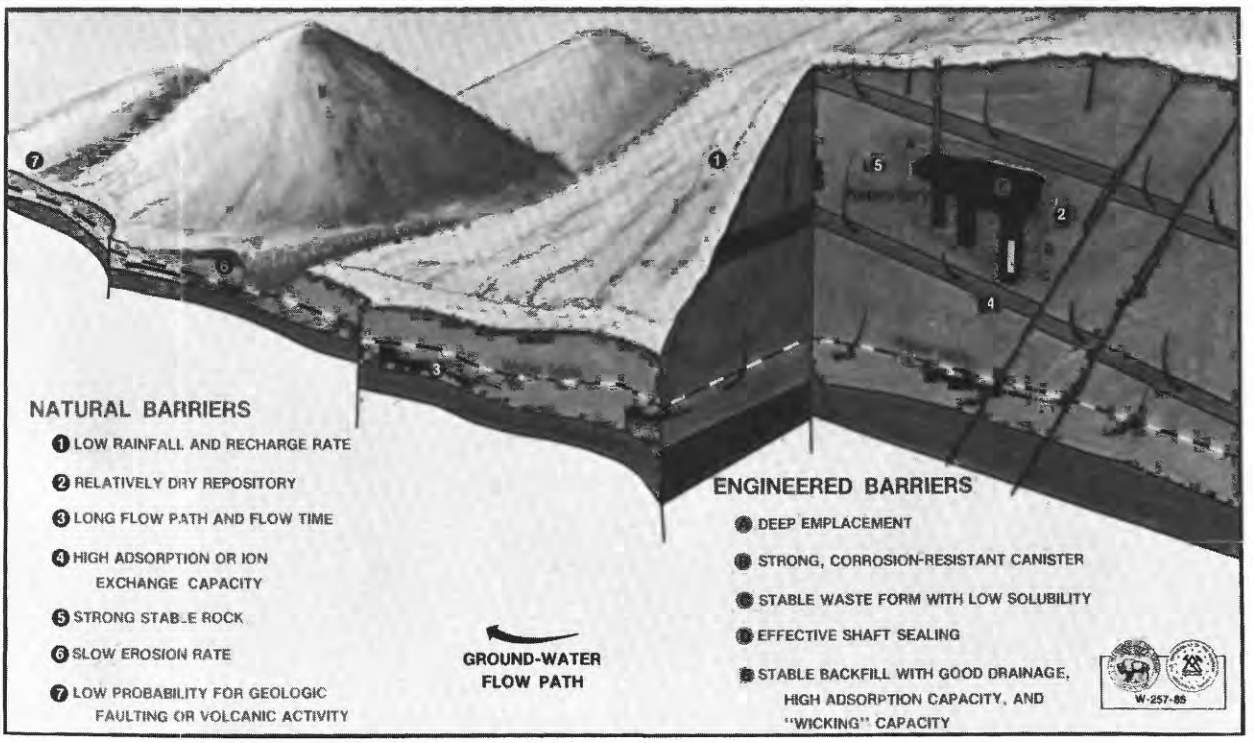
- Provide advice and results of studies of environments, and processes, techniques, and methods of geohydrologic characterization with relation to the disposal of high-level radioactive waste.

Activities:

- Identify environments with effective natural multiple barriers to the movement of radionuclides.
- Develop techniques and methods for characterizing geohydrologic environments.
- Investigate processes related to radionuclide migration.
- Contribute geohydrologic information to aid development of rules, regulations, and guidelines concerning the disposal of high-level radioactive wastes.
- Review significant reports by other agencies as related to disposal of radioactive waste.
- Define the technical basis for determining the hydrologic suitability of the Department of Energy (DOE) Nevada Test Site for the disposal of high-level nuclear waste.
- Consult with the DOE on site-specific technical problems.

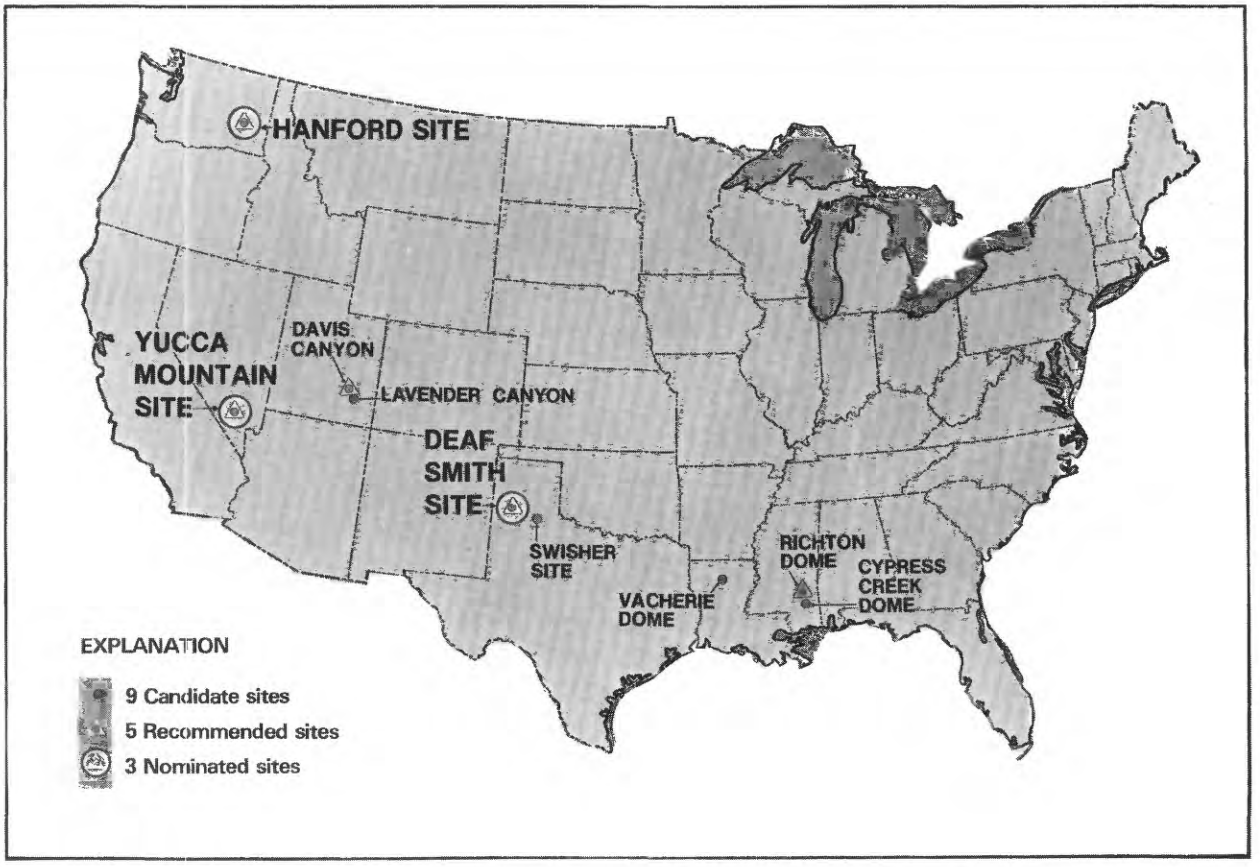
Accomplishments:

- Completed a study of the Basin and Range physiographic province in close cooperation with the involved States to define areas that have geohydrologic conditions for multiple natural barriers.
- Completed a reconnaissance study in the east to determine if buried crystalline rocks might be used to construct a repository.
- Conducted ongoing research in techniques of drilling and hydraulic testing in boreholes, and in geophysical methods of characterizing environments.
- Conducted ongoing research in geochemistry to understand the interaction and influence of rock, ground water, and forms of waste on the mobility of radionuclides in ground-water systems.
- Conducted ongoing research in the hydrology of fractured rock and of unsaturated geohydrologic environments.
- Conducted hydrologic investigations at the Nevada Test Site to define the rate and directions of ground-water movement.
- Developed the concept of waste disposal in arid unsaturated zones which has been adopted by the DOE.
- Reviewed drafts of environmental assessments, aiding in the selection of nine potential repository sites for the disposal of high-level radioactive waste (see facing page).
- Provided geohydrologic information instrumental in the selection of the Yucca Mountain location at the Nevada Test Site as a principal candidate site for a high-level waste repository.
- Played principal role in selecting and characterizing the Waste Isolation Pilot Plant site in New Mexico for disposal of military waste in bedded salt deposits.



Source: U.S. Geological Survey exhibit panel W-275-85.

BARRIERS TO THE MIGRATION OF WASTE FROM REPOSITORY SITES



NINE CANDIDATE SITES FOR DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE

Nuclear Waste Hydrology—Continued

Low-Level Radioactive Wastes

Low-Level radioactive wastes result from virtually all activities involving radioactive materials, such as research programs, medical diagnosis and treatment, and electrical power generation. In the United States, disposal of low-level waste has been by shallow land burial. The Geological Survey has conducted geohydrologic studies at both commercial and Department of Energy low-level waste disposal sites for many years and identified the principal geohydrologic problems encountered in shallow land burial. Through research and investigations the Geological Survey develops geohydrologic information that assists Federal agencies, States, and compacts to meet their responsibilities under the Low-Level Waste Policy Act of 1980. The major objective of the act is to develop suitable regional sites for the disposal of low-level radioactive wastes.

Purpose:

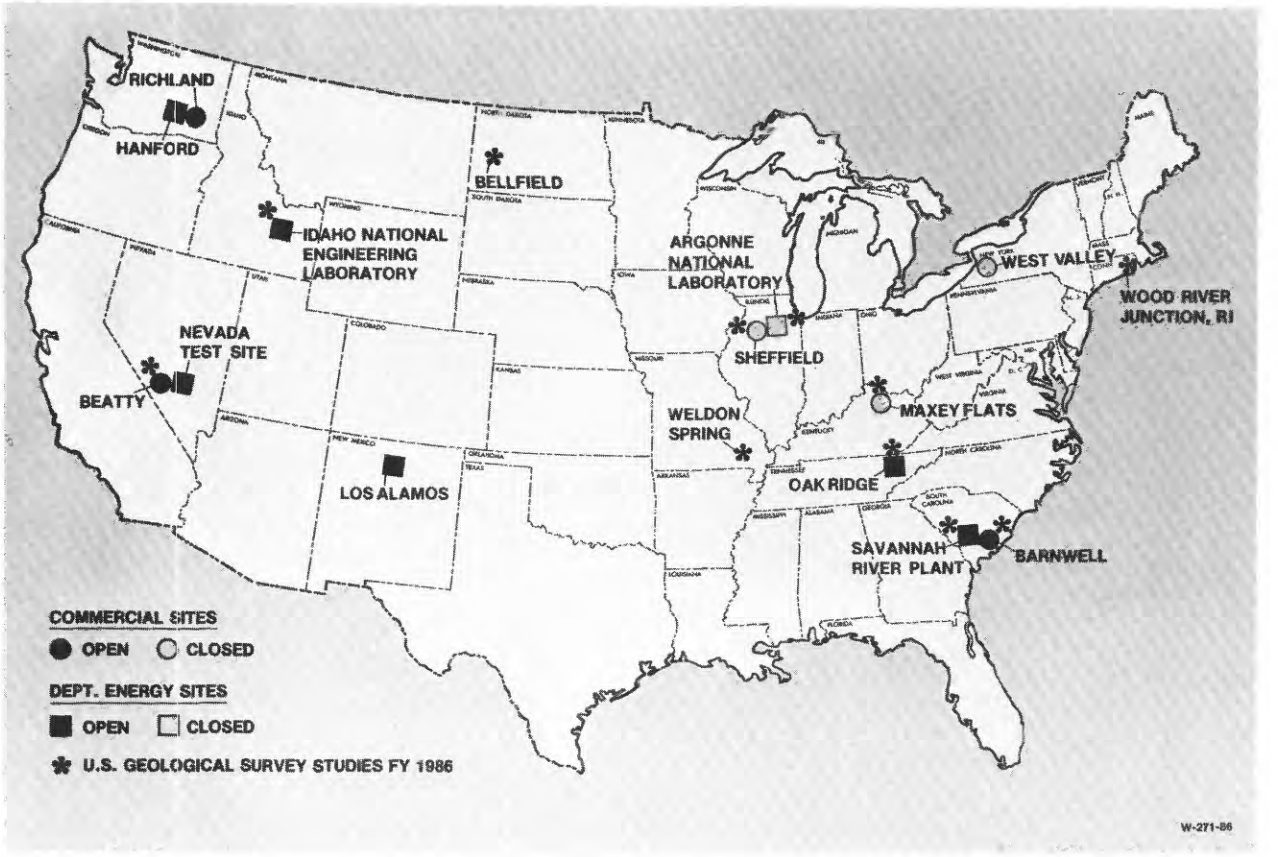
- Develop geohydrologic guidelines that can be used to characterize, select, operate, and decommission sites for burial of low-level radioactive waste; provide advice and results of studies of processes, environments, methods, and techniques of geohydrologic evaluation.

Activities:

- Conduct field and laboratory research into processes controlling the performance of existing shallow land disposal sites.
- Develop techniques and guidelines for the geohydrologic characterization, design, and selection of potential sites, and for determination of suitable remedial measures to be used at existing sites where site performance is not satisfactory.
- Investigate processes that affect radionuclide migration.
- Contribute geohydrologic information to aid the development of rules, regulations, and guidelines by other Federal agencies and the States.
- Review significant reports by other agencies related to disposal of low-level waste.
- Consult with Department of Energy (DOE), Evironmental Protection Agency, (EPA), Nuclear Regulatory Commission (NRC), and State agencies on specific technical problems.
- Assist Federal and State agencies in developing and implementing effective low-level waste management programs.

Accomplishments:

- Completed detailed field investigations at five existing commercial low-level waste burial sites in New York, South Carolina, Kentucky, Illinois, and Nevada.
- Conducted studies at DOE waste-disposal sites in Idaho, Tennessee, Illinois, and South Carolina.
- Demonstrated and documented in reports the usefulness of complex computer models to simulate movement of radionuclides in ground water, at the Idaho National Engineering Laboratory.
- Identified and described in reports major geologic and hydrologic problems associated with existing disposal sites for low-level wastes.
- Provided technical assistance to the EPA in the development of standards for release of low-level waste contaminants into the environment.
- Provided technical assistance to State agencies and compacts preparing to select new low-level waste sites in accordance with the Low-Level Waste Policy Act.
- Provided technical assistance to the NRC in the preparation of criteria for the selection of low-level waste burial sites.
- Provided technical assistance to EPA in the review of a radionuclide transport model.
- Conducted ongoing research in—
    - Techniques for evaluating ground-water movement in the unsaturated zone.
    - Gas transport in the unsaturated zone.
    - Ground-water movement and solute transport in fractured rock.
    - Surface-based and borehole geophysical techniques applicable for characterization of existing and potential low-level waste sites.
    - The influence of interactions of rock, ground water, and waste on the mobility of radionuclides.
    - Surface hydrologic processes involving runoff, sediment transport, landform modification, and trench-cap collapse.



LOW-LEVEL RADIOACTIVE WASTE SITES AND U.S. GEOLOGICAL SURVEY STUDIES

Toxic Substances Hydrology

The Toxic Substances Hydrology Program of the U.S. Geological Survey was established in 1985, in response to rising national concern about contamination of the Nation's ground water and surface water. Hundreds of toxic substances have been identified in urban and agricultural runoff, industrial effluents, drainage from mines, and seepage from waste-disposal sites. The threat of widespread ground-water contamination increases as the ground is infiltrated daily by millions of gallons of waste.

Purpose:

- Provide the Nation with earth-science information to improve waste-disposal practices, and mitigate or prevent further contamination of water resources by toxic substances.

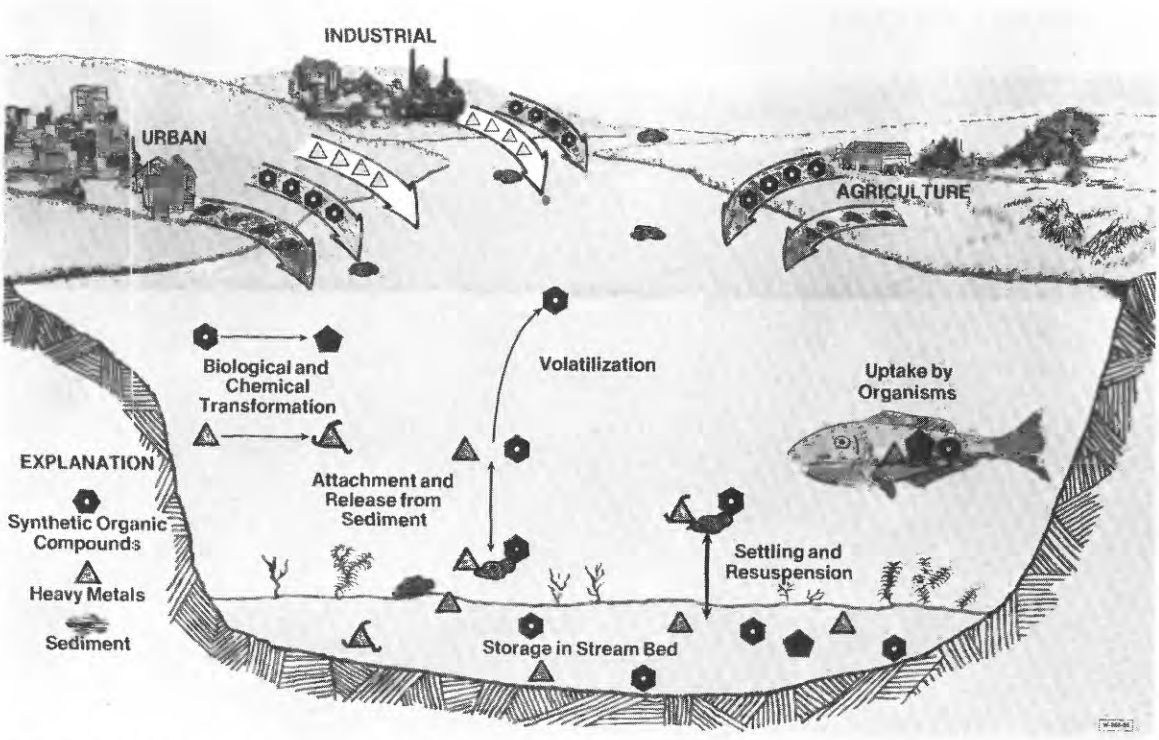
Activities:

The Toxic Substances Hydrology Program requires extensive research in ground water hydrology, erosion and sediment transport, geochemistry, and ecology—to improve knowledge about the occurrence, movement, and fate of contaminants in ground-water and surface-water systems. Ongoing efforts include—

- Develop and evaluate methods to assess the distribution and magnitude of ground-water contamination.
- Characterize the process by which contaminants move through the subsurface.
- Conduct intensive field investigations of ground-water contamination, to—
  - Apply theoretical and analytical methods in real-world situations.
  - Improve monitoring and sampling procedures.
  - Develop new ways to mitigate ground-water contamination.
  - Evaluate the reliability and value of predictive models for characterizing and predicting the course of ground-water contamination.
- Conduct investigations of the six most common and persistent groups of ground-water contaminants: petroleum products (gasoline and diesel fuels), volatile chlorinated organic solvents (trichloroethylene, for example), wood treatment and related products (such as creosote and pentachlorophenol), sewage, other selected organic compounds, and selected trace metals (lead, mercury and cadmium, for example).
- Conduct detailed field investigations of 3 to 4 years duration into surface-water contamination in selected river basins, to—
  - Determine the occurrence, distribution, and movement of organic substances and trace metals under different conditions.
  - Improve knowledge of the processes and factors which govern the movement and fate of different classes of toxic substances in different hydrologic settings.
  - Develop improved study approaches and sampling methods for evaluating the magnitude, distribution, and movement of toxic substances in water, sediment, and biota.

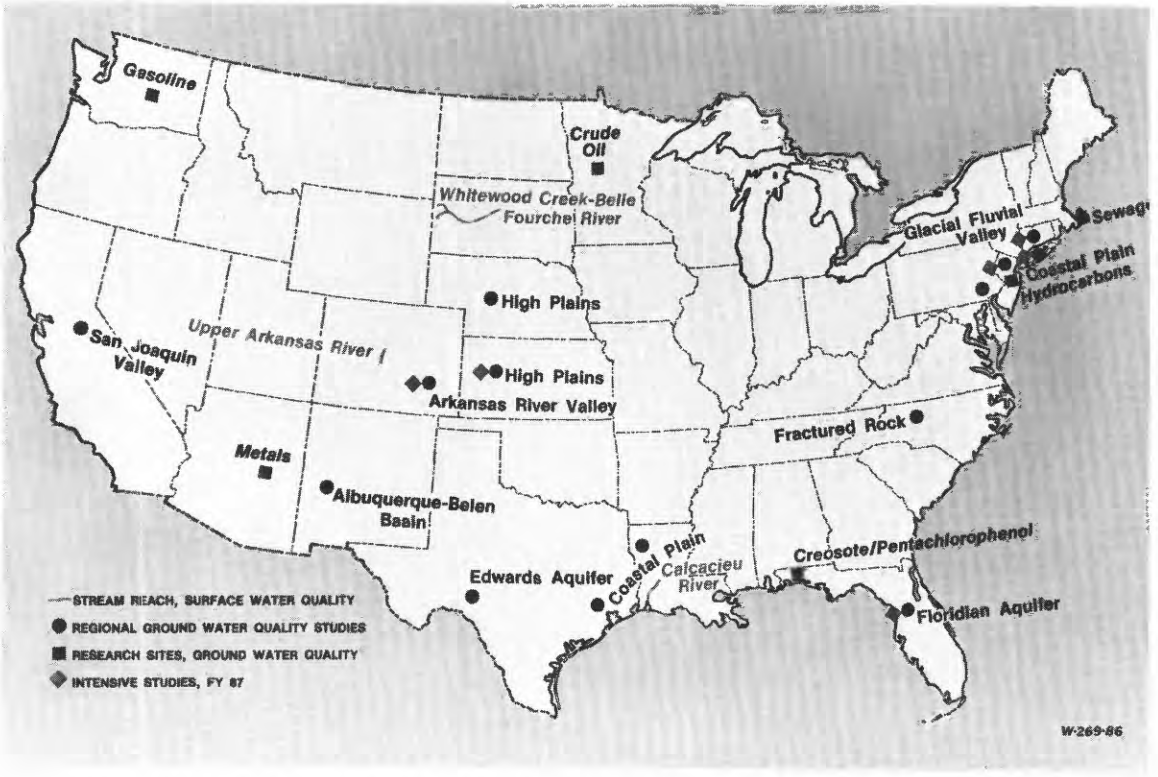
Accomplishments:

- Completed reconnaissance phase of 14 regional ground-water quality studies in Connecticut, New York, New Jersey, Pennsylvania, North Carolina, Louisiana/Mississippi (one study), Florida, Colorado, New Mexico, Texas (two studies), Kansas, Nebraska, and California.
- Published reports on earth-sciences processes affecting the transport of contaminants through the subsurface, including:
  - Absorptive control of cadmium mobility in ground water.
  - Trace metal adsorption on calcareous aquifer materials.
  - Complexation of trace metals by adsorbed natural organic matter.
  - Hydrochemical studies of a landfill in Delaware.
  - Ground-water contamination and aquifer reclamation at Rocky Mountain Arsenal, Colorado.
- Completed evaluation of methods to—
  - Sample volatile organics in ground water.
  - Use geophysical methods to characterize plumes of contaminated ground water.



U.S. Geological Survey exhibit panel W-265-85.

HAZARDOUS SUBSTANCES IN SURFACE WATER AND SEDIMENT



TOXIC SUBSTANCES HYDROLOGY STUDIES

National Water-Quality Assessment Program

The protection of water quality is a high-priority concern that is addressed at all levels of government by legislation, regulation, and remedial actions. The costs of protecting water quality are borne by business, industry, agriculture, and consumers, as well as Federal, State, and local governments.

Federal water-quality protection programs such as the cleanup of toxic-waste sites and the construction and enhancement of sewage treatment plants are often costly and complex. To appraise the effectiveness of these programs, Federal policymakers rely on reports of localized conditions which may be inadequate for accurate evaluation. They need answers to basic questions: What are the nature, extent, and seriousness of water-quality problems? Is the overall quality of the Nation's water getting better or worse? Will proposed solutions be effective in improving water quality? State and local policymakers also need better information to improve the basis for their decisions on water-quality protection.

In recognition of these needs, Federal funds were made available to the U.S. Geological Survey in 1986 to plan a national water-quality assessment program. As of mid-1986 the Geological Survey had developed a preliminary plan for the National Water-Quality Assessment (NAWQA) Program—a blueprint for the first ongoing and comprehensive quality appraisal of the Nation's surface-water and ground-water resources.

Purpose:

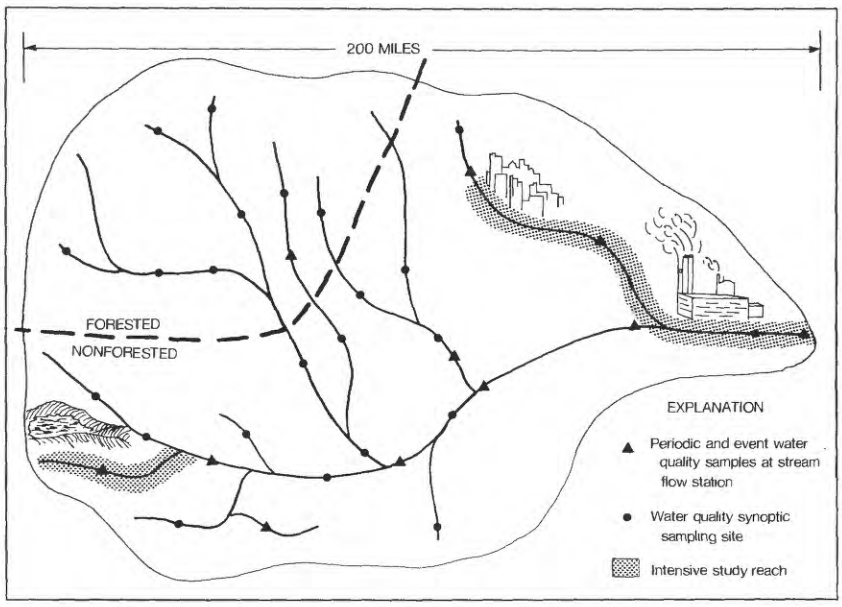
- Define the quality of the Nation's water resources by a scientific nationwide assessment of the status, trends, and causes of water-quality conditions.
- Improve water-quality protection decisions by increasing the understanding of water pollution from chemical contamination, sedimentation, acidification, and eutrophication.

Activities:

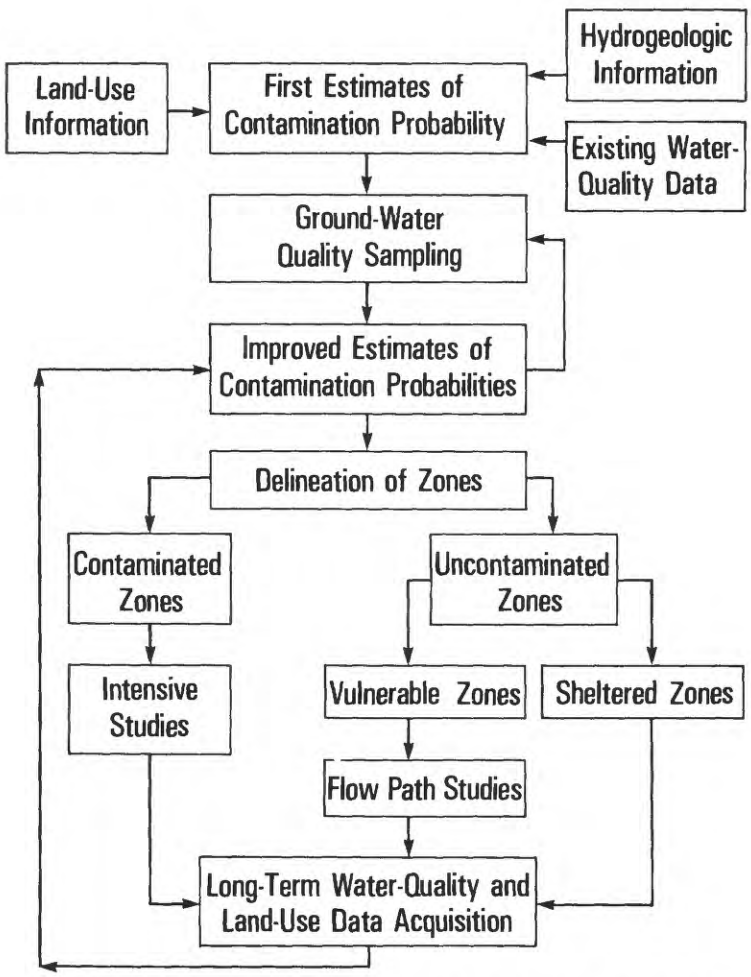
- Make preparations for the NAWQA to use existing data-acquisition programs, knowledge of study areas, and laboratory facilities. Programs of the Water Resources Division provide a solid scientific basis for national water-quality assessment, including the National Water Data Storage and Retrieval System (page 30), the National Stream-Quality Accounting and Bench-Mark networks (page 36), Toxic Substances Hydrology (page 44), Regional Aquifer-System Analysis (page 48), and the National Water-Quality Laboratory (page 58).
- Coordinate the NAWQA plan at all levels of government, to obtain interagency cooperation and participation, and to assure that the assessment meets the informational needs of other Federal, State, and local agencies.

Accomplishments:

- Started seven pilot NAWQA studies—three ground-water and four surface-water projects—for areas that range in size from 2,500 to 60,000 square miles. They represent agricultural to urban land uses and very wet to very dry climates.
- Established a liaison committee for each NAWQA pilot study, to ensure the effective flow of information and comment between the Geological Survey and other interested scientists, water-management personnel, and the public.
- Developed plan for a national water-quality assessment by which the Division would—
  - Conduct systematic interpretive studies of ground water and surface water, organized into hydrologic "study units" (aquifers or river basins) several thousand square miles in size. The study units—about 90 river basins and 50 to 90 aquifers—will be widely distributed around the country, represent most of the Nation's water use, and include major centers of population.
  - Study surface water by employing fixed-station sampling; by conducting periodic, wide-area surveys of water, sediment, and biota; and by performing intensive surveys of problem areas.
  - Study ground water by determining zones of probable contamination within a study unit, based on hydrogeology, soils, and land-use information. Conduct intensive studies in zones of probable contamination, and in zones vulnerable to contamination. After the initial characterization is completed, conduct long-term low-frequency sampling of wells and springs.
  - Conduct cause-and-effect investigations of selected problem areas to evaluate the effects of various proposed remedies for specific problems.



HYPOTHETICAL NAWQA SURFACE-WATER STUDY UNIT



NAWQA GROUND-WATER STUDY CYCLE

Regional Aquifer-System Analysis Program

The Regional Aquifer-System Analysis (RASA) Program is a systematic effort to study a number of regional ground-water systems that represent a significant part of the Nation's water supply. A regional aquifer system, as the term is used here, may be of two general types: (1) aquifers that are of regional extent, such as those underlying the Great Plains and the Atlantic Coastal Plain; and (2) groups of aquifers that share so many characteristics that investigation of a few of these aquifers can establish common principles and hydrologic factors controlling the occurrence, movement, and quality of ground water throughout similar aquifer systems.

Purpose:

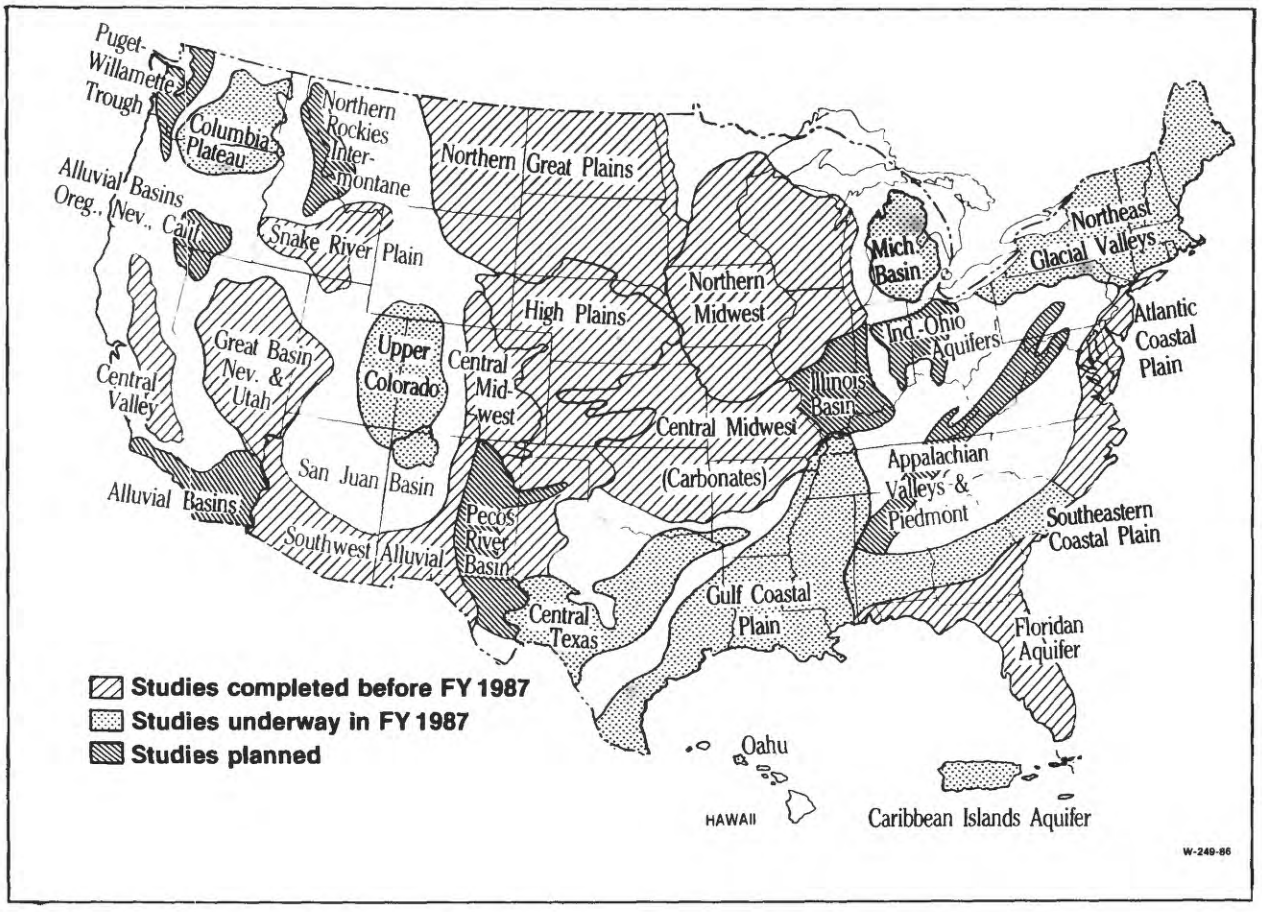
- Provide the basic information and knowledge needed to manage ground-water development from a regional perspective.

Activities:

- Determine availability and chemical quality of water stored in and being transmitted through each aquifer system.
- Evaluate discharge-recharge characteristics of each aquifer system.
- Evaluate geologic, hydrologic, and chemical controls that govern the responses of the aquifer systems to stresses.
- Develop computer-based flow-simulation models to assist in understanding the aquifer systems and their response to such human activities as pumping or irrigation.

Accomplishments:

- Completed initial RASA investigations of 7 of the 28 regional aquifer systems designated for possible study. Identified major problems which will lead to followup studies in 6 of the 7 completed studies. Continued initial investigations of 12 other designated aquifer systems, and scheduled the start of 1 new RASA study in fiscal year 1986.
- Mapped the volume of ground water removed from the High Plains aquifer by pumping for irrigation. Used flow models to test strategies of reducing water-level declines in the High Plains aquifer system due to future increases in pumpage.
- Determined that additional development of the Floridan aquifer is feasible, if there is careful management to reduce the risk of contamination by saline water.
- Developed flow-simulation models for each RASA study, to understand the ground-water flow system, and to confirm whether the geohydrologic framework and assigned values of the hydrologic parameters of the system are reasonable and close to field-observed conditions.
- Incorporated geochemical data with geohydrologic information and modeling results to interpret the ground-water flow systems.
- Used flow simulation models to evaluate development plans and their impacts on the aquifer systems.
- Published more than 300 reports describing scientific findings and results of the RASA studies. About 75 additional reports were in preparation early in 1986.
- Developed information that has been used by government agencies and the private sector. For example:
    - U.S. Department of Commerce used the High Plains RASA information in evaluating impacts of water-level declines due to irrigation development.
    - Department of Water Resources of Idaho mapped irrigated crop areas by incorporating the Snake River Plain RASA study and the use of Landsat imagery.
    - Corps of Engineers used the West-Central Florida flow model from the Floridan aquifer study to evaluate ground-water resources.
    - Kansas Corporation Commission obtained water-quality information from the Central Midwest RASA study, for the purpose of developing legislation to require suitable well casings in protecting aquifers.
    - Department of Natural Resources and Community Development of North Carolina used information on salty ground water, part of the northern Atlantic Coastal Plain RASA study, to guide preparation of the State's ground-water protection strategy.
    - Applied Physics Laboratory of Johns Hopkins University, in evaluating the use of ground water for low-temperature geothermal energy in the northern Atlantic Coastal Plain, used information on ground-water quality and aquifer properties gathered during the RASA study of the northern Atlantic Coastal Plain.



REGIONAL AQUIFER-SYSTEM ANALYSIS PROGRAM

Acid Rain Program

The acidity of precipitation in its various forms—rain, snow, fog, dew—and of particles and gases deposited in dry form on plants and other surfaces is thought to have caused acidification of certain streams and lakes in the Northeastern United States and Eastern Canada over the last 30 years. Damage to some species of trees and to structural materials is also suspected. The U.S. Geological Survey has conducted a number of investigations of the chemistry of precipitation during the past 25 years as part of the Federal-State Cooperative Program. In 1982, as part of an interagency investigation into the acid-rain phenomenon, the Geological Survey began an itensified program to collect and interpret data to help formulate national policy decisions regarding the control or abatement of acid rain.

Purpose:

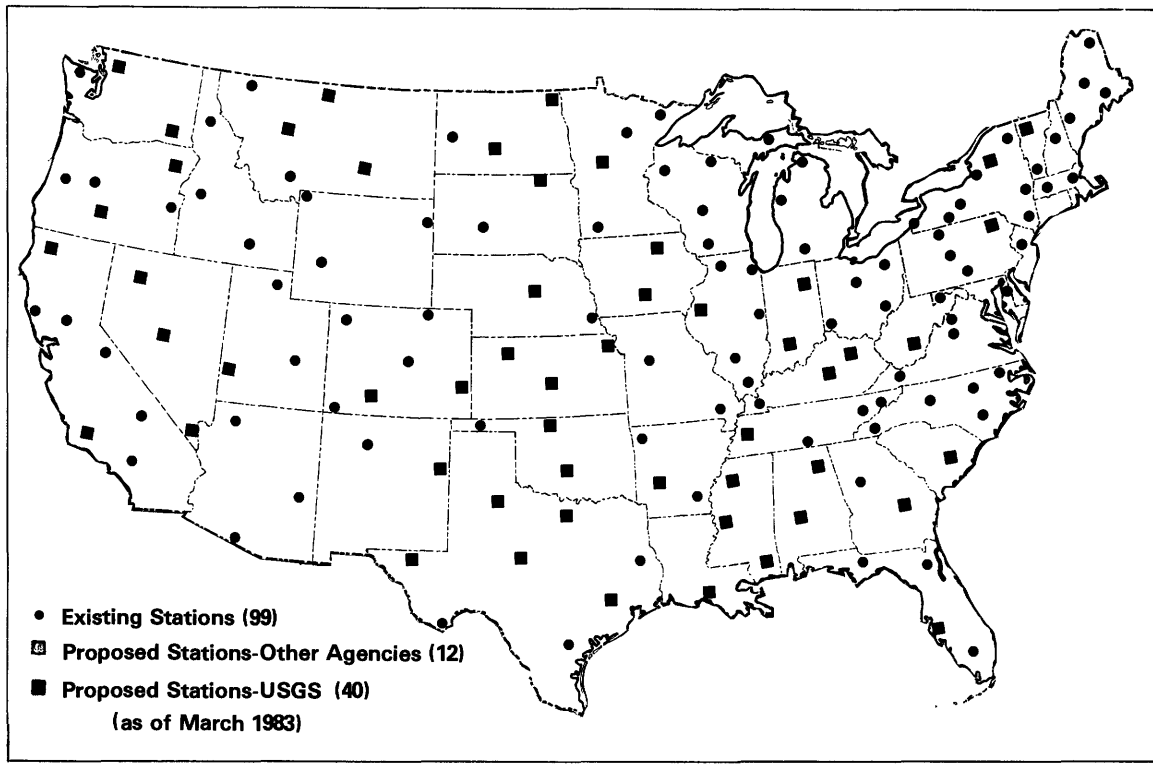
- Measure the amount, character, and variability of atmospheric deposition throughout the Nation.
- Determine the susceptibility of lakes and streams to acidification, and monitor susceptible areas for long-term changes which may result from acid deposition.
- Define the geochemical processes by which acid deposition affects water resources, soils, near-surface rocks, and building stones.

Activities:

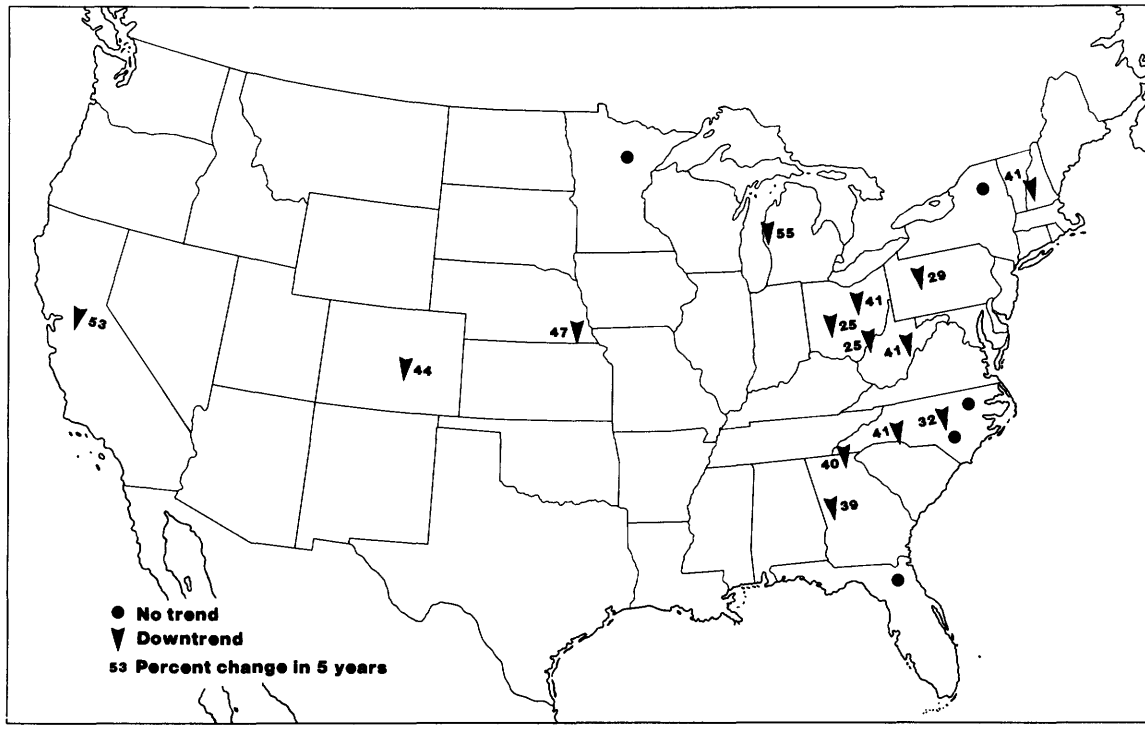
- Serve as lead agency for atmospheric deposition monitoring in the Interagency National Acid Precipitation Assessment Program. Also serve as a member of the Task Groups on Aquatic Effects, Terrestrial Effects, and Effects on Materials.
- Operate or provide funding for about 50 sites in the wet-deposition component of the National Trends Network of 150 stations. See NTN map on facing page.
- Monitor 17 sites for long-term changes in water quality in areas identified by the Aquatic Effects Task Group as being sensitive to the effects of acid rain.
- Conduct research on geochemical processes by which acid deposition affects the quality of streams, lakes, and ground water.
- Conduct pilot-scale monitoring of trace metals (for example, lead, mercury, and cadmium) in wet deposition at National Trends Network sites.
- Conduct a research program on the effects of acid deposition on building stones.

Accomplishments:

- Completed a cooperative effort to design and implement a National Trends Network for monitoring the chemistry of atmospheric precipitation.
- Completed an analysis of data from 19 weekly precipitation-monitoring stations in the National Trends Network with 5 or more years of record which revealed a number of statistically significant trends in sulfate. See map on facing page.
- Expanded a laboratory quality-assurance program for the Geological Survey and other Federal and non-Federal agencies involved in monitoring acid deposition in North America.



NATIONAL TRENDS NETWORK TO MONITOR ACID PRECIPITATION



TRENDS IN SULFATE CONTENT OF PRECIPITATION, 1978–1983

Volcano-Hazards Program

The Water Resources Division assesses hydrologic hazards at potentially active volcanoes, provides hydrologic monitoring at active volcanoes, and conducts related hydrologic research. Under the Disaster Relief Act of 1974, the U.S. Geological Survey is responsible for providing timely warnings of volcanic eruptions and related activity. The ultimate goal of the Volcano-Hazards Program is to reduce the loss of life, property, and natural resources that can result from volcanic eruptions.

Purpose:

- Assess, by detailed studies of previously active volcanoes, the areal extent of possible hazardous floods and mudflows and their impact on population centers.
- Provide early warning of hazardous floods and mudflows that can be generated from an eruption or events following eruption.
- Research the impacts of volcanic eruptions on rivers and lakes to aid in the planning of effective mitigation.

Activities:

- Conduct geomorphic studies of the debris-avalanche and mudflow deposits caused by the eruption of Mount St. Helens volcano, to assess the downstream effects of persistent erosion and channel filling.
- Maintain a flood-hazard and mudflow-warning system for the Toutle-Cowlitz Rivers which carry runoff from Mount St. Helens, using satellite and radiotelemetry units to transmit real-time data to State and local emergency centers.
- Develop sediment transport models to improve the capability for routing floods and mudflows, and for predicting areas of probable inundation in the Toutle, Cowlitz, and Columbia River Valleys in the State of Washington.
- Conduct hydrologic hazards assessments at other Cascades Volcanoes including Mt. Shasta and Lassen Peak in California; Mt. Hood and Three Sisters Volcanoes in Oregon; and Mt. Baker and Mt. Rainier in Washington.
- Continue hydrologic monitoring and modeling at Long Valley caldera in California.

Accomplishments:

- Installed and maintain a flood-hazard and mudflow-warning system in the Mount St. Helens area to monitor possible outbreaks from the debris-dammed lakes.
- Installed and maintain a comprehensive ground-water and surface-water monitoring network in the Long Valley caldera in California.
- Published reports describing the hydrologic effects of the Mount St. Helens eruption and subsequent events.
- Completed hydrologic assessments of Mt. Hood and Mt. Shasta.
- Completed a report documenting glacier-ice volumes for Mt. Shasta, Mt. Rainier, Mt. Hood, and Three Sisters volcanoes.

U.S. GEOLOGICAL SURVEY PUBLICATIONS ON THE HYDROLOGIC EFFECTS OF THE MOUNT ST. HELENS ERUPTION

National Water Summary Program

Federal and State agencies often are required to make assessment of the Nation's water resources to aid in formulating major water-policy decisions that involve river-basin development, water conservation, water allocation, and environmental protection. Although much information has been collected on the water resources of the United States, little has been done to organize the data in a way that aids analysis of current water issues.

To help improve understanding of the nature, geographic distribution, magnitude, and trends of the Nation's water resources and water issues, the U.S. Geological Survey established the National Water Summary Program in 1981.

Purpose:

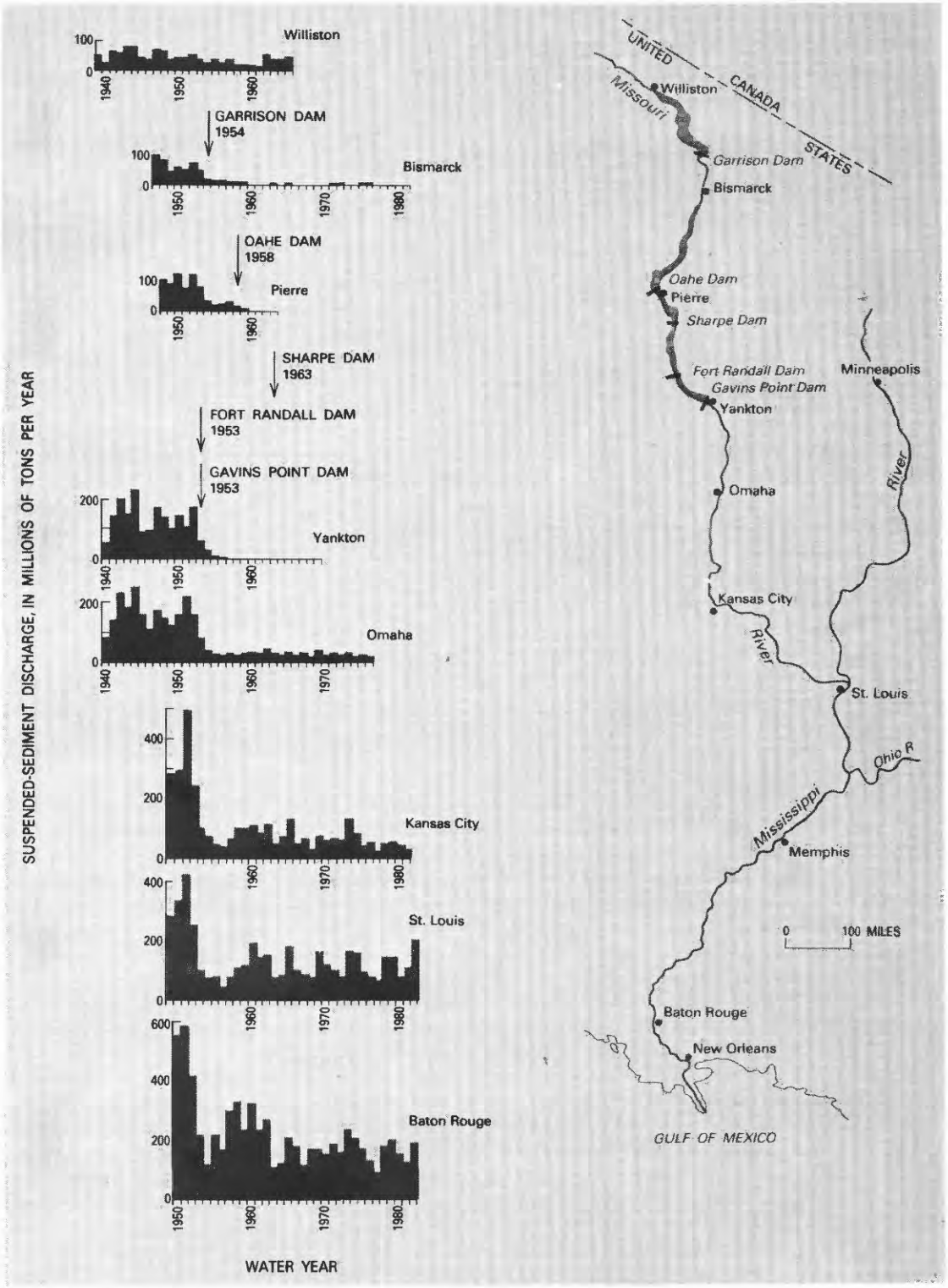
- Provide water-resources policymakers with information about the availability, quantity, quality, and use of water resources, and organize and summarize this information to portray the condition of the Nation's water resources to national, State, and local officials, and the public.

Activities:

- Develop and maintain an interpretive water-resources information system to support the identification of water issues, the characterization of current water conditions, and the water-resources assessment activities of other agencies.
- Maintain an inventory of water issues.
- Prepare an annual report on National water-resources conditions, water issues, and the nature and occurrence of water resources.
- Prepare special thematic publications such as a map showing the location of the Nation's dams and reservoirs.
- Conduct research to improve techniques for summarizing water-resources conditions.

Accomplishments:

- Published a map of the United States at a scale of 1:3,168,000 showing the location of 2,800 large (greater than 5,000 acre-feet of storage) State and Federal dams, hydropower sites, navigation channels, wild and scenic rivers, and aqueducts.
- Published an inventory of interbasin transfers between water-resources subregions, 1963-82.
- Released a report that estimates the discharge to the Nation's surface waters of 17 pollutants from more than 80,000 industrial, municipal, urban, and agricultural sources.
- Compiled data and prepared graphics on the outflow from the 21 water resources regions.
- Published "National Water Summary 1983—Hydrologic Events and Issues," which includes a State-by-State overview of major water-related issues, a perspective on national water issues, and a list of significant hydrologic events (U.S. Geological Survey Water Supply Paper 2250).
- Published "National Water Summary 1984—Hydrologic Events, Selected Water-Quality Trends, and Ground-Water Resources," which discusses the occurrence, availability, and use of ground-water resources in each State, trends in several surface water-quality constituents of ground water, and significant hydrologic and water-related events (U.S. Geological Survey Water-Supply Paper 2275).
- Published "National Water Summary 1985—Hydrologic Events and Surface-Water Resources," which summarizes the distribution, characteristics, uses, and management of surface-water resources for each of the States (U.S. Geological Survey Water-Supply Paper 2300).



EFFECTS OF RESERVOIRS ON DOWNSTREAM SEDIMENT LOADS AT STATIONS ON THE MISSISSIPPI AND THE MISSOURI RIVERS

The illustration first appeared in National Water Summary 1984, for which it was specially compiled by R. H. Meade from U.S. Army Corps of Engineers and U.S. Geological Survey data.

Instrumentation Program

The Instrumentation Program was devised to assist investigations throughout the Division that require specialized hydrologic instrumentation, and to increase the Division's ability to collect hydrologic data. The Hydrologic Instrumentation Facility at Bay St. Louis, Mississippi, and the Satellite Data Relay Project at Reston, Virginia, are major contributors to this program.

Purpose:

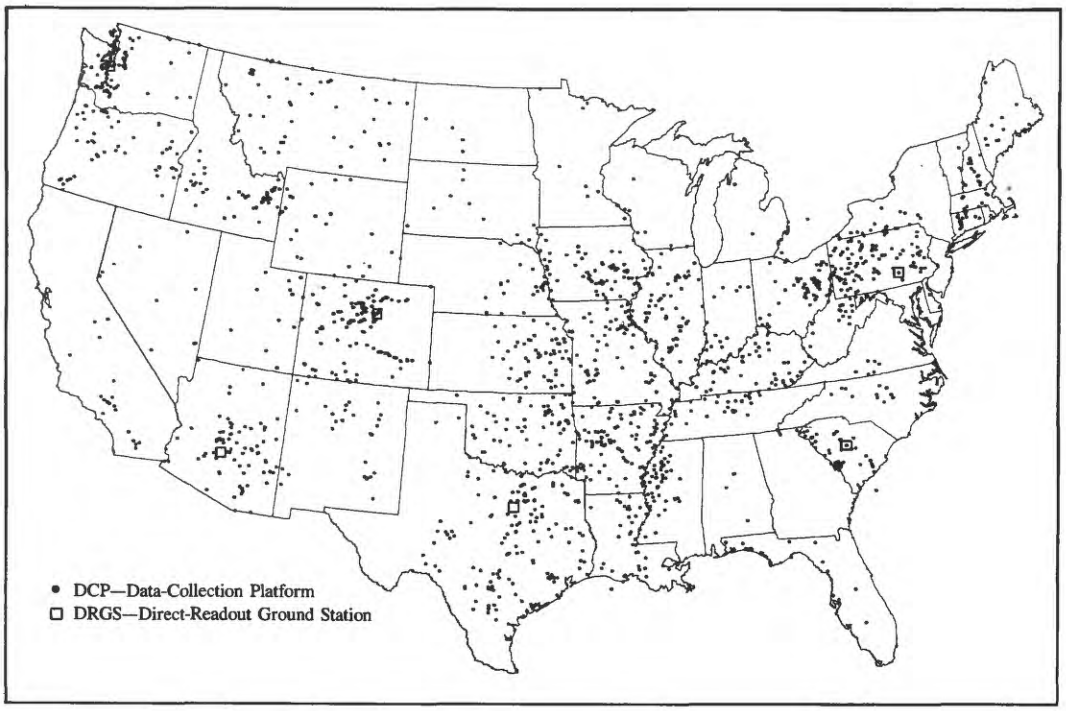
- Increase the Division's capability to provide hydrologic data by improving the technology and instrumentation used in the collection and analysis of water-quantity and water-quality data.

Activities:

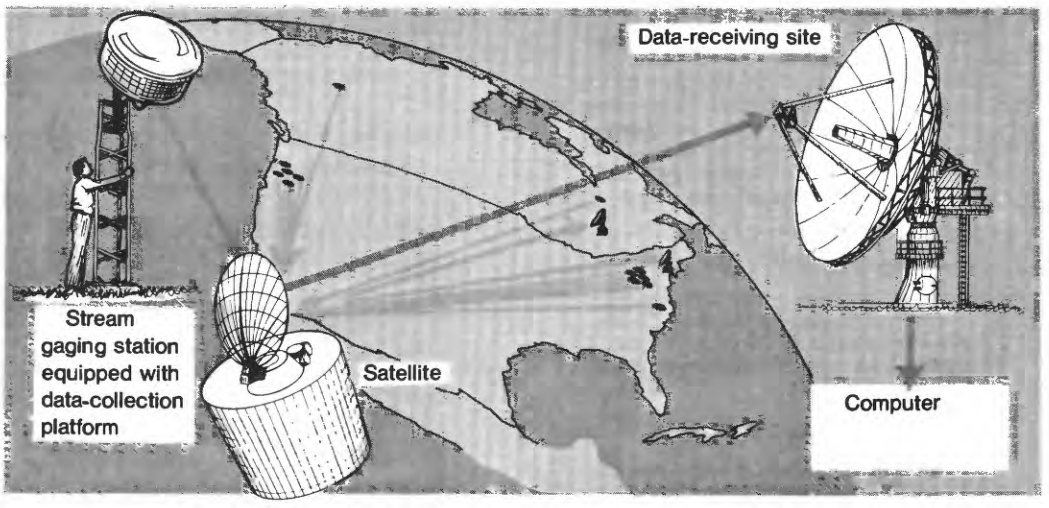
- Plan and develop hydrologic field instruments.
- Test and evaluate commercially available instrumentation.
- Supply and repair instrumentation.
- Coordinate the Geological Survey's use of the Geostationary Operational Environmental Satellite (GOES) and satellite telemetry for relay of hydrologic data.
- Assist field offices of the Water Resources Division in planning for and procuring GOES receiving stations as part of the effort to improve capabilities in data collection and processing.
- Conduct a technology exchange program in support of the Protocol on Surface Water Hydrology between the U.S. Geological Survey and the People's Republic of China.

Accomplishments:

- Established the Hydrologic Instrumentation Facility to improve the planning, development, repair, and supply of hydrologic instrumentation.
- Composed specifications and awarded a development contract for an improved and standardized field data-acquisition system known as Adaptable Hydrologic Data Acquisition System.
- Developed a Qualified Product List program to test performance of commercial water-monitoring measurement systems.
- Developed a new water-level measuring and recording system for ground-water monitoring, known as the Minimum Data Recorder.
- Increased to more than 1500 the network of Geological Survey stream-gaging stations that now operate through GOES. See illustration on facing page.
- Coordinated the procurement and the operation of six Direct-Readout Ground Stations (DRGS) to receive and process GOES telemetered hydrologic data.
- Coordinated computer software development to acquire data from the DRGS and enter data into WRD's computerized Distributed Information System, permitting the automated transfer of telemetered data in near real-time throughout the United States.



HYDROLOGIC DATA-COLLECTION STATIONS SUPPORTED BY GOES TELEMETRY AS OF NOVEMBER 1985



REAL-TIME HYDROLOGIC DATA COLLECTION BY SATELLITE

National Water-Quality Laboratory

The U.S. Geological Survey's National Water-Quality Laboratory—probably the largest of its kind—is located near Denver, Colorado. The laboratory is equipped with the most modern and sophisticated instrumentation available for performing physical and chemical analysis of water and aquatic material in support of the Geological Survey's water resources investigations. The Water Resources Division maintains the laboratory to meet the water-quality data needs of the Federal Program, the Federal-State Cooperative Program, the program of assistance to other Federal agencies, and the program of hydrologic research. The laboratory gives continuous quality assurance for analyses, and stores the results automatically in WATSTORE (see page 30).

Another large water-quality laboratory which the Division maintained near Atlanta, Georgia, merged with the Denver facility early in 1986. In 1985, the Denver and Atlanta laboratories together made 760,000 determinations on 69,000 samples.

Ion Chromatograph

Auto Analyzer

Mass Spectrometer

Computerized Auto Analyzer

CHEMICAL ANALYSTS USE SPECIALIZED EQUIPMENT AT THE NATIONAL WATER-QUALITY LABORATORY

National Training Center

The U.S. Geological Survey's National Training Center was established in 1977 at the Denver Federal Center, Lakewood, Colorado. The center is used by the entire Geological Survey to transfer earth-science information to its personnel and to update their skills. Training also is provided to personnel from other Federal, State, and local agencies, and to foreign scientists and water managers. The Center is an expansion of the former Water Resources Division Training Center. The Division continues to administer the facility for the Geological Survey.

The training center has classrooms, video-tape and closed-circuit television systems, and computer and laboratory equipment. Special methods and techniques are taught to aid in developing the expertise required to understand and efficiently conduct hydrologic investigations.

TRAINING HYDROLOGISTS

Water Resources Division Publications

The Water Resources Division of the U.S. Geological Survey is the Nation's lead agency in the collection of water data and the dissemination of information on water resources. The Division makes water data and information readily and equally available to water managers, policymakers, the scientific community, and the public in formats that meet their needs.

The Geological Survey has published the results of its studies for more than 100 years. The information is multipurpose and, after its initial use, becomes a basis for future resource evaluation and water-management decisions. The Water Resources Division releases its information through several publication series, explained below, and through computerized systems, accessible through NAWDEX (see page 26) and WATSTORE (see page 30).

A description of these publications series and the types of information presented in them is given below. Examples of these series and the number of reports released during 1975–86 are shown on the facing page.

Water-Supply Paper—Significant interpretive results of hydrologic investigations that are considered to be of broad interest.

Professional Paper—Comprehensive or topical reports on any earth-science subject of interest to multi-discipline scientific audiences.

Bulletin—Significant interpretive results of earth-science investigations of broad interest, including computer applications.

Circular—Summaries of topical investigations or programs that are of short-term or local interest.

Map series, such as Hydrologic Investigations Atlas—Significant results of hydrologic investigations presented in map format.

Techniques of Water-Resources Investigations Report—Reports on methods and techniques used in collecting, analyzing, and processing hydrologic data for technically oriented audiences.

Geological Survey Yearbook—Significant activities of the Water Resources Division that are summarized each year for general audiences.

Water Resources Investigations Report—Comprehensive or topical interpretive reports, and maps mainly of local or short-term interest, for interdisciplinary audiences.

Open-file book and map reports—Compilations of data and preliminary interpretive reports of limited interest, or reports awaiting formal publication that require interim release.

Water-Data Report—Water-year data on streamflow, ground-water levels, and quality of surface and ground water for each State, Puerto Rico, Virgin Islands, and the Trust Territories.

National Water Conditions—A monthly news release that summarizes the national water situation for water-resources-oriented audiences.

With the exception of the "National Water Conditions," which is a form of news release, all the above publication series are listed in two catalogs—"Publications of the Geological Survey, 1879–1961," and "Publications of the Geological Survey, 1962–70"—and in yearly supplements to these catalogs for 1971 through 1986.

As new publications are released, they are announced in a monthly list, "New Publications of the Geological Survey." Information for ordering publications of the Water Resources Division is provided on the facing page in the back of this Circular.

Many items of scientific interest are published in technical and scientific journals to make the information readily available to those in related fields of study. Other reports of local interest are published by cooperating State agencies and made available within the State.

Number of Water Resources Division Reports Approved for Release or Publication by the Water Resources Division

Type of Report	Number of approved reports											
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Water Supply Paper.....	25	18	17	7	13	32	28	13	30	22	22	22
Professional Paper.....	20	13	13	24	9	9	13	12	16	13	14	12
Bulletin.....	0	0	0	1	1	1	0	1	1	3	1	2
Circular.....	2	10	6	6	4	8	12	3	10	1	5	4
Techniques of Water Resources Investigations.....	1	4	0	4	0	2	3	3	3	2	1	2
Map Series.....	43	34	21	30	29	35	13	13	20	18	21	20
Water Resources Investigations Reports.....	61	134	136	144	151	222	200	222	283	398	344	270
Open-file book and map reports.....	113	107	68	180	153	295	265	275	192	220	208	158
Water Resources Annual Data Reports.....	78	68	65	71	72	81	78	76	74	64	77	64
Journal of Research articles[1]...	27	28	19	13	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Administrative releases.....	0	26	23	12	12	16	2	10	4	5	4	7
Outside publications (includes State publications, journal articles, abstracts, and other related items).....	597	621	648	700	444	501	495	599	582	702	858	835
Flood-prone area mapping project:												
Maps[2].....	1,210	451	171	103	285	222	129	173	. . .	. . .	. . .	. . .
Pamphlet[3].....	330	57	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Total (exclusive of flood-prone maps and pamphlets).....	967	1,063	1,016	1,192	888	1,202	1,109	1,227	1,215	1,448	1,555	1,396

[1]The journal was discontinued in 1979.
[2]The flood-prone area mapping project was completed in 1982.
[3]Completed in 1976.

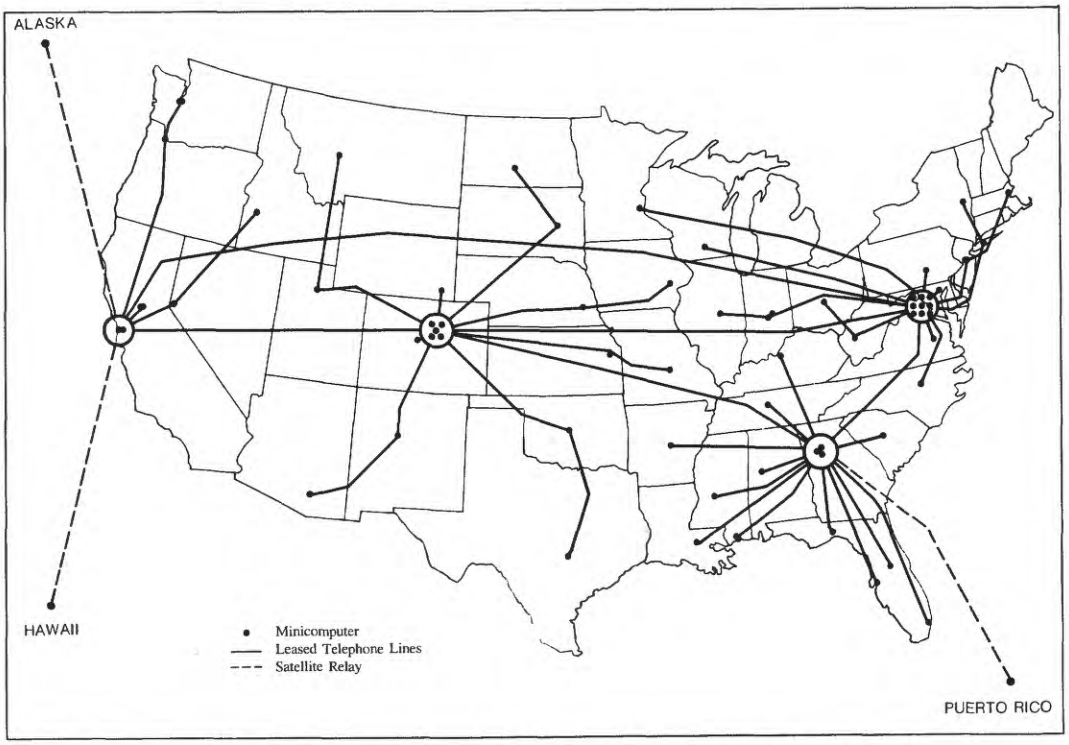
PUBLICATIONS OF THE WATER RESOURCES DIVISION

Distributed Information System

The Water Resources Division uses computers extensively to collect and manage large amounts of information needed to carry out its mission. Until 1982, the Division relied on large mainframe computers to collect, store, retrieve, and process hydrologic data. During 1982–85, the Division changed from centralized mainframe computing to a decentralized system. The Division installed more than 70 large minicomputers in its offices across the country, and connected them through a network of leased telephone lines and earth-orbiting satellites. Together, the minicomputers and the telecommunications network form the Distributed Information System (DIS).

The minicomputers are accessed from more than 1,500 terminals and microcomputers. For each terminal and microcomputer, the DIS provides computational capability to collect, store, retrieve, and process data; to perform complex computational tasks such as numerical modeling and statistical analyses; and to conduct various management programs. The DIS is used for these fundamental needs as follows.

- Data Management accounts for 50 percent of the computer workload. Activities include the collection and storage in computerized data bases of measurements of streamflow from about 11,000 stations, water levels in 39,000 wells, and water quality at 14,000 locations.
- Hydrologic analysis makes up another 40 percent of the computer workload. Large amounts of computational power are required for such tasks as data entry, statistical analysis, graphic analysis, and the simulation of hydrologic conditions to predict the movement of water and contaminants in ground and surface water.
- Administrative analysis uses 10 percent of the workload for business functions such as cost accounting, payroll management, and planning for Division programs.



DISTRIBUTED INFORMATION SYSTEM

Summary and Accomplishments

Effective management of water resources requires that up-to-date scientific hydrologic information be readily available to planners and managers. The U.S. Geological Survey has the principal responsibility within the Federal government for providing hydrologic data and appraising water resources to help evaluate water problems. The mission of the Geological Survey is to present impartial accurate data and scientific analysis, and to release the information to all parties on equal terms.

The Water Resources Division of the Geological Survey provides technical support to the missions of other Federal agencies, participates in joint-funding agreements with State and local agencies, and contributes significantly to cooperative efforts in hydrology. In this way, the Division keeps abreast of water-information needs at all levels of government and is able to develop programs that are responsive to these needs.

The Division's programs are funded by: (1) direct appropriation by Congress for Federal programs, (2) direct congressional appropriations for the Division's matching share of the Federal-State Cooperative Program, and the State Water Resources Research Institutes and National Water Resources Research Grants Programs, (3) reimbursement by other Federal agencies, and (4) miscellaneous unmatched reimbursable funds from State and local agencies.

The total enacted funds of the Water Resources Division in fiscal year 1986 amounted to about $256.3 million—a small percentage of the total funds spent by the Federal government on water-resources programs. Among the factors assuring success of the Division mission are:

- An impartial scientific approach to describing hydrologic problems and collecting, analyzing, and interpreting hydrologic data.
- A strong field organization and staff of skilled scientists.
- Cooperative programs with more than 900 State and local agencies.
- Capabilities for conducting scientific research on critical water-resources problems.
- Continuous modification of programs as required by changing water-related problems and data needs.
- Simultaneous release of findings to all interested parties.
- Credibility within the water-resources community.

The programs of the Water Resources Division are of three types: data collection and dissemination, problem-oriented water-resources appraisals, and research. In this report, the programs are classified as long-term programs, topical programs, and technical-assistance programs. Following is a selected list of accomplishments of these programs and information-dissemination activities. More information on the Division's programs and accomplishments can be obtained by referring to the reports given in "Selected References," or by contacting the appropriate key personnel listed later in this report.

Long-Term Programs

- The Federal-State Cooperative Program in 1985 evaluated water quality in numerous streams and aquifers, and assessed existing and potential impacts of contamination from toxic wastes. The Division began working cooperatively with States and localities in 1895 to resolve water-resources problems.
- The Office of Water Data Coordination worked with more than 25 U.S. agencies in the coordination of all Federal water-data acquisition activities—an activitiy for which it has been responsible since 1964.
- The National Water-Data Exchange (NAWDEX), developed as the focal point for indexing and nationwide access to a diversified water data base, reduced time, effort, and expense to its users.
- The Water Resources Scientific Information Center for the 20th year published abstracts of the world's significant water-resources literature, and expanded to 175,000 the number of abstracts in its computerized bibliographic information base.
- The National Water-Data Storage and Retrieval System (WATSTORE) was expanded and automated to improve direct user access, via NAWDEX, to its data files. It is the largest hydrologic-data system in the world, providing more than half of the Nation's water-data and information base.
- The Hydrologic Data Collection Program regularly recorded surface-water and ground-water data at about 50,000 data-collection sites located at streams, lakes and reservoirs, and water wells.
- The National Water-Use Information Program, a cooperative State and Federal program, in 1986 operated in 49 States and Puerto Rico. Research continued on methods and instumentation for acquiring water-use data. The National Water-Use Data System (NWUDS) was developed as a computerized system to store aggregated data about the amount of withdrawal, return flow, and use of water. Similar State Water-Use Data Systems were installed in 35 States. The report "Estimated Use of Water in the United States in 1980," Circular 1001, was published.
- In providing assistance to other Federal agencies, the Division published the first authoritative reports establishing the concentrations of selenium and other trace elements in the western San Joaquin Valley of California.
- For the Bureau of Land Management, the Bureau of Mines, and the Office of Surface Mining, the Division prepared and published reports describing the hydrology of eastern and western coal areas.
- In hydrologic research, movement of Alaska's Columbia Glacier increased substantially in the 1980's, confirming predictions of Division scientists that the glacier would stage a major retreat. As of July 1986, large icebergs formed by the glacier were a potential threat to shipping lanes near the Alaska pipeline port of Valdez.
- Cooperative research with the National Aeronautics and Space Administration resulted in the publication of the first comprehensive data-set on Antarctic sea ice and an interpretation of its influence on world climate.
- In assistance to others, the Division provided hydrologic information that aided the Environmental Protection Agency (EPA), Corps of Engineers, States, and local agencies in the cleanup of toxic-waste disposal sites.

- Under the Hydrologic Data-Collection Program, the Division completed the National Stream-quality Accounting Network (NASQAN), to provide a national river-quality data base suitable for examining conditions and trends in river-water quality.
- The Office of Water Data Coordination published the National Handbook of Recommended Methods for Water-Data Acquisition, to improve the comparability and usability of data collected by all water-resources agencies in the United States.
- The Office of Water Data Coordination prepared and published a hydrologic unit map of the United States and hydrologic unit maps of each State.
- In assisting other Federal agencies, the Division collaborated with the Environmental Protection Agency (EPA) in the development of national ground-water protection strategy, and implemented Memorandums of Understanding with the EPA regarding related programs of the U.S. Geological Survey.
- The Division administered programs of the Water Resources Research Act of 1984, to provide grant assistance toward the operation of 54 State Water Resources Research Institutes, and to fund selected national water-resources research projects.

Topical Programs

- The Regional Aquifer-System Analysis (RASA) Program continued planned studies of regional ground-water systems that collectively account for a significant part of the Nation's water supply. These studies are designed to determine the flow patterns and chemical quality of ground water under natural conditions; the hydrologic effects of pumping, waste disposal, and other activities; and the potential for and results of further water-resources development.
- Under the RASA program, the Division mapped the volume of ground water removed from the High Plains aquifer by pumping for irrigation, and used flow models to test strategies for reducing the amount of decline in water level due to increases in pumpage.
- The Nuclear Waste Hydrology Program provided information important to the selection of Yucca Mountain, Nevada, as a principal candidate site for a high-level radioactive-waste repository.
- The Division provided technical assistance to the Nuclear Regulatory Commission in the preparation of low-level site-selection criteria for the selection of low-level radioactive-waste burial sites.
- The Division provided technical assistance to State agencies and compacts preparing to select new low-level radioactive waste sites under provisions of the Low-Level Waste Policy Act.
- The Toxic Substances Hydrology Program concluded the reconnaissance phase of 14 regional ground-water quality studies, and intensified research efforts to prevent the contamination of water by toxic wastes.
- In the National Water-Quality Assessment (NAWQA) Program, pilot studies began in 1986. Four ground-water and three surface-water projects, encompassing areas of 2,500 to 60,000 square miles in size, presented diverse conditions for testing methods applicable to a full national water-quality assessment.
- In the Acid Rain Program, the U.S. Geological Survey continued as the lead agency for monitoring atmospheric deposition in the Interagency National Acid Precipitation Assessment Program, and participated in the cooperative establishment of the National Trends Network for monitoring the chemistry of atmospheric precipitation.

- The National Water Summary Program provided assessments of the Nation's water resources in an organized and understandable way. The National Water Summary report of 1983 established the major water issues in each State; the National Water Summary report of 1984 presented details of each State's ground water problems; and the National Water Summary of 1985 provided information about surface-water resources in each State.
- In the Volcano Hazards program, Division scientists documented hydrologic events associated with the Mount St. Helens eruption, in U.S. Geological Survey Circular 850 and other publications.

Technical-Assistance Programs

- The establishment of a centralized laboratory system improved the Division's ability to analyze the physical, chemical, and biological properties of water.
- The number of sites providing real-time water data via satellite increased from 350 in 1982 to 1,600 in 1986.
- The Hydrologic Instrumentation Facility, established in 1980, provided effective and efficient planning and management of the supply, repair, and performance of hydrologic instruments. The application of new technology led to the development of improved sensors for measuring water quality.

Dissemination of Data and Information

The Water Resources Division released information through 1,555 reports in 1985. Users of such hydrologic information include:

- Legislative bodies and associated committees.
- Courts.
- Other Federal agencies.
- State, regional, and local agencies.
- Water-management, irrigation, drainage, and conservation districts.
- Public-interest groups, universities, and consultants.
- Industry and the public.

More than 70 large minicomputers at Water Resources Division offices were linked via a communications network, to form the Distributed Information System. The system improved the volume, accuracy, and timeliness of hydrologic data. It increased the computational power available to Division hydrologists for such tasks as numerical modeling and statistical analysis.

The accomplishments listed throughout this report and highlighted above reflect the the status and trends in water-resources issues and needs in the mid-1980's.

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INDEX

Abstracts, 1, 24, 28
Accomplishments, 63
Acid precipitation, 24, 36, 50
Acid Rain Program, 50–51, 65
Acidification, 46, 50
Adaptable Hydrologic Data Acquisition System, 56
Advisory Committee on Water Data for Public Use, 20
Agriculture, 32
Alaska, 25, 64
Algal blooms, 24
Antarctic sea ice, 24, 64
Appropriations, 15
Aquatic Effects Task Group, 50
Aquifers, 46, 48
Arkansas, 18
Assessments, 4, 46, 54
Assistance centers, 26
Assistance to other Federal agencies, 22–23
Atlanta, Georgia, 58
Atlantic Coastal Plain, 48
Basin and Range physiographic province, 40
Bay St. Louis, Mississippi, 56
Bench-Mark Network, *SEE* National Hydrologic Bench-Mark Network
Bibliographic information services, 28
Brunswick, Georgia, 18
Budget, 12–15, 63
Bureau of Land Management, 22, 64
Bureau of Mines, 22, 64
Bureau of Reclamation, 22
Cadmium, 44, 50
California, 44
Cascade Range volcanoes, 24
Chief Hydrologist, 5, 8
Coal hydrology, 18, 22
Colorado, 44
Columbia Glacier, 24, 25, 64
Columbia River valleys, 52
Communications network, 62, 66
Compact, 34, 42
Computers, 62, 66
Connecticut, 44
Conservation, 54
Contaminants, 44, 46
Cooperating agencies, 18
Coordination of Federal Water-Data Acquisition, 2, 4, 20
Corps of Engineers, 22, 48, 64
Court decree, 34
Creosote, 44
Crystalline rocks, 40
Data, *SEE* Hydrologic Data
DCP, *SEE* Data-Collection Platforms
Debris avalanche, 52
Delaware, 44
Denver, Colorado, 58
Department of Agriculture, 22
Department of Commerce, 48
Department of Defense, 22
Department of Energy, 22, 40, 42
Department of State, 4
Department of the Interior, 6, 22
DIALOG Information Services, Inc., 28
Direct-Readout Ground Stations, 56
Disaster Relief Act of 1974, 52
Dissemination of Data and Information, 4, 60–61, 66
Distributed Information System, 56, 62, 66
District offices, 5, 71–77
DOE, *SEE* Department of Energy
DRGS, *SEE* Direct-Readout Ground Stations
Earth science, 59
Ecology, 24, 44
Edwards Limestone aquifer, Texas, 18
Effects of Materials Task Group, 50
Environment, 40, 42
Environmental impact statements, 36
Environmental protection, 54
Environmental Protection Agency, 22, 42, 64
EPA, *SEE* Environmental Protection Agency
Erosion, 44
Estuaries, 24
Eutrophication, 46
Federal Emergency Management Agency, 22
Federal Energy Regulatory Commission, 4, 12
Federal Program, 12
Federal-State Cooperative Program, 2, 12, 18–19, 32, 34, 50, 64
Flaming Gorge Reservoir, Utah, 24
Florida, 44, 48
Floridan aquifer, 48
Fractured rock, 18, 24, 42
Fuels, 40
Garrison Diversion project, 22
Gas transport, 42
Gasoline, 44
Geochemistry, 24, 44
Geological Survey Yearbook, 60
Geomorphology, 24
Geostationary Operational Environmental Satellite, 56
Geothermal energy, 48
Glacier ice, 52
GOES, *SEE* Geostationary Operational Environmental Satellite
Grants, 4, 38
Gravel zones, 24
Great Lakes, 36
Great Plains, 48
Green River, 24
Ground water:
- Contamination, 34, 44, 46, 48
- Data, 30, 34, 46, 48
- Flow models, 24, 48
- Levels, 34
- Monitoring, 44, 52, 56
- Movement, 40, 42, 48
- Protection strategy, 22, 65
- Quality, 34, 44, 46, 48
- Resources, 46, 54
- Studies, 44–47
- Study units, 46–47
- Systems, 44, 48
- Use, 32–33

Hazardous substances, 24, 45
High Plains aquifer, 48, 65
Human activity, 24, 34, 36, 48
Hydrologic Data:
- Collection Program, 4, 30, 34–37, 56, 64
- Dissemination, 4, 60–61, 66
- Federal acquisition, 2, 4, 20–21
- Ground water, 30, 34, 46, 48
- Management, 46, 62

INDEX—Continued

Hydrologic Data:—Continued
Master index, 26
Platforms, 30, 56
Real-time, 24, 52, 56–57, 66
Surface-water, 30, 34, 36, 46
Water use, 32, 64
Hydrologic Instrumentation Facility, 56, 66
Icebergs, 25, 64
Idaho, 42, 48
Illinois, 42
Information dissemination, 60
Instrumentation, 56–57, 58
Interagency Advisory Committee on Water Data, 20
Interbasin transfers, 54
Investigations, hydrologic, 4, 18, 22, 24, 42, 44, 48, 59
Johns Hopkins University, 48
Kansas, 44, 48
Kentucky, 42
Kesterson National Wildlife Refuge, 22
Laboratory facilities, 46, 58
Lakes and estuaries, 24
Landsat imagery, 48
Lassen Peak, California, 52
Lead, 44, 50
Long Valley Caldera, California, 52
Louisiana, 44
Low-Level Waste Policy Act of 1980, 42, 65
Master Water-Data Index, 26
Memorandum of Understanding, 22, 65
Mercury, 44, 50
Metals, 24, 44, 50
Military bases, 22
Minimum Data Recorder, 56
Mississippi, 44
Models, flow simulation, 48
Monitoring, 36, 52, 56
MOU, *SEE* Memorandum of Understanding
Mount St. Helens, Washington, 24, 52
Mt. Baker, Washington, 52
Mt. Hood, Oregon, 52
Mt. Rainier, Washington, 52
Mt. Shasta, California, 52
Mudflows, 24, 52
NASA, *SEE* National Aeronautics and Space Administration
NASQAN, *SEE* National Stream-Quality Accounting Network
National Aeronautics and Space Adminstration, 24, 64
National Engineering Laboratory, 42
National Environmental Policy Act of 1969, 8, 22
National Handbook of Recommended Methods for Water Data Acquisition, 20, 64
National Hydrologic Bench-Mark Program, 34, 36–37, 46
National Monuments, 22
National Park Service, 22
National Stream-Quality Accounting Network, 34, 36–37, 46, 65
National Training Center, 59
National Trends Network, 50, 51, 65
National Water Conditions, 60
National Water-Data Exchange, 26–27, 30, 36, 64
National Water-Data Storage and Retrieval System, 30–31, 36, 46, 64
National Water-Quality Assessment Program, 46–47, 65
National Water-Quality Laboratory, 46, 58
National Water Resources Research Grants, 12, 38
National Water Summary Program, 54–55, 66
National Water-Use Data System, 32, 64
National Water-Use Information Program, 32–33, 64
NAWDEX, *SEE* National Water-Data Exchange
NAWQA, *SEE* National Water-Quality Assessment
Nebraska, 44
NEPA, *SEE* National Environmental Policy Act of 1969
Nevada, 40, 42
New Jersey, 44
New Mexico, 40, 44
New York, 42, 44
North Carolina, 44, 48
North Dakota, 22
NRC, *SEE* Nuclear Regulatory Commission
NTN, *SEE* National Trends Network
Nuclear Regulatory Commission, 22, 42, 65
Nuclear Waste Hydrology, 40–44
Nuclear Waste Policy Act of 1982, 40
Office of Management and Budget Circular A-67, 4, 20
Office of Surface Mining, 22, 64
Office of Water Data Coordination, 26
Office of Water Research and Technology, 28
Other Federal agencies, 2, 4, 12, 22, 34, 46, 64
Pennsylvania, 44
Pentachlorophenol, 44
People's Republic of China, 56
Petroleum products, 44
Programs, 16
Publications, 60–61
Pumping, 48
Quality of water, *SEE* Water quality
Radiotelemetry, 24, 52
Radioactive wastes, 40–43
Radiochemical surveillance network, 36
Radionuclides, 24, 40, 42
RASA, *SEE* Regional Aquifer-System Analysis Program
RASA studies, 48
Real-time water data, 24, 52, 56–57, 66
Recharge, 48
Regional Aquifer-System Analysis Program, 46, 48–49, 65
Research, *SEE* Water Resources
Research-in-progress, 28
Reservoir contents, 30
River basins, 46, 54
Rocky Mountain Arsenal, Colorado, 44
Saline water, 48
San Joaquin Valley, 22, 64
Satellite Data-Collection Platforms, 30, 57
Satellites, 24, 52, 56, 62
Sediment, 24, 44, 46, 52
Selected Water Resources Abstracts, 28–29
Selenium, 22, 64
Sewage, 44
Snake River Plain, 48
Solvents, 44
South Carolina, 42
Springs, 46
State and local agencies, 4, 18–19, 46
State Water Resources Research Institutes, 4, 8, 12, 38–39, 65
State Water-Use Data System, 32, 64
Storage and retrieval system, EPA, 26, 30
STORET, *SEE* Storage and Retrieval System
Stream discharge records, 30, 34

INDEX—Continued

Stream-gaging stations, 56
Streamflow, 30, 36
Study units, 46
Suisun Bay, California, 22
Sulfate, 50, 51
Summary, 63–66
Surface water:
  Contamination, 44, 46
  Data, 30, 46
  Hydrology, 24
  Hydrology Protocol, 56
  Monitoring network, 52
  Quality, 34, 36, 46
  Quantity, 34, 36
  Resources, 46
  Study units, 46–47
Technology, 38, 56
Telecommunications network, 30, 62
Tennessee, 42
Terrestrial Effects Task Group, 50
Texas, 18, 44
Three Sisters Volcanoes, Oregon, 52
Toutle-Cowlitz Rivers, 52
Toxic Substances Hydrology, 44–45, 46, 65
Toxic wastes, 3, 18, 22, 44–46
Trace metals, 24, 44, 50
Training, 59
Transuranium element, 24
Treaty, 34
Trichloroethylene, 44
U.S. Geological Survey, organization, 6
Valdez, Alaska, 25, 64
Volcano-Hazards Program, 52–53
Volcanoes, 24, 52
Washington, 18, 52
Waste disposal, 18, 22, 40–44
Waste Isolation Pilot Plant, 40
Waste-management programs, 42
Water analysis, 58
Water availability, 3
Water-Data Sources Directory, 26
Water quality: 3, 18, 34, 38, 44, 46, 48
  Assessment, 46–47
  Constituents, 36, 54
  Data, 30, 56
  Protection, 46
Water quality:—Continued
  Study units, 46–47
  Trends, 36, 46, 54
Water quantity, 32, 34
Water resources:
  Appraisals, 36
  Assessment, 4, 46–47, 54
  Data, SEE Hydrologic data
  Information, 1, 18, 54, 60, 62
  Investigations atlas, 60
  Issues, 3, 54, 66
  Literature, 28
  Management, 3
  Maps, 20, 54, 65
  Policymakers, 46
  Problems, 38, 46, 54
  Publications, 28, 60
  Regions, 54
  Research, 4, 5, 24–25, 28, 42, 44, 64
  Research grants, 4, 38
Water Resources Division:
  Appropriations, 15
  Funding, 13, 14
  Headquarters, 5, 8, 70
  Legislative authority, 4
  Mission, 1, 4, 63
  Offices, 7
  Organization, 5–9, 70–77
  Personnel, 10, 11, 70
  Programs, 1, 16
Water Resources Research Act of 1984, 8, 38, 65
Water Resources Research Institutes, 4, 8, 12, 38–39, 65
Water Resources Scientific Information Center, 28–29, 64
Water Resources Thesaurus, 28
Water temperature, 30
Water use, 3, 30, 32–33, 64
Water-Use Data System, 32
Water wells, 30, 46
Watersheds, 22, 36
WATSTORE, *SEE* National Water-Data Storage and Retrieval System
Well casings, 48
Wood treatment products, 44
WRSIC, *SEE* Water Resources Scientific Information Center
Yucca Mountain, Nevada, 40
Zone of contamination, 46

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