Gilbert, B.K.

THE U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PROGRAM FISCAL YEAR 1988

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Open-File Report 89—389

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by B.K. Gilbert and W.B. Mann IV

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The U.S. Geological Survey Federal-State Cooperative Water-Resources Program, Fiscal Year 1988

by Bruce K. Gilbert and William B. Mann IV

ABSTRACT

The Federal-State Cooperative Program is a partnership between the U.S. Geological Survey and State and local agencies. It provides a balanced approach to the study and resolution of water-related problems and to acquiring hydrologic data. The principal program objectives are to: (1) collect, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources, and (2) appraise the availability and the physical, chemical, and biological characteristics of surface and ground water through analytical and interpretive investigations. During fiscal year 1988, hydrologic data collection, interpretive investigations, and research were conducted by Geological Survey personnel in offices in every State, Puerto Rico, and several territories in cooperation with more than 1,000 local, State, and regional agencies. In fiscal year 1988, Federal funding of almost $60 million was matched by cooperating agencies, who also provided approximately $6 million unmatched for a total program of about $126 million. This amounted to more than 40 percent of the total funds for Geological Survey water-resources activities.

This report presents examples of current (1988) investigations. It also lists about 250 water-resources investigations related to agricultural activities that the Geological Survey conducted from 1970 to 1988.

INTRODUCTION

The complexities involved in the appraisal of the Nation's water resources precludes the accomplishment of this task by Federal efforts alone. Similarly, State and local agencies working independently do not always relate to the larger regional aspects of the hydrologic system. Cooperative planning of data collection and investigations permits a balanced Federal-State-local approach to the study and resolution of water-related problems.

The Federal-State Cooperative Program, a partnership between the U.S. Geological Survey and State and local agencies, provides such a balance for water-resources investigations. The principal program objectives are to: (1) collect, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of water resources in the United States, and (2) appraise the availability and the physical, chemical, and biological characteristics of surface and ground water through analytical and interpretive investigations. The resulting information forms the foundation for many of the Nation's water-resources management and planning activities. In addition, the information may function as an early warning of emerging water problems.

The Cooperative program has contributed directly to water-resources knowledge for more than 90 years by fostering a working partnership between the Federal and State governments in the advancement of earth science, and by compiling a major part of the Nation's hydrologic information. From its earliest days, the program has been directly responsible for the development of streamgaging procedures, surface-water and ground-water flow concepts, and water-quality analytical techniques and investigations.

The first Geological Survey cooperative water-resource investigation was with the State of Kansas in 1895. In 1905, Congress appropriated funds specifically for cooperative studies, marking the official beginning of the program. In 1928, Congress gave formal recognition to the Federal-State partnership and limited the Federal financial contribution for cooperative water-resources studies to no more than 50 percent of the funds for each investigation.

During Fiscal Year (FY) 1988, hydrologic data collection, interpretive investigations, and research were conducted by Geological Survey personnel in offices in every State, Puerto Rico, and several territories in cooperation with more than 1,000 local, State, and regional agencies (see appendix A). State, county, and municipal agencies participate in the program, as do interstate compact organizations, conservation districts, sanitary districts, drainage districts, flood-control districts, and other similar organizations. In FY 1988, Federal funding of almost $60 million was matched by the cooperating agencies; cooperators also furnished approximately $6 million unmatched, for a total of about $126 million. This was more than 40 percent of the total funds for the Geological Survey's program of water-resources activities (figure 1). The Federal-State Cooperative Program is unique in that local and State agencies provide at least one-half the funds, but the Geological Survey does most of the work. At times, the cooperator's contribution to the program may be partly in the form of direct expenditures. This refers to mutually agreed upon work for which dollar-value credit is given by Geological Survey for services rendered by the cooperator in support of program objectives.

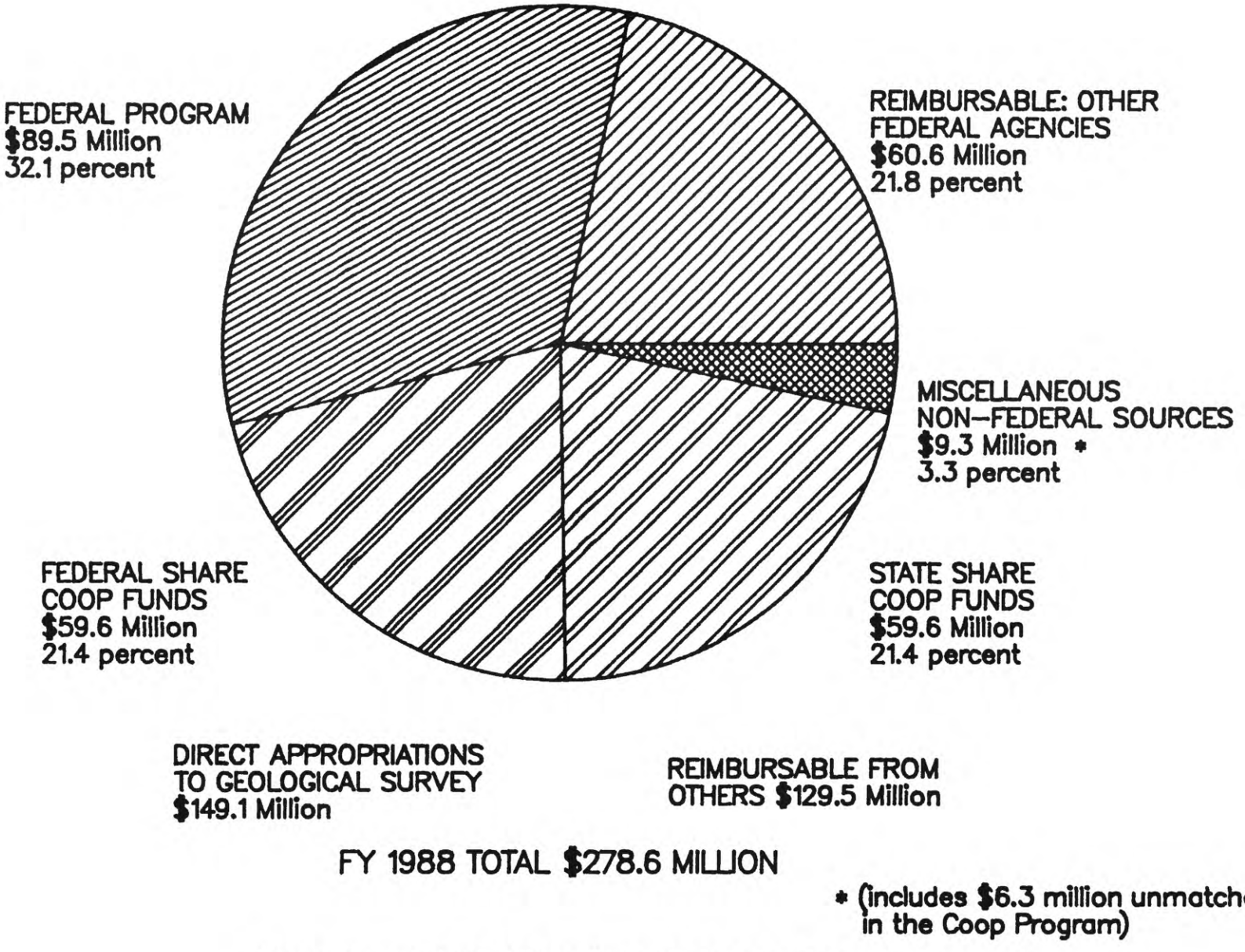

Figure 1 -- Actual obligations of the U.S. Geological Survey's Water Resources Division, fiscal year 1988

Information provided from the Cooperative Program has relevance to potential and emerging long-term problems, such as water supply, waste disposal, energy production, and environmental protection. Because common methods and techniques are used, the information also is relevant to problems having interstate, regional, national, or international significance. The benefits of the program are demonstrated, in part, by the extent to which other agencies use the information produced. For example, the National Weather Service uses streamflow and water-level information from about 3,000 Geological Survey-operated streamgaging stations for their flow- and flood-forecasting systems. More than 40 percent of the funds for the support of these stations is derived from the Geological Survey Cooperative Program.

FUNCTIONS OF THE COOPERATIVE PROGRAM

In fulfilling its water-resources mission, the Geological Survey performs four principal functions:

- Data collection needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Analytical and interpretive appraisals to describe the occurrence, availability, and physical, chemical, and biological characteristics of surface and ground water.
- Research in hydraulics, hydrology, and related scientific and engineering fields.
- Dissemination of water data and the results of investigations and research.

The collection of surface-water and ground-water data on a systematic basis under the provisions of the Federal-State Cooperative Program is a major part of the Geological Survey's coordinated water-resources activities. The resulting information provides a continuing record of the quantity and quality of the Nation's water resources. In FY 1988, the Federal-State Cooperative Program funded totally the operation of 3,800 continuous streamflow stations and funded, in combination with other sources, another 1,300 continuous streamflow stations. These stations constitute more than half the continuous streamflow stations operated by the Geological Survey.

The program provided funds for the collection of ground-water levels at almost 30,000 sites. The FY 1988 program also provided for collection of water-quality data at a total of 2,000 surface-water stations and a total of 6,300 ground-water stations. Overall in FY 1988, the Cooperative Program accounted for 88 percent of the Geological Survey's activities in ground-water data collection.

During FY 1988, the Geological Survey also conducted about 900 interpretive and research investigations, of which about 500 were part of the Cooperative Program. Interpretive investigations encompass areas that range in size from a square mile or less to multistate regions. In these investigations Geological Survey scientists bring together information to define, characterize, and evaluate the areal extent, quality, and availability of the water resource. Since the early 1970's, these investigations have emphasized water-quality issues, such as aquifer contamination, acid rain, river-quality assessments, and storm runoff.

Deterioration in the quality of water supplies for domestic, municipal, industrial, and agricultural uses is a growing problem, which can affect human health as well as the economy. At least half of the Nation's population uses ground water for drinking water. In some places, especially in densely populated and industrialized areas, disposal of toxic wastes has made ground water unsafe for use. For an isolated point source of contamination, such as an industrial disposal pond, the consequences may be severe in magnitude, but only local in extent. In some places, however, many separate agricultural and industrial activities located over a large area are contributing to widespread contamination. The intensive and multiple uses of the Nation's rivers also have contributed to water-quality problems. Historically the rivers have been used for water supplies, dilution of waste, recreation, commerce, and for production of fish and other aquatic crops. These uses are not all

compatible, and over time many problems, which managers are attempting to solve, have surfaced.

The Nation's ability to cope with new and challenging problems in ground-water development and management rests in large measure on information from investigations conducted during the past years in the Cooperative Program.

All data and results of analytical studies are made available to cooperating agencies and the public through various published reports (about 1,500 in FY 1988), and through computerized information programs such as the National Water Data Storage and Retrieval System (WATSTORE) and the National Water Data Exchange (NAWDEX) Program. Abstracts of completed reports are made available through the Geological Survey Water Resources Scientific Information Center (WRSIC).

Included as part of the Federal-State cooperative activities are the:

- Water-Use Information Program, which is designed to determine how much water is withdrawn for use; how much water is consumed during use; the purpose for which water is used; where and how much water is returned; the effect of use on water quality; and the factors that influence water use. As of FY 1988, all States except Rhode Island are participating in this program.

- Coal Hydrology Program, which is designed to assess hydrologic conditions and water-supply problems related to coal mining and land reclamation as these needs are identified jointly by the Geological Survey and by State and local governments. These studies will expedite the preparation of applications for mining permits and mine plans by the coal industry by providing needed hydrologic data. The information will also aid State authorities in reviewing the applications and plans.

ACTIVITIES RELATED TO AGRICULTURE

Because agriculture is so universally dependent on the availability, distribution, and quality of water , many hydrologic data-collection efforts and investigations conducted by the Geological Survey have importance to agricultural interests. The Geological Survey was established in 1879, and in 1888 an Act provided specific authorization for surveys to identify irrigable lands in arid regions and for the selection of sites for reservoirs necessary for the storage and utilization of water for irrigation. Thus, almost since the Geological Survey was founded, activities related to agriculture have been included in its programs.

It is noteworthy that the first three reports in the Geological Survey Water-Supply Paper series (originally known as "Water-Supply and Irrigation Papers") are entitled "Pumping water for irrigation" (Wilson, 1896), "Irrigation near Phoenix, Arizona" (Davis, 1897) and "Sewage irrigation" (Rafter, 1897). Furthermore, at least 12 of the first 20 Water-Supply Papers reported on irrigation investigations and other agriculture-related matters. The focus of investigations soon expanded from evaluations of the quantity and quality of ground and surface water available for agriculture to investigations of the effects of agricultural practices on erosion and sedimentation, ground-water levels, and on water quality.

Madison and Brunett (1985, p.98) report that from 1950 to 1970, fertilizer use in the United States increased from 20 million to 40 million tons per year. Their search of scientific publications indicated that in almost every State investigations were in progress of ground-water contamination by nitrate from agricultural activities. Insecticide use on crops is declining gradually on a national basis, but herbicide use is increasing. (Gilliom, 1985, p. 86). The greatest use of pesticides is for agricultural purposes, but the regional-use patterns and the more than 50,000 pesticide products (Gianessi, 1987) make detection in ground and surface water a constantly challenging problem.

In 1985, more than 57 million acres of land in this country were being irrigated (Solley, Merk, and Pierce, 1988). These authors also report that water withdrawals in the United States during 1985 are estimated to have averaged 399,000 Mgal/d (million gallons per day). Of this amount, about 137,000 Mgal/d were withdrawn for irrigation. Total consumptive use was estimated to be 92,300 Mgal/d, of which irrigation accounted for 73,800 Mgal/d. It is evident, therefore, that the relations among agriculture, water resources, and the environment are of the utmost importance to the Nation's well-being.

From 1970 through 1988, the Geological Survey had underway more than 250 investigations directly related to agriculture, which are listed in appendix B. Of these, 180 (about 70 percent) were conducted as part of the Federal-State Cooperative Program. The Geological Survey Federal Program and the Other Federal Agency Program provided support for the remainder. The average cost per investigation in the Cooperative Program was about $180,000; in the Federal Program, about $470,000; and in the Other Federal Agency Program, about $260,000. The total funding for the 250 investigations amounted to almost $63 million, for an overall average of about $250,000 per investigation.

Figure 2 shows the number of investigations related to agricultural activities that were ongoing each year from 1970 through 1988. The number increased from 5 in 1970 to a maximum of 101 in 1987, with 94 underway in 1988. The number of

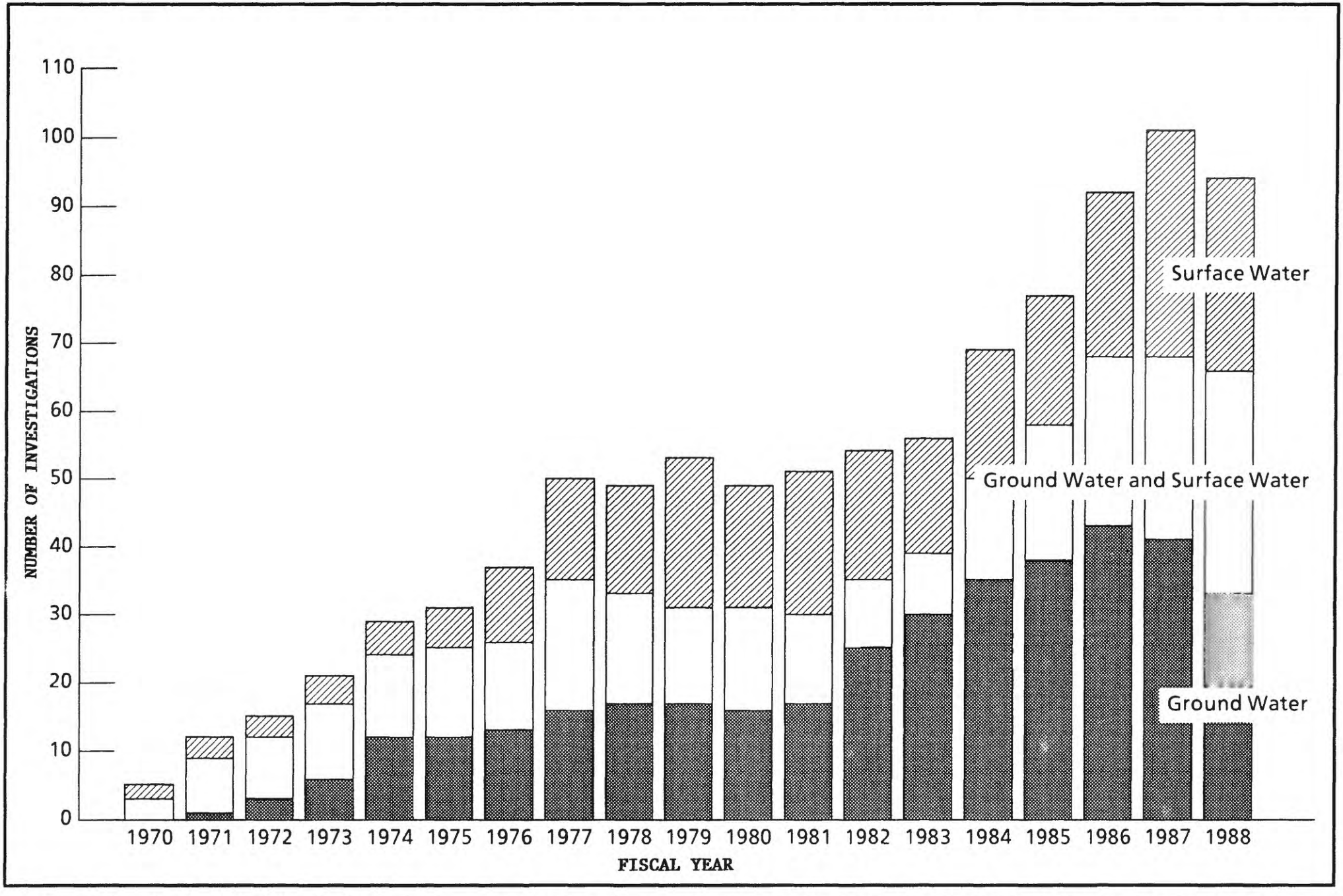

Figure 2 - Number of U.S. Geological Survey investigations related to agricultural activities that were ongoing each year 1970 through 1988

investigations with ground-water components increased from 40 in 1983 to 50 in 1984, and averaged nearly 70 from 1986 through 1988. These increases reflect the widespread, growing concern regarding ground-water quality. Almost 60 percent of the 94 investigations in FY 1988 were conducted as part of the Cooperative Program.

Examples of selected Cooperative Program investigations related to agricultural activities are included among those shown in the following section of this report. Other examples of investigations related to the effects of agricultural chemicals or practices on water resources in the Cooperative Program and in other Geological Survey programs are described in "Some Aspects of U.S. Geological Survey Activities Related to the Effects of Contaminants on Water Resources" (Gilbert, Mann, and Emery, 1987).

EXAMPLES OF CURRENT INVESTIGATIONS

Several examples of recent cooperative investigations follow:

- Pesticides in soil and ground water, Iowa River basin, Iowa -- Recently established ground-water quality monitoring programs have detected pesticides in a number of shallow ground-water supplies throughout Iowa. Increasing concern about the leaching of agricultural chemicals into aquifers has highlighted the need to improve our understanding of the movement of these contaminants. Data collected by the State indicate that nearly 56 million pounds of herbicides are applied annually to fields in Iowa. In cooperation with the University of Iowa Hygienic Laboratory, the Geological Survey is evaluating the movement and distribution of selected pesticides in the field environment.

- Effects of agricultural best management practices.
  --- Patuxent River basin, Maryland: Nutrients in runoff from agricultural areas in the Patuxent River basin substantially affect the water quality of the Chesapeake Bay. Best management practices, proposed to reduce the nutrients in runoff, may increase infiltration to the ground-water flow system and, consequently, increase the concentration of nutrients in shallow ground water. In cooperation with the Maryland Department of Health and Mental Hygiene, the Geological Survey is conducting an investigation to determine the effects of best management practices on ground-water flow and nitrogen concentrations.

  --- Lower Susquehanna River basin, Pennsylvania: The Pennsylvania Departments of Environmental Resources and Agriculture are testing traditional programs and best management practices for control of nonpoint-source runoff from agricultural land in the lower Susquehanna River basin. The Geological Survey, in cooperation with the Susquehanna River Basin Commission, has underway an investigation to evaluate the effects of various farming practices on nutrient and sediment discharges in the areas, as well as the effects on the quality of water in the underlying noncarbonate rocks. The study will include an analysis of the relative influence on water quality of physiography, geology, soils, land use, and precipitation as they relate to best management practices.

- Agricultural chemicals in ground water and streams, Missouri -- The initial effort to document the occurrence of pesticides and nitrate in the water resources of intensively developed agricultural areas of Missouri took place in 1986 and 1987. The Geological Survey, in cooperation with the Missouri Department of Health, sampled ground water and streams at 129 sites in the southeast lowlands area. Twenty-three different pesticides were detected, and at least one pesticide was present at most sites. Nitrate concentrations exceeded drinking water standards in 10 of 40 samples from domestic water supplies. As a continuation of this effort, in 1988 samples were being collected and analyzed for pesticides and nitrate from approximately 60 domestic wells in the Missouri River alluvium, northwestern Missouri.

- Effects of land use on streams in North Carolina -- The North Carolina Department of Natural Resources and Community Development and the Geological Survey are cooperating on the examination of the relations among land use, water quality, and aquatic biota. The study is focusing on concentrations of suspended sediment, heavy metals, and nutrients in three streams in the North Carolina Piedmont. One of the streams drains a predominantly forested area, one drains an agricultural area, and one drains an urban area. The biological health of each stream is being measured by monitoring the macroinvertebrate communities. Data show that all three land-use types contribute high concentrations of suspended sediment to the receiving streams, but highest concentrations are found in the urban stream. In general, metals are highest in the urban stream, but nutrients are substantially higher in the agricultural stream.

- Solute transport in the unsaturated zone, Tucson basin, Arizona -- In cooperation with the city of Tucson, the Geological Survey is investigating the mechanisms that control solute transport through the unsaturated zone of the unconsolidated, poorly-sorted alluvial sediments beneath the Santa Cruz River flood plain near Tucson. The knowledge gained is expected to have application in determining how contaminants move through the unsaturated zone in alluvial basins throughout the arid Southwest.

- Pesticides at North Hollywood dump, Memphis, Tennessee -- The Geological Survey, in cooperation with the city of Memphis, is conducting an investigation of hazardous wastes at a closed municipal-industrial landfill, the North Hollywood dump. The site is Tennessee's top-ranking facility on the 'Superfund' list of the U.S. Environmental Protection Agency. The city of Memphis is concerned primarily with the possible contamination of the underlying aquifer, which provides drinking water for almost one million people.

- Ground-water/surface-water relations, Massachusetts -- The flow in many small streams in the Northeast has been reduced to abnormally low levels by pumping from nearby wells. Also, some municipal water-supply wells have been closed because of infiltration of stream water of degraded quality. The Geological Survey, in cooperation with the Massachusetts Division of Water Pollution Control, is using recently developed methods to relate the physical and chemical properties of the stream water, streambed, and underlying aquifer to the quantity and quality of water withdrawn by wells.

- Bridge scour in Delaware, Maryland, and Virginia -- The undermining (scouring) of bridge-pier and abutment foundations by erosive action of water can result in structural failure of bridges. The numerous equations developed to predict scour produce a wide range of estimates for the same set of conditions, and field data to test the validity of these equations are sparse. The Geological Survey, in cooperation with State Highway Departments in Delaware, Maryland, and Virginia, has begun a pilot study to develop techniques for measuring scour continuously at bridge piers to improve the predictive equations.

- Selenium in ground water, Powder River basin, Wyoming -- In cooperation with the Wyoming Department of Environmental Quality, the Geological Survey is conducting an investigation of geochemical processes controlling the concentration of selenium in ground water from coal-mine spoils.

Results from the study will be used by State regulatory agencies to evaluate aquifer-reclamation strategies at surface coal mines where large concentrations of selenium are present in the overburden. Knowledge gained here is expected to have application to other areas where selenium in ground water is a problem.

- Flood capacity of the Puyallup River basin, Washington -- In cooperation with the Washington Department of Ecology, the Geological Survey is investigating: (1) present and past flow-carrying capacities and streambed elevations of the river channels (most of which are leveed) in the lower Puyallup River basin; (2) sediment processes in the rivers; (3) salmon and steelhead habitat in the streams; and (4) the interrelations among proposed changes in river channels for flood control and the previous three conditions. This infor-mation is of keen interest to government agencies concerned with the need to improve or maintain the present flood capacity of the river channel, and to Indian tribes concerned with fish habitats.

- Nutrients in wetlands streams, Florida -- A study by the Geological Survey in cooperation with the Reedy Creek Improvement District is intended to improve the understanding of the processes governing nutrient cycling and dissolved-oxygen concentrations in a central Florida wetland stream. The objectives are to determine waste-water treatment requirements and to assess the effects of nutrient-enriched effluents on stream quality.

- Monitoring of the Ogallala aquifer--In FY 1988, the USGS began a cooperative effort for increased ground-water level monitoring activities associated with the Ogallala aquifer. As part of the High Plains Aquifer Monitoring Program, deficiencies are being eliminated in the present programs for collection of data on aquifer conditions. The work varies from State to State, but includes the drilling of additional monitoring wells and the measuring of additional water levels; the installation of continuous recorders where the annual fluctuations in water levels are not defined; and the compilation of existing data into compatible formats.

PROGRAM PRIORITIES

Program priorities are based on national needs that have been identified by the President and Administration advisors, by the Congress, by the Department of the Interior, by other Federal agencies, and from information the Geological Survey has received from cooperating agencies and other interested parties. Issues that are identified through the National Water Summary (U.S. Geological Survey 1984, 1985, 1986, and 1988) are also taken into consideration. As a result, the priorities are developed in response to mutual Federal, regional, State, and local requirements.

Thus, the Geological Survey and its cooperating agencies work together in a continuing process that leads to adjustments in each year's program. The number of requests for scientific and technical assistance continues to grow from State agencies responsible for ground-water protection and for controlling and mitigating contamination. The State offerings, which typically exceed Federal matching funds by $5-$10 million each year, reflect the increasing emphasis on water-quality issues, as well as on other concerns regarding the availability and distribution of the resource. The water-quality issues include aquifer contamination, effects of acid rain, river-quality assessment, effects of storm runoff, and the effects of agricultural chemicals and practices on ground and surface water.

The Geological Survey has included water-quality activities in its programs virtually from the time it was established. Until 10 years ago, most of the Geological Survey's emphasis on contamination concerns was concentrated in the Federal-State Cooperative Program. The effects of urban and agricultural runoff, saltwater intrusion, acid precipitation, industrial and sewage discharges, and the underground storage of wastes, for example, were topics of local urgency and were being investigated long before their emergence as problems of national importance.

The Nation's ability to cope with new and challenging problems in ground-water development and management rests in large measure on information from investigations made in the Cooperative Program. Historically, ground water was studied almost entirely through this program. As a result many of the major scientific advances achieved by the pioneers in hydrology were also the direct result of work conducted in this program. Following is a list of selected national ground-water issues and examples of where and when they were first identified as part of the Cooperative Program.

Issue	Where and when first identified
Acid mine drainage	Kentucky, 1955
	Pennsylvania, 1964
Deep-well waste-water injection	Florida, 1966
Ground-water mining	New Mexico, 1926
	Utah, 1950
	Colorado, 1960
Hazardous-waste disposal	Georgia, 1963
Land subsidence	California, 1940
Oil-shale development	Colorado, 1962
Plumes of contaminated ground water	New York, 1961
Radioactive-waste disposal	New York, 1961
Saltwater intrusion	New Jersey, 1923
	California, 1940
	Florida, 1945
Solid-waste disposal	Florida, 1970
Streamflow depletion by wells	New Mexico, 1941
	Colorado, 1963

The program priorities for FY 1989 have not changed greatly from those of the past several years. Water-quality issues again head the list. Approximately three-fourths of the investigations undertaken in the Cooperative Program will in part address ground- or surface-water quality. Of these, it is estimated that more than one in four will focus on contamination problems.

The following issues have been identified as highest priority in developing the FY 1989 Cooperative Program:

Ground-Water Quality--Concern over the quality of the Nation's ground-water resources is creating increasing demands for studies relating to both protection of available supplies and remediation of existing contamination problems. Studies are needed to define present water quality as a baseline for evaluating future changes and for implementing programs to protect the ground-water resource. Of equal importance are studies of the movement and fate of contaminants in ground-water systems. Studies will address flow dynamics and solute-transport processes with emphasis on those geochemical processes that influence the suitability of water for use -- particularly those uses that could affect human health. These include natural processes as well as those related to human activities that act to alter, add, or remove contaminants. Also needed are studies of the environmental effects of waste disposal, contamination by nonpoint sources, and saltwater encroachment.

Stream Quality--Appraisals of the water quality of the Nation's streams continue to be a high-priority need both in areas where contamination has been documented and in areas where contamination may or may not be a problem. Studies are needed of stream quality and sediment chemistry as related to land-use and land-use changes, stream biota, ground-water contribution of contaminants, and overland runoff. Particular emphasis will be given to the occurrence and transport of toxic substances and the impact of contamination on the stream environment.

Water Supply and Demand--Increasing diversion, withdrawal, and use of water places stress on the quantity and quality of existing supplies, thereby raising costs of

delivery and treatment and presenting ever more difficult problems of allocation and quality management. Information defining present water use is required to quantify such stresses over time and space. Topical studies are needed to improve estimates of water use in categories outlined in the National Water-Use Program. Emphasis also must be placed on the identification of aquifers that are major sources for water supply. Topics for study will include streamflow response to drought conditions and system response both to projected uses and supply-augmentation schemes.

Hydrologic Hazards--Economic losses from floods, droughts, rising lake levels, mudflows, debris flows, sedimentation, and other hydrologic hazards amount to billions of dollars annually in addition to loss of life. These hazards are related not only to meteorological conditions, but also to such phenomena as landslides, volcanic eruptions, and earthquakes. Studies are needed to define the magnitude and probability of occurrence of hazardous hydrologic events and to improve understanding of the processes that cause them.

Wetlands, Lakes, and Estuaries--These valuable ecosystems deserve special consideration because of their importance as habitats for fish and wildlife, sources of water supply, and recreational activities. These areas are particularly sensitive to human encroachment, but increasingly function as sinks for waste products. Studies will address the availability, movement, and quality of water including surface-water/ground-water interactions. Emphasis will be placed on physical, chemical, and biological processes, particularly on waste-assimilation studies.

Hydrometeorological Effects--Scientific evidence is accumulating regarding the effects of man's activities on the chemical composition of the Earth's atmosphere and consequent effects on the worldwide hydrologic regimen. Specific issues of immediate concern include acid precipitation, airborne transport and deposition of toxic substances, changing ocean and lake levels, and long-term climate change. Studies of the effects of the chemistry of precipitation on stream quality and the interaction of acid rain with biological systems will continue to receive priority attention in terranes that have limited ability to buffer ground and surface waters, and in urban settings that produce large loads of atmospheric pollutants. In addition to the damage associated with rising lake levels, other issues will include extreme fluctuations in water availability and water-quality changes resulting from intrusion of saltwater or other highly mineralized water.

Hydrologic Effects of Fossil Fuel and Mineral Extraction--The mineral extraction industries, oil and gas production and processing, solid-fuel mining and processing (such as coal and oil shale), and metallic and nonmetallic mining, greatly affect hydrologic systems. Effects may relate to a wide spectrum of hydrologic phenomena, including interaction of subsurface fluids having different chemical and physical characteristics, large-scale aquifer dewatering to permit mining, disruption of surface drainage, and disturbance of geochemical equilibria. Investigations will include studies of the hydrologic effects of land reclamation, mining, and waste disposal.

SUMMARY

The U.S. Geological Survey's Federal-State Cooperative Water-Resources Program (50:50 matching of funds) has responded to national needs for hydrologic information since 1895. During FY 1988, water-resources data collection, investigations, and research were conducted in cooperation with more than 1,000 local, State, and regional agencies in every State, Puerto Rico, and several territories. Total funding in FY 1988 amounted to about $126 million and accounted for more than 40 percent of the total obligations for the Geological Survey's Water Resources Division. The Cooperative Program provides much of the information required by those responsible for water-resources planning and management, water-supply development, and environmental improvement through hydrologic data collection, investigations, and research. The program is a unique activity in that, although the cooperating agencies provide more than half the funds, the Geological Survey accomplishes most of the work with a nationwide staff of about 4,000 scientists, engineers, and support personnel. The program also is the source of much of today's knowledge concerning techniques for collection and analysis of the quantity, quality, and movement of surface and ground water.

Water-resources data collection and investigations related to agricultural activities have been conducted by the Geological Survey since the time it was founded. From 1970 through 1988, about 250 such investigations were underway of which about 70 percent were part of the Federal-State Cooperative Program. The number of agriculture-related investigations with ground-water components increased from 40 in 1983 to 66 in 1988. This growth is indicative of the mounting national concern of the relation between agricultural activities and ground-water quality.

Because the availability of water of suitable quality is a fundamental limiting factor in an expanding economy, a comprehensive and forward-looking data-collection and investigation operation is imperative for planning the best development and use of the Nation's water resources. The job is too large to be supported at either Federal or State level alone. The jointly planned and funded Cooperative Program provides convincing assurance that the work is designed to meet both national and local needs.

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APPENDIX A

COOPERATORS BY STATE, FISCAL YEAR 1988

Alabama:
- Alabama Department of--
  - Environmental Management
  - Highways
- Alabama Surface Mining Commission
- Alabaster, City of
- Anniston, City of
- Ashville, Town of
- Birmingham, City of
- Calhoun County Commission
- Coffee County Commission
- Dauphin Island Water Authority
- Geological Survey of Alabama
- Heflin, City of
- Huntsville, City of, Public Works
- Jacksonville, City of
- Jefferson County Commission
- Mobile, City of
- Montgomery, City of, Water Works and Sanitary Sewer Board
- Prattville, City of
- Reece City, Town of
- Southside Water Works
- Sumter, County of
- Tuscaloosa, City of

Alaska:
- Alaska Department of--
  - Fish and Game
  - Natural Resources, Division of--
    - Geological and Geophysical Surveys
    - Technical Services
  - Transportation and Public Facilities
- Alaska Power Authority
- Anchorage, Municipality of--
  - Department of Health and Human Services
  - Department of Solid Waste Services
  - Water and Wastewater Service

Alaska--Continued
- Fairbanks, City of
- Fairbanks North Star Borough
- Juneau, City and Borough of
- Kenai Peninsula Borough
- Matanuska - Susitna Borough
- Sitka, City and Borough of
- University of Alaska, Fairbanks

Arizona:
- Arizona Department of Water Resources
- Arizona Department of Environmental Quality
- Arizona State Land Department
- Colorado Department of Highways
- Franklin Irrigation District
- Gila Valley Irrigation District
- Maricopa County--
  - Flood Control District
  - Municipal Water Conservation District No. 1
- Metropolitan Water District of Southern California
- Pima County Transportation and Flood Control District
- Safford, City of
- Salt River Valley Water Users Association
- San Carlos Irrigation and Drainage District
- Scottsdale, City of
- Show Low Irrigation Company
- The Navajo Nation
- Tucson, City of

Arkansas:
- Arkansas Department of--
  - Pollution Control and Ecology
  - Highway and Transportation
- Arkansas Game and Fish Commission, Fisheries Division
- Arkansas Geological Commission
- AR-OK Arkansas River Compact Commission
- Arkansas Soil and Water Conservation Commission

Arkansas--Continued
Independence County

California:
Alameda County --
Flood Control and Water Conservation District (Hayward)
Water District
Antelope Valley - East Kern Water Agency
California Department of --
Boating and Waterways
Parks and Recreation
Water Resources --
Central District (Sacramento)
Northern District (Red Bluff)
San Joaquin District (Fresno)
California Water Control Board - Colorado Region
Carpinteria County Water District
Casitas Municipal Water District
Coachella Valley Water District
Contra Costa County --
Department of Health Services
Flood Control and Water Conservation District
Crestline - Lake Arrowhead Water Agency
Desert Water Agency
East Bay Municipal Utility District
East Valley Water District
Fresno Metropolitan Flood Control District
Georgetown Divide Public Utility District
Goleta Water District
Humboldt Bay Municipal Water District
Imperial County Department of Public Works
Imperial Irrigation District
Indian Wells Valley Water District
Inyo County Water Department
Lompoc, City of
Los Angeles Department of Water and Power
Madera Irrigation District
Marin County Department of Public Works

California--Continued
Marin Municipal Water District
Merced, City of
Merced Irrigation District
Mojave Water Agency
Montecito Water District
Monterey County Flood Control and Water Conservation District
Monterey Peninsula Municipal Water District
Oakdale - South San Joaquin Irrigation District
Orange County--
Environmental Management Agency
Water District
Oroville - Wyandotte Irrigation District
Rancho California Water District
Riverside County Flood Control and Water Conservation District
Sacramento Department of Health Services
Sacramento Municipal Utility District
Sacramento Regional County Sanitation District, Department of Public Works
San Benito County Water Conservation and Flood Control District
San Bernardino County Flood Control District
San Bernardino Valley Municipal Water District
San Diego City Water Utilities
San Diego County, Department of--
Planning and Land Use
Public Works
San Francisco, City and County of, Public Utilities Commission
San Francisco Water Department
San Luis Obispo County, County Government Center
San Mateo County--
Department of Public Works
Santa Barbara, City of, Department of Public Works
Santa Barbara County--
Flood Control and Water Conservation District
Water Agency
Santa Clara Valley Water District
Santa Cruz, City of
Santa Cruz County--
Flood Control and Water Conservation District
Santa Maria Valley Water Conservation District

California--Continued

Santa Ynez River Water Conservation District
Scotts Valley Water District
Siskiyou County Flood Control and Water Conservation District
Sonoma County--
  Planning Department
  Water Agency
Tahoe Regional Planning Agency
Terra Bella Irrigation District
Tulare County Flood Control District
Turlock Irrigation District
United Water Conservation District
Ventura County Public Works Agency
California State Water Resources Control Board
Western Municipal Water District
Woodbridge Irrigation District
Yolo County Flood Control and Water Conservation District
Yuba County Water Agency

Colorado:

Arkansas River Compact Administration
Arvada, City of
Aspen, City of
Aurora, City of
Bent County
Boulder, City of
Boulder County Department of Public Works
Breckenridge, Town of
Castle Pines Metro District
Castle Rock, Town of
Chaffee County
Cherokee Water and Sanitation District
Colorado Department of--
  Health
Colorado Division of Mined Lands Reclamation
Colorado Division of Water Resources, Office of the State Engineer
Colorado Geological Survey
Colorado River Water Conservation District

Colorado--Continued

Colorado Springs, City of--
  Department of Public Utilities
  Office of the City Manager
Colorado Water Conservation Board
Delta County Board of County Commissioners
Denver Board of Water Commissioners
Denver Regional Council of Governments
Eagle County Board of Commissioners
Englewood, City of, Wastewater Treatment Plant
Evergreen Metropolitan District
Fort Collins, City of
Fountain Valley Authority
Fruita, City of
Garfield County
Glendale, City of
Glenwood Springs, City of
Grand County Board of Commissioners
Longmont, City of
Lost Creek Ground Water Management District
Loveland, City of
Lower Fountain Water-Quality Management Assoc.
Metropolitan Denver Sewage Disposal District No. 1
Moffat County
Northern Colorado Water Conservancy District
North Kiowa-Bijou Ground Water Management District
North La Junta Water Conservation District
Pikes Peak Area Council of Governments
Pitkin County Board of Commissioners
Pueblo, City of, Board of Water Works
Pueblo Civil Defense Agency
Pueblo County Commissioners
Pueblo West Metropolitan District
Rio Blanco County
Rio Grande Water Conservation District
Southern Ute Indians
Southwestern Colorado Water Conservancy District
St. Charles Mesa Water District
Steamboat Springs, City of

Colorado--Continued
- Thornton, City of
- Trinchera Conservancy District
- Uncompahgre Valley Water Users Association
- Upper Arkansas River Water Conservancy District
- Upper Black Squirrel Ground Water Management District
- Upper Eagle Valley Water and Sanitation District
- Upper Yampa Water Conservancy District
- Urban Drainage and Flood Control District
- Vail Valley Conservation Water Authority
- Water Users No. 1 (Rangely)
- Westminster, City of
- Yellow Jacket Water Conservancy District

Connecticut:
- Connecticut Department of Environmental Protection
- Fairfield, Town of, Conservation Commission
- New Britain, City of, Board of Water Commissioners
- South Central Connecticut Regional Water Authority
- Torrington, City of

Delaware:
- Department of Natural Resources and Environmental Control
- Geological Survey

District of Columbia:
- Department of Public Works
- Metropolitan Washington Council of Governments

Florida:
- Boca Raton, City of
- Bradenton, City of
- Brevard County Board of County Commissioners
- Bradenton, City of
- Broward County--
  - Environmental Quality Control Board
  - Water Resources Management Division
- Cape Coral, City of
- Cocoa, City of

Florida--Continued
- Collier County
- Cottondale, City of
- Edgewater, City of
- Englewood Water District Board of Supervisors
- Escambia County, Board of County Commissioners
- Florida Department of--
  - Environmental Regulation, Bureau of Laboratories and Special Programs
  - Natural Resources, Division of Marine Resources
  - Transportation
- Florida Division of Recreation and Parks (Hobe Sound and Tallahassee)
- Florida Institute of Phosphate Research
- Florida Keys Aqueduct Authority
- Fort Lauderdale, City of
- Fort Walton Beach, City of
- Game and Freshwater Fish Commission
- Hallendale, City of
- Highland Beach, Town of
- Hillsborough County
- Hollywood, City of
- Jacksonville, City of--
  - Department of Health and Environmental Services
  - Department of Planning
  - Water Service Division
- Jacksonville Beach, City of
- Jacksonville Electric Authority
  - Research and Environmental Affairs
- Lake County, Board of County Commissioners
- Lake County Water Authority
- Lake Mary, City of
- Lee County, Board of County Commissioners
- Leon County
- Leon County Department of Public Works
- Madison, City of
- Manatee County, Board of County Commissioners
- Metropolitan Dade County, Department of Environmental Resources Management
- Miami-Dade Water and Sewer Authority
- Northwest Florida Water Management District
- Palm Beach County, Board of County Commissioners

Florida--Continued
- Palm Beach County Solid Waste Authority
- Perry, City of
- Pinellas County
- Polk County, Board of County Commissioners
- Pompano Beach, City of, Water and Sewer Department
- Quincy, City of
- Reedy Creek Improvement District
- Sanford, City of
- Sarasota, City of
- Sarasota County
- South Dade Soil and Water Conservation District
- South Florida Water Management District
- Southwest Florida Regional Planning Council
- Southwest Florida Water Management District
- St. Johns County
- St. Johns River Water Management District
- St. Petersburg, City of
- Stuart, City of
- Suwannee River Authority (Trenton)
- Suwannee River Water Management District
- Tallahassee, City of
  - Electric Department
  - Streets and Drainage
  - Underground Utilities
  - Water Quality Laboratory
- Tampa, City of
- Tampa Port Authority
- University of Florida, Center for Wetlands
- Volusia, County of
- Walton County
- West Coast Regional Water Supply Authority

Georgia:
- Albany, City of
- Albany Water, Gas, and Light Commission
- Bibb County, Board of County Commissioners
- Blairsville, City of
- Brunswick, City of

Georgia--Continued
- California Air Resources Board
- Clayton County Water Authority
- Cobb, County of
- Covington, City of
- Alabama Department of Economic and Community Affairs
- Georgia Department of--
  - Natural Resources-- Environmental Protection Division,
    - Water Management Branch
    - Water Protection Branch, Water Quality Support Program
    - Geological Survey Branch
  - Transportation, Materials and Research
- Georgia State University
- Gwinnett County
- Helena, City of
- Macon-Bibb County Water and Sewage Authority
- Moultrie, City of
- Summerville, City of
- Thomaston, City of
- Thomasville, City of
- Valdosta, City of

Hawaii:
- Hawaii Department of--
  - Land and Natural Resources--
    - Division of Water and Land Development
  - Transportation
- Honolulu, City and County of --
  - Board of Water Supply
  - Department of Public Works
  - County of Hawaii, Department of Water Supply
  - Kauai, County of, Department of Water Supply
  - County of Maui Department of Water Supply

Idaho
- Boise, City of
- College of Southern Idaho

Idaho--Continued
- Idaho Department of--
  - Fish and Game
  - Health and Welfare
  - Water Resources
- Shoshone County
- Sun Valley Water and Sewer District
- SW Irrigation District
- Teton County, Board of Commissioners
- The Shoshone- Bannock Tribes, Fort Hall Business Council
- Water District No. 1--Idaho Falls
- Water District No. 31

Illinois:
- Bloomington and Normal Sanitary District
- Cook County Forest Preserve District
- Decatur, City of
- De Kalb, City of
- Du Page County --
  - Department of Environmental Concerns
  - Forest Preserve
- Illinois State Water Survey --
  - Department of Energy and Natural Resources, Special Studies
- Illinois Department of Transportation, Division of Water Resources
- Illinois Environmental Protection Agency, Division of Water Pollution Control
- Metropolitan Sanitary District of Greater Chicago
- Springfield, City of
- Vermilion County Conservation District

Indiana:
- Carmel, Town of
- Elkhart Water Works
- Indiana Department of--
  - Environmental Management
  - Highways
  - Natural Resources, Division of Water
  - Division of Parks
- Indianapolis Department of Public Works

Iowa:
- Carroll County Health Department
- Cedar Rapids, City of
- Charles City, City of
- Des Moines, City of
- Des Moines Water Works
- Fort Dodge, City of
- Gutherie County Health Department
- Iowa Department of--
  - Natural Resources--Des Moines
  - Natural Resources--Iowa City
  - Geological Survey Bureau
  - Transportation, Highway Division
- Iowa State University
- Marshalltown, City of--
  - Water Pollution Control Plant
- Sioux City, City of
- University of Iowa--
  - Institute of Hydraulic Research
  - University Hygenic Laboratory
  - University Physical Plant
- Union Electric Company
- Waterloo, City of
- Waterloo Sewage Disposal Plant

Kansas:
- Arkansas River Compact Administration
- Clay County Board of County Commissioners
- Emporia Department of Public Works
- Equus Beds Groundwater Management District No. 2
- Geary County Board of County Commissioners
- Hays, City of
- Kansas Department of--
  - Health and Environment
  - Transportation
- Kansas Geological Survey
- Kansas State Board of Agriculture, Division of Water Resources
- Kansas State University

Kansas--Continued
- Kansas Water Office
- Sedgwick County Department of Environmental Resources
- Southwest Kansas Ground Water Management District No. 3
- Western Kansas Ground Water Management District No. 1
- Wichita, City of

Kentucky:
- Elizabethtown, City of
- Jefferson County Public Works and Transportation Department
- Hardin County Water District
- Kentucky Department of--
  - Natural Resources and Environmental Protection
- Kentucky Geological Survey
- Lincoln Trail Health Department
- Metropolitan Sewer District
- University of Louisville

Louisiana:
- Bayou Lafourche Freshwater District
- Capital-Area Groundwater Conservation Commission
- East Baton Rouge Parish
- Jefferson Parish Department of Public Utilities
- Louisiana Department of--
  - Natural Resources--
    - Environmental Quality
  - Transportation and Development--
    - Materials Lab
    - Office of Public Works
  - Wildlife and Fisheries
- Louisiana State University and A&M College
- Sabine River Compact Administration
- Slidell, City of

Maine:
- Androscoggin Valley Council of Governments
- Cobbossee Watershed District
- Greater Portland Council of Governments

Maine--Continued
- Maine Department of--
  - Conservation, Geological Survey
  - Environmental Protection
  - Inland Fisheries and Wildlife
  - Transportation
- North Kennebec Regional Planning Commission
- Penobscot Valley Council of Governments
- University of Maine

Maryland:
- Anne Arundel County Planning and Zoning Office
- Baltimore County--
  - Department of Permits and Licenses
  - Department of Public Works
  - Office of Planning and Zoning
- Calvert County Courthouse
- Caroline County Courthouse
- Carroll County Commission
- Howard County Department of Public Works
- Maryland Department of Environment
- Maryland Geological Survey
- Maryland State Highway Administration
- Maryland Water Resources Administration
- Montgomery County--
  - Department of Environmental Protection, Division of Environmental Planning and Monitoring
  - Storm Water Management
- Poolesville, Town of
- St. Marys County Commissioner
- Upper Potomac River Commission
- Washington Suburban Sanitary Commission

Massachusetts:
- Barnstable County Commissioners
- Brewster, Town of
- Harwich, Town of

Massachusetts--Continued
- Massachusetts Department of--
  - Environmental Management
    - Division of Water Resources
  - Environmental Quality Engineering--
    - Division of Water Pollution Control
    - Division of Water Supply
  - Fisheries, Wildlife and Environmental Law Enforcement
    - Division of Fisheries and Wildlife
  - Public Works
- Massachusetts Hazardous Waste Facility
- Massachusetts Water Resources Authority
- Metro District Commission, Watershed Management Division
- Metropolitan District Commission, Parks Engineering and Construction Division
- New England Interstate Water Pollution Control Commission

Michigan:
- Ann Arbor, City of
- Battle Creek, City of
- Cadillac, City of, Wastewater Treatment Plant
- Cadillac, City of
- Clare, City of
- Coldwater, City of, Board of Public Utilities
- Flint, City of, Department of Public Works and Utilities
- Genesee County Drain Commission, Division of Water and Waste Services
- Grand Traverse County Board of Commissioners
- Huron-Clinton Metropolitan Authority
- Imlay, City of
- Kalamazoo, City of, Department of Public Utilities
- Kalamazoo County Board of Commissioners
- Lansing, City of, Board of Water and Light, Water and Stream Division
- Macomb County
- Mason, City of
- Michigan Department of--
  - Agriculture, Soil and Water Conservation Division
  - Natural Resources
  - Transportation
- Oakland County Drain Commission

Michigan--Continued
- Otsego County Road Commission
- Portage, City of
- Village of Elsie
- Wayne County Environmental Health Division
- Ypsilanti, City of

Minnesota:
- Beltrami County Soil and Water Conservation District
- Elm Creek Conservation Commission
- Fond du Lac Reservation Business Commission
- Leech Lake Reservation Business Commission
- Lower Red River Watershed Management District
- Metropolitan Waste Control Commission
- Mille Lac Reservation Business Commission
- Minneapolis Water Works
- Minnesota Department of--
  - Natural Resources, Division of Waters
  - Transportation
- Red Lake Reservation Business Commission
- Rochester Public Utilities
- St. Paul Water Utility, Water Purification Plant
- University of Minnesota, Minnesota Geological Survey
- White Earth Reservation Business Commission

Mississippi:
- Harrison County--
  - Board of Supervisors
  - Development Commission
- Jackson, City of
- Jackson County--
  - Board of Supervisors
  - Port Authority
- Mississippi Department of--
  - Highways
  - Natural Resources--
    - Bureau of Geology
    - Bureau of Land and Water Resources
    - Bureau of Pollution Control

Mississippi--Continued
- Pat Harrison Waterway District
- Pearl River Basin Development District
- Pearl River Valley Water Supply District

Missouri:
- Branson, City of
- Cape Girardeau, City of
- Little River Drainage District
- Missouri Department of--
  - Conservation
  - Health
  - Natural Resources--
    - Division of Environmental Quality, Lab Service Program
    - Division of Geology and Land Survey
    - Land Reclamation Commission
- Missouri Highway and Transportation Commission
- Springfield City Utilities Engineering Department

Montana:
- Daniels County
- Fort Peck Tribes
- Helena, City of
- Lewis and Clark, County of
- Lower Musselshell
- Montana Bureau of Mines and Geology
- Montana Department of--
  - Fish, Wildlife, and Parks
  - Health and Environmental Sciences
  - Highways
  - Natural Resources and Conservation
  - State Lands
- Montana State University
- Office of the Governor
- Salish and Kootenai Tribes of Flathead Reservation
- University of Montana
- Wyoming State Engineer

Nebraska:
- Central Platte Natural Resources District
- Kansas-Nebraska Big Blue River Compact Administration
- Lincoln, City of
- Little Blue Natural Resources District
- Lower Loup Natural Resources District
- Lower Republican Natural Resource District
- Nebraska Department of--
  - Environmental Control
  - Water Resources
- Middle Niobrara Natural Resources District
- Middle Republican Natural Resource District
- North Platte Natural Resource District
- South Platte Natural Resource District
- Twin Platte National Resources District
- University of Nebraska, Conservation and Survey Division
- Upper Elkhorn Natural Resource District
- Upper Loup Natural Resources District
- Upper-Niobrara White Natural Resources District
- Upper Republican Natural Resource District

Nevada:
- Carson City, Department of Public Works
- Clark County --
  - Public Works Department
  - Regional Flood Control District
  - Sanitation District
- Douglas County
- Elko County
- Las Vegas, City of
- Las Vegas Valley Water District
- Mackay School of Mines
- Nevada Bureau of Mines and Geology
- Nevada Department of--
  - Conservation and Natural Resources--
    - Division of Environmental Protection
    - Division of Water Resources
  - Human Resources, Division of Health
  - Transportation

Nevada--Continued
Nevada Senate Interim Finance Committee
Regional Water Planning and Advisory Board
Reno, City of
South Lake Tahoe, California, City of
South Lake Tahoe, California, Public Utility District
Summit Lake Paiute Tribe
Tahoe Regional Planning Agency
University of Nevada-Reno

New Hampshire:
New Hampshire Department of --
Environmental Services Transportation

New Jersey
Bergen County Department of Public Works
Brick Township Municipal Utilities Authority
Cape May, City of
Delaware River Basin Commission
Glouster City Health Department
Gloucester County Planning Commission
Greenwich, Township of
New Jersey Department of Environmental Protection,
Division of Water Resources
Morris City Municipal Utilities Authority
North Jersey District Water Supply Commission
Passaic Valley Water Commission
Somerset County Board of Chosen Freeholders
Township of Lower, Municipal Utilities Authority
West Windsor Township
Wildwood, City of

New Mexico:
Alamogordo, City of
Albuquerque, City of
Albuquerque Metropolitan Arroyo Flood Control Authority
Canadian River Municipal Water Authority
Costilla Creek Compact Commission

New Mexico--Continued
El Paso Water Utilities Public Service Board
Gallup, City of
Highlands University
Las Cruces, City of
Las Vegas, City of
Los Alamos, County of
Navajo Indian Nation, Navajo Tribal Council
New Mexico Bureau of Mines and Mineral Resources
New Mexico Department of Highways
New Mexico Environmental Improvement Division
New Mexico Interstate Stream Commission
New Mexico State University
Office of State Engineer
Pecos River Commission
Pueblo of Acoma
Pueblo of Zuni
Raton, City of
Rio Grande Compact Commission,
Commissioner for Colorado
Commissioner for Texas
Ruidosa, Village of
Santa Fe Metropolitan Water Board
Santa Rosa, City of

New York:
Amherst, Town of, Engineering Department
Auburn, City of
Chautauqua County Department of Planning and Development
Cheektowaga, Town of
Cornell University--
Department of Natural Resources
Department of Utilities
Dutchess County Environmental Management Council
Hudson-Black River Regulating District
Kiryas Joel, Village of
Monroe County Department of Health,
Environmental Health Lab

New York--Continued
Nassau, County of
Department of Health
Department of Public Works
New York City--
Department of Environmental Protection, Air and Water Resources-Energy
New York State Department of--
Environmental Conservation--
Division of Water
Transportation, Bridge and Construction Bureau
New York State Energy Research and Development Authority
New York State Power Authority
Nyack, Village of, Board of Water Commissioners
Onondaga, County of--
Department of Drainage
Water Authority
Orange County Department of Public Works
Oswego County Health Department
Schuyler County
Suffolk, County of--
Department of Health Services
Water Authority
Tompkins County Department of Planning
Ulster County Legislators
Westchester, County of--
Department of Planning
Department of Public Works

North Carolina:
Ashville, City of
Bethel, Town of
Brevard, City of
Chapel Hill, Town of
Charlotte, City of
Durham City Department of Water Resources
Forsyth, County of
Greensboro City Department of Public Works
Guilford County Soil and Water Conservation District

North Carolina--Continued
Jacksonville, City of
North Carolina State Department of--
Human Resources
Natural Resources and Community Development
Transportation, Division of Highways
Orange County
Orange Water and Sewer Authority
Raleigh, City of
Rocky Mount, City of
Triangle Area Water Supply Monitoring Project Steering Committee
University of North Carolina

North Dakota:
Dickinson, City of
Lower Heart River Water Resources District
North Dakota Geological Survey
North Dakota State University
Oliver County Board of Commissioners
Public Service Commission
State Water Commission
Three Affiliated Tribes

Ohio:
Akron, City of
Canton, City Water Department
Columbus, City of
Eastgate Development and Transportation Agency
Freemont, City of
Geauga County Planning Commission
Lima, City of
Lucas County
Miami Conservancy District
Ohio Department of--
Natural Resources
Transportation
Ohio Air Quality Development Authority
Ohio Environmental Protection Agency

Ohio--Continued
- Ohio State University
- Ohio Water Development Authority
- Roseville, City of
- Ross County
- Sandusky County
- Seneca Soil and Water District
- Toledo Metropolitan Area Council of Governments
- Wood County

Oklahoma:
- Ada, City of
- Altus, City of
- Central Oklahoma Master Conservancy District
- Edmond, City of
- Fort Cobb Reservoir Master Conservancy District
- Foss Reservoir Master Conservancy District
- Lawton, City of
- Lugert-Altus Irrigation District
- Mountain Park Master Conservancy District
- Norman, City of
- Department of Public Works
- Oklahoma City, City of
  - Department of Water Resources
- Oklahoma Geological Survey, University of Oklahoma
- Oklahoma State Health Department
- Oklahoma Water Resources Board
- Tulsa, City of, Department of Storm Water Management
  - Water and Sewer Department

Oregon:
- Clark County Intergovernmental Resources Center
- Confederated Tribes of--
  - Umatilla Indian Reservation
  - Warm Springs Indian Reservation
- Coos Bay-North Bend Water Board
- Douglas County Department of Public Works
- Eugene City Water and Electric Board

Oregon--Continued
- McMinnville City Water and Light Department
- Oregon Department of--
  - Fish and Wildlife
  - Human Resources, Health Division
  - Natural Resources
  - Transporation, Highway Division
  - Water Resources
- Portland City Water Bureau

Pennsylvania:
- Academy of National Science of Philadelphia
- Allentown, City of
- Berks County
- Bethlehem, City of
- Chester County Water Resources Authority
- Delaware River Basin Commission
- Erie County Department of Health
- Geological Survey, University of Delaware
- Harrisburg City Department of Public Works
- Indiana County
- Lancaster County Planning Commission
- Letort Regional Authority
- Media Borough Water Department
- Neshaminy Water Resources Authority
- New York State Department of Environmental Conservation
- Philadelphia City Water Department
- Pennsylvania State--
  - Agriculture Department
  - Mining and Reclamation Bureau
  - Office of Resources Management, Bureau of Water Resources Management
  - Topographic and Geologic Survey Bureau
  - Water Quality Management Bureau
- Susquehanna River Basin Commission
- University Area Joint Authority
- Williamsport, City of

Rhode Island:
- Narragansett Bay Water Quality Commission
- New Shoreham, Town of
- Rhode Island State Department of Environmental Management,
  - Division of Water Resources
- State Water Resources Board

South Carolina:
- Beaufort-Jasper County Water Authority
- Charleston Commission of Public Works
- Cooper River Water Users Association
- Georgetown County Water and Sewer District
- Grand Strand Water and Sewer Authority
- Irmo, Town of
- Lexington, County of
- Myrtle Beach, City of
- Newberry, City of
- Richland, County of
- South Carolina State--
  - Department of Highways and Public Transportation
  - Geological Survey
  - Health and Environmental Control
  - Public Service Authority
  - Sea Grant Consortium
  - Water Resources Commission
  - Water Resources Research Institute
  - Wildlife and Marine Resources Department
- Spartanburg Water System
- Spartanburg Sanitary Sewer District
- University of South Carolina
- Waccamaw Regional Planning and Development Commission
- Western Carolina Regional Sewer Authority

South Dakota:
- East Dakota Water Development District
- Lawrence, County of
- Oglala Sioux Tribe
- Rapid City, City of

South Dakota--Continued
- Sioux Falls, City of
- Sisston-Wahpeton Sioux Tribe
- South Dakota Department of--
  - Game, Fish, and Parks, Division of Wildlife
  - Transportation
  - Water and Natural Resources--
    - Geological Survey Division
    - Water Development Division
    - Water Rights Division
    - Water Quality Division
- South Dakota School of Mines and Technology
- Watertown, City of
- West Dakota Water Development District

Tennessee:
- Alcoa, City of
- Bell Buckle, City of
- Dickson, City of
- Eastside Utility District
- Franklin, City of
- Government of Nashville and Davidson County
- Hamilton, County of
- Hixson Utility District
- Humphreys, County of
- Jackson, City of
- Lawrenceburg, City of
- Lincoln County Board of Public Utilities
- Memphis, City of--
  - Light, Gas, and Water Division
  - Public Works Division
- Memphis State University
- Murfreesboro Water and Sewer Department
- Rogersville, Town of
- Sevierville, City of
- Shelby County Public Works

Tennessee Department of--
Health and Environment--
Construction Grants and Loans
Division of Solid Waste Management
Division of Superfund
Environmental Policy Group
Division of Groundwater Protection
Transportation, Research Division
Tennessee State Planning Office
Tennessee Wildlife Resources Agency
Union, City of

Texas:
Abilene City Water Utilities
Arlington City Public Utilities
Austin, City of
Bexar-Medina-Atascosa Counties, Water Improvement District No. 1
Brazos River Authority
Carrollton, City of
Coastal Industrial Water Authority
Colorado River Municipal Water District
Corpus Christi City Public Works
Dallas, City of --
Public Works
Edwards Underground Water District
El Paso City Public Service Board
Fort Bend County
Fort Stockton, City of
Franklin County Water District
Gainesville, City of
Galveston County
Garland City Public Works Department
Georgetown, City of
Graham, City of
Greenbelt Municipal and Industrial Water Authority
Guadalupe-Blanco River Authority
Harris County Flood Control District
Harris-Galveston Coastal Subsidence District
Houston City Public Works Department

Texas--Continued
Lavaca-Navidad River Authority
Lower Colorado River Authority
Lower Neches Valley Authority
Lubbock City Water Utilities
Nacogdoches, City of
North Central Texas Municipal Water Authority
Northeast Texas Municipal Water District
Orange County
Pecos River Commission
Red Bluff Water Power Control District
Runaway Bay, City of
Sabine River Authority
Sabine River Compact Administration
San Angelo, City of
San Antonio, City of--
Department of Environmental Management
Public Service Board
Water Board
San Antonio River Authority
San Jacinto River Authority
Tarrant County Water Control and Improvement District No. 1
Texas --
Department of Highways
Water Commission
Water Development Board
Titus County Fresh Water Supply District No. 1
Trinity River Authority
Upper Guadalupe River Authority
Upper Neches River Municipal Water Authority
Upper Trinity Basin Water Quality Compact
West Central Texas Municipal Water District
Wichita County Water Improvement District No. 2
Wichita Falls City Public Works

Utah:
Bear River Commission
Salt Lake City/County Health Department

Utah--Continued
Salt Lake, County of--
Division of Flood Control
Utah Department of--
Health --
Division of Environmental Health
Natural Resources--
Oil, Gas, and Mining Division
Water Resources Division
Water Rights Division
Wildlife Resources Division
Transportation
Toole, City of
Toole, County of
Utah Geological and Mineral Survey
Weber Basin Water Conservancy District

Vermont:
Vermont Department of Environmental Conservation

Virginia:
Accomack County
Alexandria City Department of Transportation and Environmental Services
Clarke, County of
Henrico, County of
James City, County of--
Department of Public Works
Service Authority
Mount Rogers Planning District Commission
Newport News City Department of Public Utilities
Northampton County
Northern Virginia Planning District Commission
Prince William Health District
Roanoke City Utilities and Operations
Southeastern Public Service Authority of Virginia
Southeastern Virginia Planning District Commission
University of Virginia, Department of Environmental Sciences
Virginia Beach, City of

Virginia--Continued
Virginia Department of--
Transportation
Mines, Minerals and Energy--
Division of Mined Land Reclamation
Virginia Water Control Board
Williamsburg, City of
York County

Washington:
Bellevue City Public Works Department
Centralia City Light Department
Chelan County Public Utilities District #1
Douglas County Public Utilities District #1
Hoh Indian Tribe
King County Department of Public Works
Lewis County Board of Commissioners
Pend Oreille County, Utility District #1
Pierce County Department of Public Works
Portland Bureau of Water Works
Public Utility District No. 1 of Kitsap County
Quinault Indian Business Committee
San Juan County Board of Commissioners
Seattle, City of--
Department of Lighting
Skagit County Department of Public Works
Snohomish County
South King County Regional Water Association
Spokane Agency
Tacoma, City of--
Public Utilities
Public Works Department
Thurston County Department of Public Works
Thurston County Health Department
Washington Department of--
Ecology
Emergency Management
Fisheries
Transportation

Washington--Continued
- Walla Walla, City of
- Whatcom County Department of Public Works
- Yakima Tribal Council

West Virginia:
- Jefferson County Commission
- Morgantown Utility Board
- Washington Public Service District
- West Virginia Department of--
  - Energy
  - Highways
  - Natural Resources--
    - Division of Water Resources
- West Virginia Geological and Economic Survey

Wisconsin:
- Bad River Tribal Council
- Balsam Lake Protection and Rehabilitation District
- Beaver Dam, City of
- Big Muskego Lake District
- Chippewa County Land Conservation Department
- Dane, County of--
  - Department of Public Works
  - Regional Planning Commission
- Delavan Lake Sanitary District
- Delavan, Town of
- Fond du Lac, City of
- Fowler Lake Management District
- Fox Valley Water Quality Planning Agency
- Green Bay Metropolitan Sewerage District
- Green Lake Sanitary District
- Hillsboro, City of
- Lac Courte Oreilles Governing Board
- Little Muskego Lake District
- Madison Metropolitan Sewage District
- Menominee Indian Tribe of Wisconsin
- Middletown, City of

Wisconsin--Continued
- Morris Lake Management District
- Noquebay Lake District
- Norway, Town of
- Ocohomowoc Lake, Village of
- Okauchee Lake Management District
- Oneida Tribe of Indians
- Peshtigo, City of
- Powers Lake, District of
- Rock County
- Sand Lake, Town of
- Southeastern Wisconsin Regional Planning Commission
- Stockbridge - Munsee Tribal Council
- Thorp, City of
- University of Wisconsin -- Extension, Geological and Natural History Survey
- Waukesha Water Utility
- Waupun, City of
- Wind Lake Management District
- Wisconsin Department of--
  - Natural Resources
  - Transportation --
  - Division of Highways

Wyoming:
- Cheyenne, City of
- Evanston, City of
- Evansville, Town of
- Laramie County
- Northern Arapahoe Tribe
- Shoshone Tribe
- Sublette County
- Uinta County County Commissioners
- Western Wyoming Community College
- Wyoming Department of--
  - Agriculture
  - Economic Development and Stabilization Board
  - Environmental Quality
  - Highways

Wyoming--Continued
- Wyoming State --
  - Attorney General
  - State Engineer
  - Water Development Commission
  - Water Research Center

Commonwealth and Territories:
- Government of --
  - American Samoa
  - Guam
  - Northern Mariana Islands
- Federated States of Micronesia--
  - Kosrae
  - Pohnpei
  - Yap
- Puerto Rico:
  - Aqueduct and Sewer Authority
  - Department of Natural Resources
  - Environmental Quality Board
  - Industrial Development Company
  - Planning Board
  - University of Puerto Rico, Center for Energy and Environmental Research
- Republic of Palau

Appendix B. -- List of selected U.S. Geological Survey investigations and research related to agriculture.
[Note: Principal emphasis -- GW, ground water; SW, surface water. Source of funding -- C, Federal-State Cooperative Program; F -- Federal program; OFA -- Other Federal Agency Program.]

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Alabama					
AL83-052	Reconnaissance of the ground water resources in southeast Alabama	10/82 to 9/83	GW	Water supply for irrigation	C
Arizona					
AZ82-064	Determination of consumptive use of water along the Lower Colorado River	10/81 to 9/84	GW - SW	Use of irrigation water by crop type	F
AZ80-066	Ground-water/surface-water relationships in the Verde Valley, Yavapai County	7/80 to 7/83	GW - SW	Effects of irrigation on water quality	C
AZ85-085	Accounting system for water and consumptive use in the Lower Colorado River, Lake Mead to Mexico	10/84 to 9/88	GW - SW	Use of irrigation water	F OFA
AZ86-097	Irrigation drainage quality activities for the Lower Colorado and Gila River projects.	9/85 to 9/87	SW	Quality of irrigation drainage water	F OFA
Arkansas					
AR79-035	Water-quality assessment of the L'Anguille River basin	10/78 to 9/79	GW - SW	Effects of fertilizers, pesticides, and sediment on water quality	C
California					
CA69-188	Perris Valley urban hydrology study	8/68 to 6/76	SW	Effects of change in land use from agricultural to urban	C
CA72-262	Lompoc Plain salt balance	7/71 to 6/73	GW - SW	Effects of irrigated agriculture on water quality	C F

Appendix B. -- List of selected U.S. Geological Survey investigations and research related to agriculture.
[Note: Principal emphasis -- GW, ground water; SW, surface water. Source of funding -- C, Federal-State Cooperative Program; F -- Federal program; OFA -- Other Federal Agency Program.]

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Alabama					
AL83-052	Reconnaissance of the ground water resources in southeast Alabama	10/82 to 9/83	GW	Water supply for irrigation	C
Arizona					
AZ82-064	Determination of consumptive use of water along the Lower Colorado River	10/81 to 9/84	GW - SW	Use of irrigation water by crop type	F
AZ80-066	Ground-water/surface-water relationships in the Verde Valley, Yavapai County	7/80 to 7/83	GW - SW	Effects of irrigation on water quality	C
AZ85-085	Accounting system for water and consumptive use in the Lower Colorado River, Lake Mead to Mexico	10/84 to 9/88	GW - SW	Use of irrigation water	F OFA
AZ86-097	Irrigation drainage quality activities for the Lower Colorado and Gila River projects.	9/85 to 9/87	SW	Quality of irrigation drainage water	F OFA
Arkansas					
AR79-035	Water-quality assessment of the L'Anguille River basin	10/78 to 9/79	GW - SW	Effects of fertilizers, pesticides, and sediment on water quality	C
California					
CA69-188	Perris Valley urban hydrology study	8/68 to 6/76	SW	Effects of change in land use from agricultural to urban	C
CA72-262	Lompoc Plain salt balance	7/71 to 6/73	GW - SW	Effects of irrigated agriculture on water quality	C F

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
CA--con't.					
CA74-293	Ground-water quality in the Santa Maria Valley	5/74 to 6/76	GW	Effects of agriculture on water quality	C
CA75-306	Concentration and distribution of nitrates in Redlands area	7/74 to 12/75	GW - SW	Effects of fertilizers on water quality	C
CA76-323	Distribution of nitrate in the saturated and unsaturated zone in southwestern San Bernardino County	1/76 to 9/82	GW	Effects of agriculture on water quality	C
CA78-349	Ground-water quality in the Santa Ana River basin	10/77 to 9/79	GW	Effects of agriculture on ground-water quality	C
CA77-350	Salinity monitoring of return flows from California to the Colorado River	7/77 to 9/80	GW - SW	Effects of agriculture on water quality	C
CA79-360	Fresno County ground-water resources	10/81 to 12/84	GW	Effect of agriculture and urbanization on water supply	C
CA79-364	Evaluation of ground-water quality in the Santa Ynez Valley	7/79 to 9/82	GW	Effects of agriculture on water quality	C
CA80-381	Evaluation of ground-water resources in Borrego Valley and vicinity	7/80 to 9/83	GW	Effects of agriculture and land use change on water supplies	C
CA80-383	Ground-water flushing demonstration program, lower Palo Verde Valley	8/80 to 9/82	GW	Effects of excessive application of irrigation water on water quality	OFA

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
CA--con't.					
CA74-415	Erosion and sedimentation in natural and disturbed forested drainage basins in the Douglas fir region of the Pacific Coast	7/73 to 9/90	SW	Effects of logging and associated activities on erosion	F OFA
CA83-421	San Luis Drain receiving water monitoring studies	1/83 to 9/86	SW	Possible effects of agriculture on water quality	OFA
CA83-426	Ground-water investigations in Owens Valley	10/82 to 9/88	GW	Effects of ground-water pumping on phyreatophytes	C
CA84-428	Central Valley RASA II	1/85 to 9/90	GW	Effects of irrigation on ground-water chemistry	F
CA84-438	Bonsall ground-water study, San Diego County	10/83 to 9/86	GW - SW	Irrigation return flows and ground-water management	C
CA84-441	Assessment of quality and contaminant transport in the soils and ground water of the San Luis Project service area	10/83 to 9/88	GW	Effects of irrigated agriculture on water quality	F
CA84-445	Agricultural return chemistry in the San Luis Drain service area	10/83 to 9/84	SW	Effects of agriculture on water quality	C
CA88-453	Irrigation drainage field-screening study of Sacramento Refuge complex	10/87 to 9/89	SW	Effects of irrigation drainage on water quality	OFA
CA85-456	Western San Joaquin Valley studies	10/84 to 9/89	GW - SW	Effects of irrigation on water quality	OFA

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
CA--con't.					
CA88-460	Irrigation drainage field-screening study of Klamath Basin Refuge complex	10/87 to 9/89	SW	Effects of irrigation drainage on water quality	OFA
CA86-462	Irrigation drainage field reconnaissance study, Salton Sea area	5/86 to 9/89	SW	Effects of irrigation drainage on water quality	F OFA
CA86-463	Irrigation drainage field reconnaissance study, Tulare Lake	5/86 to 9/87	SW	Effects of irrigation drainage on water quality	F OFA
CA86-466	Evaluation of ground-water contamination from agricultural irrigation, Lompoc	10/86 to 9/89	GW	Effects of irrigation on water quality	C
CA88-470	Assessment of irrigation drainage in the Salton Sea area, Imperial Valley	10/87 to 9/90	SW	Effects of irrigation drainage on water quality	OFA
Colorado					
CO74-056	Effects of a cattle feedlot on the quality of ground water in an alluvial aquifer	7/73 to 9/83	GW	Effects of a cattle feedlot on water quality	F
CO74-058	Ground- and surface-water study for an experimental recharge project on Bijou Creek, Morgan and Adams Counties	5/74 to 6/79	GW - SW	Effectiveness of recharge from a stream for irrigation pumping	C
CO76-078	Water quality and availability in Boulder County	7/75 to 10/77	GW - SW	Effects of agriculture on water quality	C
CO79-130	Streamflow and water-quality monitoring in Larimer and Weld Counties	6/79 to 9/84	SW	Effects of agriculture on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
CO--con't.					
CO81-151	Nitrogen and dissolved ions in the ground- and surface-water resources of Rio Grande and Alamosa Counties	10/80 to 9/82	GW - SW	Effects of fertilizers and irrigation on water quality	C
CO84-180	Effects of non-point source contamination of the Fountain Creek alluvial aquifer	4/84 to 9/90	GW - SW	Effects of agriculture on water quality	F
CO85-197	Effects of soil application of sewage sludge on farmland near Denver	10/84 to 9/88	GW	Effects on groundwater quality of sewage sludge on farmland	C
CO85-198	Comprehensive water-quality evaluation of Pueblo Reservoir	3/85 to 9/89	SW	Effects of agriculture on water quality	C
CO85-209	Water-quality evaluation, Pueblo Reservoir	3/85 to 9/89	SW	Effects of agriculture on water quality	OFA
CO88-230	Irrigation drainage field-screening study of the Arkansas River, Colorado and Kansas	11/87 to 9/89	GW - SW	Effects of irrigation drainage on water quality	OFA
CO88-231	Irrigation drainage field-screening of Gunnison River and Sweitzer Lake	11/87 to 9/89	SW	Effects of irrigation drainage on water quality	OFA
Connecticut					
CT77-017	Significant changes in ground-water quality in Connecticut as a result of human activities	1/77 to 9/78	GW	Effects of agriculture on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
CT--con't.					
CT81-047	Water quality in Little River watershed	7/81 to 9/84	SW	Effects of agricultural management practices on water quality	C
CT84-051	Relationships between land use and ground-water quality in stratified-drift aquifers in Connecticut	7/84 to 9/87	GW	Effects of agriculture on ground-water quality	F
CT87-055	Effect of pesticides on ground-water quality	10/86 to 9/89	GW	Effects of pesticides on ground-water quality	C
Delaware					
DE85-019	Geochemistry of water in the unconfined aquifer in Eastern Sussex County	10/84 to 12/87	GW	Effects of agriculture on nitrate concentrations in ground water	C
DE88-022	Pesticides in the shallow ground water of two agricultural areas	1/88 to 9/90	GW	Effects of pesticides on ground-water quality	C
Florida					
FL71-141	Evaluation of hydrologic effects of spray irrigation using sewage effluent	7/70 to 6/74	GW - SW	Effects of spray irrigation on water quality and recharge	C
FL71-163	South Florida ecological study	1/71 to 6/73	GW - SW	Quantities and quality of water available for irrigation	OFA
FL72-174	Nutrient loading study on the Kissimmee River	7/71 to 6/74	SW	Effects of fertilizers and pesticides on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
FL75-242	Preliminary evaluation of hydrologic conditions in Manatee County	10/74 to 10/77	GW - SW	Effects of agriculture on water quality	C
FL76-265	Water supply assessment and evaluation of the Hillsborough River basin	10/75 to 9/80	SW	Effects of agriculture on water quality	C
FL78-290	Caloosahatchee River study	10/77 to 9/80	SW	Effects of agricultural chemicals on water quality	C
FL81-352	Crop irrigation with sprayed sewage effluent, Tallahassee	10/80 to 9/83	GW	Effects of irrigation with sprayed sewage effluent on ground water	C
FL83-401	Organic contaminants in waste and ground water in Florida	10/82 to 9/84	GW	Effects of agriculture on water quality	C
FL84-419	Organic compounds in treated wastewater applied by spray irrigation to fields near Tallahassee	10/83 to 9/86	GW	Effects of spray irrigation and pesticides on ground-water quality	C
FL84-422	Quality of water in the Floridan aquifer system, central Florida	4/84 to 9/90	GW	Effects on groundwater quality of pesticides and fertilizers used in citrus groves	F

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
FL84-424	Quantity and quality of water applied to irrigated crops at selected sites in the East Gladges agricultural area, south Dade County	2/84 to 9/86	GW - SW	Effects of agricultural management practices and irrigation on water quality	C
FL85-432	Application of domestic wastewater treatment sludge to soils overlying the Biscayne aquifer, Dade County	10/84 to 9/88	GW	Comparison of the effects on groundwater quality of applications of sludge with applications of fertilizers	C
FL85-436	Quality of ground water in the Floridan aquifer system as related to selected land use, central Florida	10/84 to 9/86	GW	Effects on water quality of fertilizers and pesticides used in citrus groves.	C
FL86-451	Nutrient loads in the Apopka - Beauclair canal, upper Oklawaha basin, central Florida	5/86 - 9/88	SW	Contribution of muck-farming operations to nutrient load	C
FL87-465	Potential for contamination of the Floridan aquifer system, west-central Florida	10/86 to 9/90	GW	Effects of pesticides on groundwater quality	C
FL88-476	Importance of hydrologic and vegetative factors to fish ecology in a seasonally inundated flood-plain forest	9/87 to 9/90	SW	Potential effects of agricultural development on fish habitats	C
FL88-477	Hydrologic evaluation of indicators used to delineate wetland boundaries on north Florida streams	10/87 to 9/90	SW	Effects on wetlands of converting hardwood forests to agriculture	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Georgia					
GA77-053	Agricultural impact on ground-water availability in southwest Georgia	10/76 to 4/79	GW	Effects of irrigation withdrawals on ground-water availability	C
GA77-058	Effects of agriculture on stream quality in southwest Georgia	1/77 to 9/79	SW	Effects of agriculture on stream quality	C
GA83-079	Migration of pesticides through the unsaturated and saturated zones at a site in southeast Lee County	10/82 to 9/89	GW	Effects of agricultural chemicals on ground-water quality	OFA
GA85-087	Movement and fate of agricultural chemicals in the subsurface, southwest Georgia	10/84 to 9/89	GW	Effects of agricultural chemicals on ground-water quality	F OFA
GA87-089	Effects of ground-water pumping on streamflow in the Appalachicola-Chattahoochee-Flint River system	10/86 to 9/90	GW - SW	Effects of pumping for irrigation on streamflow	C OFA
GA87-091	Hydrology of the Upper Floridan aquifer in the Albany area	10/86 to 9/89	GW - SW	Effects of farming practices on ground-water availability	C
Hawaii					
HI83-173	Investigation of perched and underlying ground-water bodies in relation to contamination by pesticides	5/83 to 9/87	GW	Effects of agricultural chemicals on ground-water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
HI--con't.					
HI84-177	Effects of the cell grazing method on soil loss and water quality	3/84 to 9/87	SW	Effects of cell grazing on reducing sedimentation and water pollution	C
HI85-179	Evaluation of organic constituents in ground water	10/84 to 9/88	GW	Effects of pesticides on groundwater quality	C
Idaho					
ID79-137	A hydrologic assessment of the Snake River Plain regional aquifer, southern Idaho	6/79 to 9/88	GW	Effects of agricultural practices on water quality	F
ID80-139	Water quality of irrigation return flows, Bannock and Twin Falls Counties	10/79 to 1/82	SW	Effects of irrigation on surface-water quality	C
ID84-154	Ground-water contamination in the Westside area, Bingham County	1/84 to 12/86	GW	Effects of irrigation on groundwater quality	C
ID88-157	Irrigation drainage reconnaissance study of American Falls Reservoir	10/87 to 9/89	SW	Effects of irrigation drainage on water quality	OFA
Illinois					
IL72-013	Hydrologic effects of reclaiming strip-mined land by sludge irrigation	8/71 to 9/78	GW - SW	Potential effects of irrigation on water quality	C
IL82-048	An evaluation of bedload data in Illinois	10/81 to 9/82	SW	Evaluation of farmland erosion	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
IL82-052	Ground-water quality of the American Bottoms	10/81 to 9/83	GW	Suitability of ground water for irrigation	OFA
IL84-062	Illinois ground-water observation network	10/83 to 9/87	GW	Effects of agriculture on water levels and water quality	C
IL86-075	Upper Illinois River basin water-quality assessment	4/86 to 9/90	SW	Effects of agriculture on water quality	F
Indiana					
IN74-034	Descriptions of the water quality of selected watershed management projects	1/74 to 9/79	SW	Effects of agriculture on water quality	OFA
IN79-071	A water-quality assessment of the Cypress Creek Watershed	2/79 to 6/80	SW	Effects of agricultural chemicals on water quality	OFA
IN80-077	A water-quality reconnaissance of the Eagle Creek watershed	8/80 to 9/81	SW	Potential effects of agricultural chemicals on water quality	C
IN82-084	Streamflow, sediment, and water-quality modeling of an agricultural watershed in the coal-mining region of southwest Indiana	10/81 to 9/84	SW	Simulation of hydrologic characteristics related to agriculture	F
IN86-112	Effect of storage in an aquitard and on the ground-water system in irrigated areas of northwest Indiana	1/86 to 9/88	GW - SW	Effects of irrigation pumpage on ground and surface water	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Iowa					
IA76-032	Feasibility of developing irrigation water supplies in northwest Iowa	9/76 to 3/82	GW - SW	Effects of irrigation on ground and surface water	C
IA83-047	Iowa ground-water quality monitoring program	10/82 and continuing	GW	Effects of agriculture on ground-water quality	C
IA84-049	Water resources and distribution of nitrate in the Iowa River aquifer, Iowa and Benton Counties	10/83 to 9/86	GW	Effects of fertilizer on ground-water quality	C
IA85-053	Southwest Iowa ground-water appraisal	10/84 to 10/88	GW	Availability of ground-water for agriculture	C
IA86-055	An accounting of pesticides in soil and ground water at selected sites in the Iowa River basin	10/85 to 9/88	GW	Effects of pesticides on ground-water quality	C
IA88-057	Evaluation of factors influencing the occurrence of agricultural chemicals in shallow ground water in the central Midwest	10/87 to 9/91	GW	Effects of agriculture on ground-water quality	F
IA88-058	Hydrologic analysis of water quality and the flow system in the Big Spring basin, Clayton County	10/87 to 9/91	GW - SW	Effects of agricultural chemicals on water quality	C
IA88-061	Analysis of herbicide transport to the Cedar River, Iowa - Minnestota, by overland flow	5/88 to 9/92	GW - SW	Effects of agricultural chemicals and practices on water quality	F

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Kansas					
KS76-075	Availability of ground water in north-central Kansas	1/76 to 9/80	GW - SW	Availability of water for irrigation	C
KS76-082	Geohydrology for water-supply planning in Groundwater Management District No.1, west-central Kansas	7/76 to 1/80	GW	Availability of ground water for irrigation	C
KS66-103	Water quality, Cedar Bluff Irrigation District, west-central Kansas	7/65 to 6/74	GW - SW	Effects of irrigation on water quality	C
KS81-125	Effects of irrigation return flow on the chemical quality of water in the Smoky Hill River, Prairie Dog Creek and Republican River	7/81 to 6/83	GW - SW	Effects of irrigation on water quality	C
KS83-132	Effects of multi-purpose use on the water quality of public supply lakes	4/83 to 3/84	SW	Effects of agriculture on water quality of lakes	C
KS84-135	Water quality in the High Plains aquifer western Kansas, related to petroleum production, irrigated and non-irrigated cropping land use	1/84 to 9/89	GW	Effects of agriculture on water quality	F OFA
KS84-136	Hydrology and water quality of Sedgwick County	1/84 to 9/88	GW - SW	Availability and quality of water for irrigation	C
KS85-145	Assessment of agricultural pesticides in the saturated and unsaturated zones	5/85 to 9/85	GW	Effects of pesticides on soils and water quality	C
KS86-150	Transport, occurrence, and effects of agricultural pesticides in the Tuttle Creek Lake system	10/85 to 9/88	SW	Effects of pesticides on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
KS--con't.					
KS86-151	Movement and persistence of agricultural pesticides in the saturated and unsaturated zones in Kansas	10/85 to 9/88	GW	Effects of pesticides on water quality	C
KS86-152	Water-quality assessment of the lower Kansas River basin, Kansas and Nebraska	4/86 to 9/90	GW - SW	Effects of agriculture on water quality	F
KS88-157	Chemical and microbial degradation rates of atrazine in ground-water systems	10/87 to 9/90	GW	Effects of atrazine on water quality	C
KS88-159	Soil and cropping management effects on atrazine movement in soil water	4/88 to 9/90	GW - SW	Movement and effects of atrazine in the hydrologic system	C
KS88-163	Soils data base for part of northeast Kansas	7/88 to 4/89	Gw - SW	Automate soils, crop and other data through a geographic information system	OFA
Louisiana					
LA81-066	Limnological study of Lake Bruin	3/81 to 9/83	SW	Effects of agricultural chemicals on water quality	C
LA83-078	Development of methods for determining water use in rice irrigation	10/82 to 9/87	SW	Estimates of water use for irrigation	C
Maine					
ME80-033	Evaluation of attempts to reduce phosphorus yields from agricultural land into Lovejoy Pond	3/80 to 9/85	SW	Effects of agricultural chemicals on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Maryland					
MD81-061	Nitrate in ground water, central Delmarva Peninsula	7/81 to 6/84	GW	Effects of agriculture on water quality	C
MD85-080	Nonpoint source contamination of the Patuxent River estuary	5/84 to 9/91	SW	Effects of agriculture on water quality	C
MD85-085	Effects of agricultural best management practices on shallow ground water in the Patuxent River basin	7/85 to 9/91	GW - SW	Effects of agricultural practices on water quality	C
MD86-086	Ground-water quality on the Delmarva Peninsula, Delaware, Maryland, and Virginia	3/86 to 9/90	GW	Effects of agricultural chemicals on ground water quality	F
Massachusetts					
MA78-047	Ground-water contamination from surface impoundments	8/78 to 9/79	GW	Effects of agricultural chemicals on water quality	C
Michigan					
MI75-025	Relation of agricultural land-use practices to erosion of chemical and physical materials in the upper reaches of St. Joseph River basin	7/74 to 6/79	SW	Effects of agriculture on water quality	C
MI80-033	Water resources of Van Buren County	1/80 to 12/82	GW - SW	Effects of agriculture on water quality	C
MI84-040	Water resources of Grand Traverse County	5/84 to 8/88	GW - SW	Effects of agriculture on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
MI--con't.					
MI86-046	Ground-water protection in Kalamazoo County	3/86 to 9/88	GW	Effects of agricultural chemicals on ground-water quality	C
MI87-048	Hydrogeology of Huron County	5/87 to 4/90	GW	Effects of irrigation on ground-water quantity and quality	C
Minnesota					
MN72-024	Water budget of Eagle Lake near Wilmar	7/71 to 12/78	GW - SW	Effects of agriculture on water quality	C
MN75-033	Ground water for irrigation from deep aquifers in the Brooten - Belgrade area, west-central Minnesota	7/74 to 6/76	GW	Water supply for irrigation	C
MN75-040	Hydrogeologic reconnaissance of sand-plain aquifers in Minnesota	7/74 to 6/78	GW	Water supply for irrigation	C
MN75-043	Water-quality appraisals of selected watershed management projects	4/75 to 6/76	SW	Effects of agriculture on water quality	OFA
MN77-058	Appraisal of ground water in part of Big Stone County, west-central Minnesota	7/77 to 6/80	GW	Water supply for irrigation	C
MN79-062	Hydrologic and water-quality assessment of the Coon Creek watershed Anoka County	10/78 to 3/81	SW	Effects of agriculture on water resources	C
MN81-083	Flow and sediment transport in Garvin Brook, Winona County	6/81 to 6/90	SW	Effects of agriculture on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
MN--con't.					
MN82-088	Impact of agriculture on quality of water in surficial sand-plain aquifers in Douglas, Pope and Stearns Counties	7/82 to 9/84	SW	Effects of agriculture on water quality	C
MN83-096	Impact of agriculture and rural-residential development on ground-water quality in the Anoka sand plain, eastern Minnesota	7/83 to 9/86	GW	Effects of agriculture on water quality	C
MN84-102	Preliminary evaluation of possible ground-water contamination near pesticide burial sites in Minnesota	7/84 to 9/85	GW	Effects of pesticides on ground-water quality	C
MN86-106	Hydrogeology and water quality of the Bemidji and Bagley surficial - outwash aquifers, north-central Minnesota	10/85 to 9/88	GW	Effects of agricultural chemicals on ground-water quality	C
MN86-107	Use of stable nitrogen - isotope ratios to identify sources of nitrate in unconfined sand and gravel aquifers	10/85 to 9/87	GW	Effects of agriculture on ground-water quality	C
MN87-110	Impact of agricultural chemicals and tillage practices on the quality of ground water in sand-plain aquifer in Minnesota	10/86 to 9/90	GW	Effects of agricultural chemicals and practices on water quality	C
MN87-114	Effects of ground-water withdrawals on the temperature and quality of the Straight River	10/86 to 12/89	SW	Effects of agriculture on water quality	C
Mississippi					
MS73-032	Water for industry and agriculture in Coahoma, DeSoto, Panola, Quitman, Tate, and Tunica Counties	7/72 to 6/75	GW - SW	Water supply for agriculture	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
MS--con't.					
MS76-042	Water for industrial and agricultural development in Bolivar, Carroll, Leflore, Sunflower, and Tallahatchie Counties	7/75 to 6/77	GW - SW	Water supply for agriculture	C
MS82-067	Synoptic study of the Mississippi River Valley alluvial aquifer in the Yazoo basin	10/81 to 9/85	GW - SW	Effects of ground-water withdrawals for agriculture	C OFA
Missouri					
MO75-029	Water resources of the southeastern lowlands in Missouri	7/74 to 12/78	GW	Water supply for agriculture	C
MO78-032	Water for irrigation in Audrain County	10/77 to 1/81	GW - SW	Water supply for agriculture	C
MO78-033	An assessment of water quality in the area of the proposed Prosperity Reservoir, Center Creek basin	10/77 to 3/80	SW	Effects of agricultural chemicals on water quality	OFA
MO81-048	Ground-water resources in Barton, Bates, and Vernon Counties	10/80 to 3/83	GW	Effects of irrigation pumping on water quantity and quality	C
MO86-068	Effects of special area land treatment on sediment and nutrient transport in the Higginsville Reservoir watershed	10/85 to 9/90	SW	Effects of agriculture on water quality	C
MO86-069	The occurrence of pesticides in ground water, streams and streambed sediments in the southeast lowlands of Missouri	7/86 to 6/88	GW - SW	Effects of pesticides on the hydrologic system	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Montana					
MT81-083	Milk River and St. Mary River apportionment study	3/81 to 9/83	SW	Determination of amount of irrigation	OFA
MT86-115	Irrigation drainage field-screening study, Sun River Unit	6/86 to 6/87	SW	Effects of irrigation on water quality	F OFA
MT86-116	Irrigation drainage field-screening study, Milk River Unit	6/86 to 6/87	SW	Effects of irrigation on water quality	OFA
MT88-119	Occurrence and mobility of persistent pesticides in agricultural environments in the northern Great Plains	1/88 to 9/89	GW - SW	Effects of pesticides on water quality	C
Nebraska					
NE74-028	Movement of nitrogen into aquifers in the Central Platte Natural Resources District	1/74 to 12/75	GW	Effects of agriculture on water quality	C
NE74-029	An assessment of ground-water quality in the Central Platte Natural Resources District	1/74 to 12/76	GW	Effects of agriculture in water quality	C
NE77-038	Hydrogeology of Butler County	4/77 to 6/78	GW	Effects of irrigation on water supply and quality	C
NE81-045	Evaluation of ground-water quality in Nebraska	5/81 to 4/82	GW	Effects of agriculture on ground-water quality	F
NE84-048	A study of nonprint-source derived nitrate-nitrogen and organic constituents in water from selected areas of the High Plains aquifer in Nebraska	12/83 to 3/88	GW	Effects of agricultural chemicals on ground-water quality	F

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
NE--con't.					
NE86-051	Consumptive water use and recharge of the Great Plains and adjacent areas	10/85 to 9/88	GW - SW	Effects of agricultural water use on the hydrologic system	F
NE88-056	Effects of conservation tillage practices on ground-water quality of unconfined aquifers	3/88 to 9/89	GW	Effects of agricultural practices and chemicals on water quality	OFA
Nevada					
NV83-117	Investigation of ground water in the basalt and sedimentary aquifers in the Fallon area, Churchill County	10/82 to 9/85	GW - SW	Effects of recharge from irrigation water	C
NV86-141	Reconnaissance of irrigation return flows in the Newlands Irrigation Project area	10/85 to 9/89	GW - SW	Effects of irrigation on water quality	C
NV86-143	Reconnanissance of irrigation drainage quality in and near the Stillwater Wildlife Management Area, Churchill County	5/86 to 9/88	GW - SW	Effects of irrigation on water quality	F OFA
NV88-148	Detailed assessment of irrigation drainage in and near the Stillwater Wildlife Management Area, Churchill County	10/87 to 9/90	GW - SW	Effects of irrigation on water quality	OFA
New Jersey					
NJ73-012	Wastewater solids utilization on land demonstration project	7/72 to 6/77	GW	Effects of agricultural practices on ground-water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
New Mexico					
NM72-213	Ground-water investigation in the Taos and Cerro Irrigation Units	9/71 to 12/75	GW	Water supply for irrigation	C
NM72-214	Water resources of the Mimbres basin	7/71 to 9/78	GW - SW	Effects of irrigation withdrawals on the hydrologic system	C
NM76-223	Hydrologic assessment of the Elephant Butte Irrigation District well field	2/76 to 6/79	GW	Effects of irrigation withdrawals on the hydrologic system	C
NM83-246	Hydrology of the San Andres - Glorieta aquifer system, Pueblos of Acoma and Laguna	7/83 to 1/86	GW - SW	Water supply for irrigation	C F OFA
NM83-249	Geohydrology of the Estancia basin	7/83 to 9/87	GW - SW	Effects of irrigation withdrawals on the hydrologic system	C
NM85-257	Ground-water flow characteristics and chemical quality in the Animas, LaPlata, and San Juan River valleys	7/85 to 6/88	GW - SW	Effects of irrigation on recharge and water quality	C
NM87-260	Effects of forest management practices on water quality of a high mountain stream in the southern Rocky Mountains	4/87 to 9/92	SW	Effects of silvicultural activities on water quality	C
NM87-352	Effects of forest management practices on sedimentation of a high mountain stream in the southern Rocky Mountains	4/87 to 9/92	SW	Effects of silvicultural activities on stream sedimentation	OFA
NM88-357	Irrigation drainage field-screening study of Middle Rio Grande Project, Bosque del Apache National Wildlife Refuge	10/87 to 9/89	SW	Effects of irrigation on water quality	OFA

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
New York					
NY77-051	Reconnaissance of organic compounds in ground-water systems	8/77 to 9/79	GW	Effects of agriculture on water resources	C
NY78-056	Removal of nitrogen pollution from an aquifer near Olean	10/77 to 9/80	GW	Contamination of ground-water from fertilizer plant operations	C
NY79-064	Ground-water recharge and nitrogen content near the Agriculture Teaching and Research Farm, Harford	10/78 to 9/80	GW	Effects of dairy farming on ground-water quality	C
NY79-077	Nonpoint-source pollution of Irondequoit Bay	8/79 to 9/79	SW	Effects of agriculture on water quality	C
NY81-103	Ground-water contamination resulting from the use of Aldicarb pesticide in eastern Suffolk County, Long Island	11/80 to 7/83	GW	Effects of pesticide on ground-water quality	C
NY87-169	Subsurface transport of pesticides and nitrates under conventional and conservation tillage practices	1/87 to 12/91	GW	Effects of agricultural chemicals on water quality	C
North Carolina					
NC76-055	Effect of land clearing and drainage for agricultural development on hydrology of Albemarle-Pamlico Peninsula	7/75 to 6/80	GW - SW	Effects of farmland development on hydrologic system	C
NC76-056	Study of nonpoint-source pollution	7/76 to 9/79	SW	Effects of agriculture on water quality	C
NC78-062	Effect of land use on streamflow quality	10/77 to 9/79	SW	Effects of agriculture on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
NC--con't.					
NC84-076	Effect of land use on biological environment of streams on the Piedmont	1/84 to 9/86	SW	Effects of agriculture on water quality	C
NC85-081	Effects of land-management practices on sediment and chemical transport in Guilford County	10/84 to 9/90	GW - SW	Effects of agricultural chemicals and management practices on water quality	C
North Dakota					
ND82-103	Water-quality assessment of the Souris River within North Dakota	10/81 to 9/85	SW	Effects of agriculture on surface-water quality	C
ND83-120	Evaluation of theory and methodology for quantifying recharge and evapotranspiration for shallow glacial aquifers in North Dakota	10/82 to 9/83	GW	Review of agronomic research related to recharge and evapotranspirations	C
ND84-130	Effects of fallowed land on soil erosion, northeastern North Dakota	7/84 to 9/85	SW	Effects of agricultural practices on soil erosion	C
ND85-135	Generation of a data base for the James River salinity model, North Dakota and South Dakota	4/85 to 9/87	GW - SW	Water supply for irrigation	OFA

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Oklahoma					
OK86-081	Hydrogeology of the Blaine aquifer and associated units in southwestern Oklahoma	10/85 to 9/88	GW	Effects of agriculture on water quantity and quality	C
Oregon					
OR76-084	Bear Creek basin water-quality study	3/76 to 9/79	SW	Effects of irrigation on water quality	C
OR80-102	Umatilla structural basin ground-water study	3/80 to 9/84	GW - SW	Effects of agriculture on the hydrologic system	C
OR83-119	Columbia basin regional aquifer system analysis, north-central Oregon and Washington	12/82 to 9/87	GW	Effects of irrigation pumping on the availability of ground water	F
OR88-147	Irrigation drainage field-screening study on Malheur National Wildlife Refuge	10/87 to 9/89	SW	Effects of irrigation on water quality	OFA
Pennsylvania					
PA69-017	Pesticide contributions from forested, agricultural and urban areas	1/69 to 6/73	SW	Effects of pesticides on water quality	C
PA77-079	An assessment of nonpoint-source discharges, Pequea Creek basin, Lancaster County	11/76 to 3/82	SW	Effects of agricultural chemicals on water quality	C
PA80-113	Water-quality loads of the Susquehanna River at Harrisburg	4/80 to 11/81	SW	Effects of agricultural chemicals on water quality	OFA
PA84-155	Ground water -- its sources, movement, and quality in agricultural areas	7/84 to 12/85	GW	Effects of agriculture on ground-water quality	F

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
PA--con't.					
PA85-158	Evaluation of agricultural best management practices and other methods of controlling nutrient discharges in the lower Susquehanna River basin	10/84 to 9/90	SW	Effects of agricultural practices on water quality	C
PA85-164	Ground-water flow systems and water quality of the Gettysburg area	9/85 to 10/88	GW - SW	Effects of agricultural activities on water quality	OFA
PA88-182	Effect of land use and organochloride insecticides on benthic - invertebrate diversity indices, Chester County	2/88 to 9/90	SW	Effects of pesticides on the hydrologic system	C
Puerto Rico					
PR83-089	Feasibility of artificial ground-water recharge, rice growing areas	10/83 to 9/86	GW	Artificial recharge to augment rice irrigation	C
Rhode Island					
RI88-025	Assessment of water quality in major Rhode Island streams	10/87 to 9/91	SW	Effects of agricultural chemicals on water quality	C
South Carolina					
SC82-054	Disposal of wastewater effluent by spray irrigation, coastal South Carolina	1/82 to 9/84	GW	Effects of spray irrigation on water quality	C
South Dakota					
SD78-048	Water resources of Yankton County	10/77 to 9/81	GW - SW	Availability of water for agriculture	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
SD--con't.					
SD81-057	A geochemical survey of ground water in the Big Sioux aquifer in eastern South Dakota	10/80 to 9/83	GW	Effects of agriculture on ground-water quantity and quality	C
SD83-069	Evaluation of withdrawal and consumptive use of ground water for irrigation in the James River valley	2/83 to 9/83	GW	Estimates of ground-water use for agriculture	C
SD88-086	Irrigation drainage field-screening study of the Angostura Unit	2/88 to 9/89	GW - SW	Effects of irrigation on water quality	OFA
SD88-087	Irrigation drainage field-screening study of the Belle Fourche Project	2/88 to 9/89	GW - SW	Effects of irrigation on water quality	OFA
Tennessee					
TN76-034	Migration of leachates from pesticide waste landfill in Hardeman County	1/76 to 9/77	GW - SW	Effects of pesticides on water quality	C
TN88-077	Geochemical and geomicrobial processes affecting the fate of organochlorine pesticides in ground water	10/87 to 9/88	GW	Effects of pesticides on ground-water quality	C
Texas					
TX84-085	Assessment of ground-water contamination in Houston	10/83 to 9/86	GW	Effects of agriculture on water quality	F
TX84-087	Investigation of return flow from irrigation in Castro and Palmer Counties	10/83 to 9/85	GW	Effects of irrigation on the availability of ground water	F
TX86-100	Irrigation drainage quality of the lower Rio Grande valley	3/86 to 9/87	GW - SW	Effects of irrigation on water quality	OFA

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Utah					
UT79-141	Reconnaissance of the chemical quality of surface water in the Weber basin	7/79 to 6/81	SW	Effects of agriculture on water quality	C
UT86-179	Irrigation drainage problems at Stewart Lake Waterfowl Management Area	6/86 to 9/87	SW	Effects of irrigation on water quality	F OFA
UT87-180	Surface/ground-water relationships in the central Sevier valley	10/86 to 6/90	GW - SW	Effects of irrigation on water availability and quality	C
UT88-190	Ground water - surface water relations in the upper Sevier river basin	3/88 to 6/90	GW - SW	Effects of irrigation on water availability and quality	C
UT88-191	Irrigation drainage in the middle Green River basin	10/87 to 9/90	GW - SW	Effects of irrigation on water quality	OFA
UT88-194	Hydrology of Heber and Round Valleys, Wasatch County	5/88 to 6/90	GW - SW	Effects of irrigation on water availability and quality	C
Virginia					
VA76-044	Assessment of the water quality of selected watersheds	7/76 to 10/77	SW	Effects of agriculture on water quality	OFA
Washington					
WA70-147	Water resources of the Yakima Indian Reservation	4/70 to 9/80	GW - SW	Effects of irrigation on water availability and quality	C
WA74-173	Water quality investigation of the Yakima Indian Reservation	10/73 to 6/75	GW - SW	Effects of irrigation on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
WA--con't.					
WA76-195	Sulphur Creek pilot program investigation	3/76 to 10/81	SW	Effects of irrigation on water quality	C
WA77-207	A demonstration of best management practices on Columbia basin irrigated lands	4/77 to 9/82	SW	Effects of agricultural practices on water quality	C
WA78-211	Water resources of the Shoalwater Indian Reservation	10/77 to 9/79	GW - SW	Effects of agricultural chemicals on water quality	C
WA78-212	Water resources of developed areas in Clallam County	4/78 to 9/81	GW - SW	Effects of irrigation on groundwater recharge	C
WA79-220	Sediment data for evaluation of best management practices in irrigated agriculture	6/79 to 6/86	SW	Effects of agricultural practices on stream sedimentation	C
WA80-232	Ground-water flow in the Horse Heaven Hills area of south-central Washington	11/79 to 9/84	GW	Effects of irrigation on groundwater availability	C
WA82-277	Yakima River basin water enhancement	3/82 to 9/86	SW	Water supply for irrigation	OFA
WA82-281	Ground-water pumpage and water levels in the Columbia Plateau	3/82 to 9/87	GW	Effects of irrigation pumpage on availability of ground water	C
WA84-300	Use of LANDSAT imagery to define the distribution and rate of water use	2/84 to 9/85	GW - SW	Water use by agriculture	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
WA--con't.					
WA85-305	Crop-water determination through remote sensing	10/84 to 9/86	GW	Use of ground water for irrigation	C
WA86-315	Ground-water study for Benton and Franklin Counties	10/85 to 9/89	GW	Effects of irrigation on ground-water availability and quality	C
WA86-321	National water-quality assessment of surface water in the Pacific Northwest	10/85 to 9/88	GW - SW	Effects of irrigation on water quality	F
Wisconsin					
WI74-044	Irrigation and ground-water quality	8/73 to 6/76	GW - SW	Effects of irrigation on water quality	C
WI79-096	Nonpoint-source pollution for urban and rural areas in the lower Fox River basin	10/78 to 9/81	SW	Effects of agriculture on water quality	C
WI79-101	Chemical loading from selected streams tributary to Lake Michigan	8/79 to 9/83	SW	Effects of pesticides on water quality	C
WI86-146	Long-term effects of intensive farming and sprinkler irrigation on ground-water quality	10/85 to 9/87	GW	Effects of irrigation on ground-water quality	C
WI87-155	Hydrology and water quality of southwest Wisconsin bass streams	10/86 to 9/92	SW	Effects of agricultural pesticides on water quality	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Wyoming					
WY73-021	Study of ground-water systems in the Albin and LaGrange areas, southeastern Wyoming	8/72 to 12/75	GW	Effects of irrigation wells on the availability of ground water	C
WY74-024	Hydrologic evaluation of the Arikaree formation near Lusk	7/73 to 9/79	GW	Effects of irrigation wells on the availability of ground water	C
WY74-025	Hydrologic analysis of the Arikaree and alluvium aquifer system in the Dwyer Junction area, southeastern Wyoming	7/73 to 12/75	GW	Water supply for irrigation	C
WY77-038	Quantitative study of the Tertiary aquifers in southern Laramie County	10/76 to 9/79	GW	Water supply for irrigation	C
WY77-042	The effects of pumping from the Arikaree aquifer in the Uva area, southeastern Wyoming	4/77 to 9/77	GW - SW	Effects of irrigation withdrawals on water availability	C OFA
WY77-043	Effects of herbicide usage on the water quality of selected streams	6/77 to 9/82	SW	Effects of herbicides on water quality	C
WY78-046	Digital -model study of the Arikaree aquifer in Muleshoe Flat, southeastern Wyoming	10/77 to 9/78	GW	Effects of irrigation withdrawals on water availability	OFA
WY78-047	Digital - model study of the alluvial aquifer in Bates Hole, central Wyoming	11/77 to 9/81	GW - SW	Effects of irrigation withdrawals on water availability	C

Appendix B. -- List of selected U.S. Geological Survey investigations and research -- continued.

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
WY--con't.					
WY78-048	Digital - model study of the hydrologic system in the LaGrange area, southeastern Wyoming	10/77 to 9/81	GW - SW	Effects of irrigation withdrawals on water availability	C
WY79-052	Hydrologic conditions in the Wheatland Flats area, Platte County	4/79 to 3/82	GW - SW	Effects of irrigation withdrawals on water availability	F
WY82-068	Hydrologic evaluation of the shallow aquifer system in Saratoga Valley, south-central Wyoming	10/81 to 9/84	GW	Effects of irrigation withdrawals on water availability	C
WY86-096	Field-screening of irrigation drainage from the Kendrick Project near Casper	1/86 to 9/90	SW	Effects of irrigation on water quality	F OFA
WY88-106	Field screening of water quality, bottom sediments, and biota of the Riverton Irrigation Project	10/87 to 9/89	SW	Effects of irrigation on water quality	OFA
WY88-111	Assessment of irrigation drainage in the Kendrick Reclamation Project area	10/87 to 9/90	GW - SW	Effects of irrigation on water quality	OFA