THE U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PROGRAM FISCAL YEAR 1989

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 1989

by Bruce K. Gilbert and William B. Mann IV

ABSTRACT

The Federal-State Cooperative Program is a major U.S. Geological Survey (USGS) activity for the collection, analysis, and reporting of information on the quantity and quality of the Nation's water resources. The fundamental characteristic of the program is that most of the work is undertaken by the USGS through partnership agreements (50:50 matching of funds) with State, regional, and local agencies. The program's main 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) analyze the data for the purpose of appraising the availability and the physical, chemical, and biological characteristics of surface and ground water. During fiscal year 1989, hydrologic data collection, interpretive investigations, and research under the provisions of the Cooperative Program were conducted by Geological Survey personnel in offices in every State, Puerto Rico, and several territories in concert with more than 1,000 cooperating agencies. In fiscal year 1989, Federal funding of almost $59 million was matched by cooperating agencies, who also provided approximately $8 million unmatched for a total program of about $126 million. This amounted to more than 40 percent of the total funds for the Geological Survey's water-resources activities.

This report presents examples of current (1989) investigations, as well as updated information on the National Water-Use Information Program, hydrologic investigations and research related to agriculture, and projects selected and funded under the merit proposal system.

INTRODUCTION

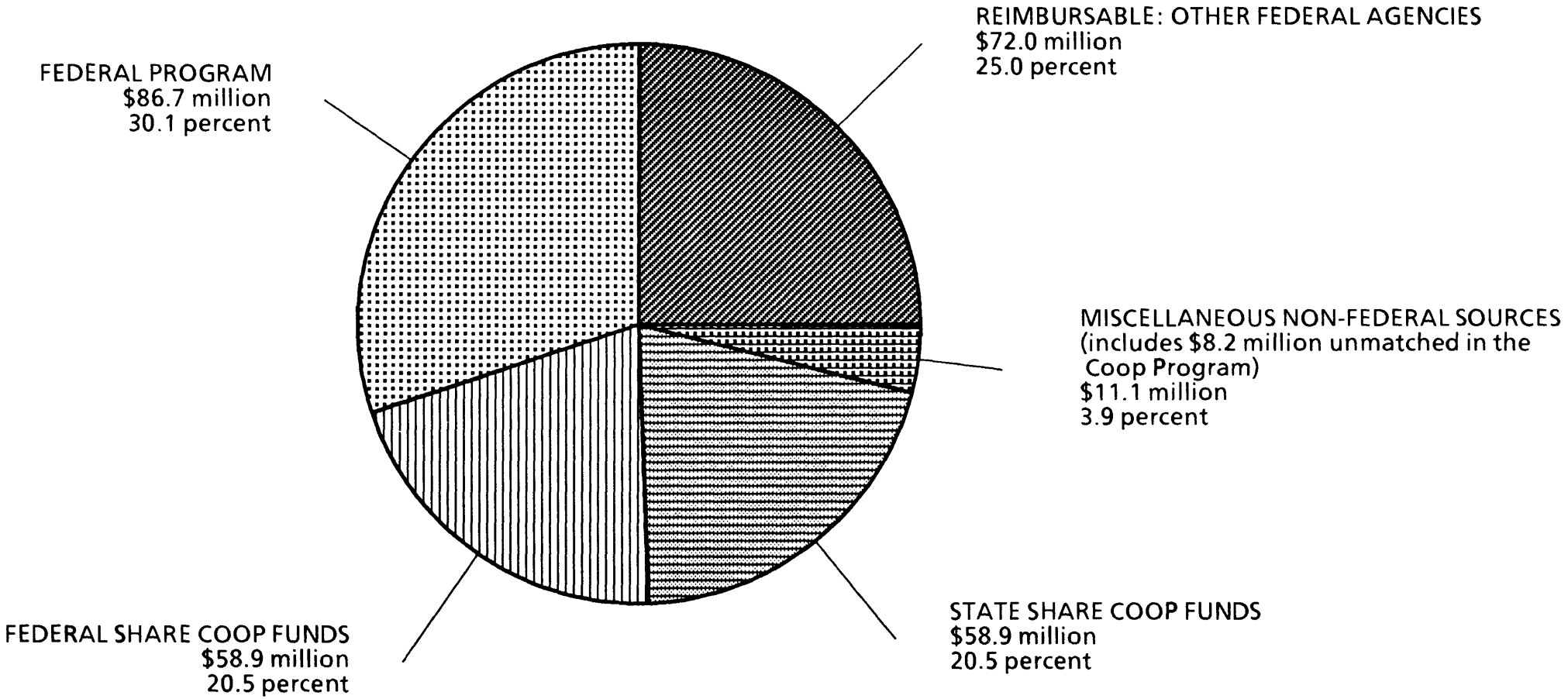
Federal, State, regional, and local agencies share keen interests in appraising the Nation's water resources and in seeking solutions to water-related problems. Because of varying missions and areas of responsibility, at times there are diverse perceptions of need, priorities, and approaches. One of the principal strengths of the U.S. Geological Survey's (USGS) Federal-State Cooperative Program is that this diversity can be accommodated through joint planning and funding (50:50 matching) of hydrologic data collection, investigations, and research.

The Cooperative Program, a partnership between the Geological Survey and State and local agencies, provides a balance for water-resources investigations. It is a major part of the Geological Survey's coordinated program of water-resources investigations and research. 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) analyze the data for the purpose of appraising the availability and the physical, chemical, and biological characteristics of surface and ground water. 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) 1989, hydrologic data collection, interpretive investigations, and research were conducted under the provisions of the Cooperative Program by Geological Survey personnel in offices in every State, Puerto Rico, and several territories in concert with more than 1,000 cooperating 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 1989, Federal funding of almost $59 million was matched by the cooperating agencies; cooperators also furnished approximately $8 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). Of the $67 million provided by cooperators, approximately 60 percent was contributed by State agencies and 40 percent was contributed by regional, county, city and other local entities.



FY 1989 TOTAL $287.6 MILLION

Figure 1 - Actual obligations of the U.S. Geological Survey
Water Resources Division, fiscal year 1989

The fundamental characteristic of Federal-State Cooperative Program is 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 support known as direct expenditures, rather than funds. 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.

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 1989, the Federal-State Cooperative Program funded totally the operation of 3,800 continuous streamflow stations and funded, in combination with other sources, another 1,000 continuous streamflow stations. These stations constitute more than half of the continuous streamflow stations operated by the Geological Survey. The program provided funds for the collection of ground-water levels at approximately 30,000 wells. The FY 1989 program also provided for collection of water-quality data at a total of more than 2,100 surface-water stations and a total of about 6,100 ground-water stations. These data are necessary to determine the suitability of water for various uses, to identify trends, and to evaluate the effects of stresses on surface and ground water.

During FY 1989, the Geological Survey also conducted about 900 interpretive and research investigations, of which about 540 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, storm runoff, and the effects of coal mining and agricultural activities on the hydrologic system.

All data and results of analytical studies are made available to cooperating agencies and the public through various published reports (more than 1,600 in FY 1989), 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). Hydrologic data can be accessed by computer terminals at offices in every State.

In many places, the Cooperative Program provides the only source of support for water-data collection and investigations required to assess, on a continuing basis, the status of the Nation's water resources. Information developed in the Cooperative Program has relevance to potential and emerging long-term problems,

such as water supply, waste disposal, energy development, and environmental management and protection. Because common analytical methods and techniques are used, the information also is relevant to problems having interstate, regional, national, or international significance. The information furnishes the basis required to carry out interstate and international compacts, Federal law and court decrees, congressionally mandated studies, regional and national water-resources assessments, and planning activities. The Cooperative Program also expedites the preparation of applications for mining permits and mine plans by the coal industry by providing needed hydrologic data, and aids State authorities in reviewing the applications and plans. In addition, the Cooperative Program provides support for most of the streamgaging stations used by the National Weather Service for flood forecasts and warnings. Within the Cooperative Program, typically about half of the funds support the collection of hydrologic data; the remaining half support the conduct of hydrologic studies and investigations.

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 the program each year. 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 $10 million or more 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 program priorities have changed little during the past several years. Water-quality continues to head the list. The following issues have been identified as highest priority in developing the FY 1990 Cooperative Program:

Ground-Water Quality--Concern over the quality of the Nation's ground-water resources continues to create demands for studies relating to both management 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 manage 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.

Water Supply and Demand--Increasing diversion, withdrawal, and use of water stress 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 is needed on the identification of aquifers that are major sources for water supply. Flow-system definition and simulation are essential to anticipate stress response and for management by regulatory agencies, especially for stream-aquifer systems. Topics for study will include streamflow response to drought conditions and system response both to projected uses and supply-augmentation schemes.

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.

Hydrologic Hazards--Economic losses from floods, droughts, rising lake levels, mudflows, debris flows, sedimentation, and other hydrologic hazards amount to billions of dollars annually. 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.

Hydrology and Changing Climate or Atmospheric Chemistry--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 water, and in urban settings that produce large loads of atmospheric pollutants. In addition to the damage associated with rising lake levels, other issues 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.

MERIT PROPOSAL PROCESS

Most of the Federal matching funds are allocated to highest priority activities by the Water Resources Division's four regional offices after ranking the work proposed in their respective geographical areas of responsibility (figure 2). However, in FY 1983, the Geological Survey instituted a "merit proposal" process for evaluating and funding selected proposals for water-resources investigations as part of the Federal-State Cooperative Program. The federal matching fund support for merit proposals was $1 million in FY 1983 and has continued at or about that level ever since then. Thus, with the cooperators providing an equal amount of funds, a total of about $2 million has been allocated each year.

The new system formalizes existing procedures that have been used for the past 15-20 years to rank candidate proposals for allocation of funds. Each merit proposal is reviewed and evaluated separately by staff members of six different organizational units of the Division. The rankings are then consolidated, differences are arbitrated, and funds are allocated to the investigations in priority order. Additional effort is applied, however, to ensure that the highest priority work is undertaken with the merit funds and that the anticipated technical contributions to the science of hydrology will be of top quality. A list of 88 projects selected and funded in the competitive merit proposal process is presented as Appendix B to this report.

Although it is highly probable that most of the merit investigations would have been funded under traditional procedures, the merit proposal process has strengthened the program. The program development process has been strengthened because of the increased deliberation within WRD during the merit ranking. Incentive has been added for the planning and development of high quality proposals and technology transfer has been enhanced through closer interaction of the Federal-State Cooperative Program and the National Research Program. (A report by Friedman and Donato, 1989, describes activities in the National Research Program in FY 1988.) Plans are to continue and perhaps expand this process, depending on the availability of funds.

Figure 2.--U.S. Geological Survey Water Resources Division regional boundaries and location of principal offices.

NATIONAL WATER-USE INFORMATION PROGRAM

The Geological Survey's National Water-Use Information Program is designed to determine how much water is withdrawn for use, how much water is consumptively used, the purpose for which water is used, where and how much water is returned, the effect of use on water quality, and the factors which influence water use. The goal of this program is to make accurate, consistent, and timely water-use information available to water policy makers, planners, managers, hydrologists, and others.

This part of the Federal-State Cooperative Program was started in FY 1978 to provide for the comprehensive and systematic collection, storage, analysis, and dissemination of water-use data and information throughout the United States. Statistics on domestic, industrial, and agricultural water use are required for the planning, management, and development of the Nation's water resources and to provide information that will assist in identifying and resolving critical water problems related to resource allocations, environmental impacts, energy development, and water-quality. The major categories of water use for which information is being obtained are irrigation, livestock, commercial, domestic, industrial, mining, public supply, sewage treatment, thermoelectric power generation, and hydroelectric power generation.

All states (except Vermont) and Puerto Rico are participating in the program. Thirty-five of the participating States and Puerto Rico have an operational State water-use data system capable of storing and retrieving water-use data for the major water-use categories. The remaining States have information for certain categories of water-use information and utilize their own systems for managing the water-use data. In some States that have completed data-collection inventories, sampling strategies and techniques are being developed to update the data.

Program activities and recent accomplishments include:

- ARKANSAS: The Eastern Arkansas Comprehensive Study (EARCS) involves mathematical modeling of the Mississippi River Valley alluvial aquifer in a 26 county area. Computer programs developed by the University of Arkansas use water-use projections through the year 2030 and a constraint of maintaining at least 20 feet of saturated aquifer thickness to optimize the amounts of ground and surface water that may be withdrawn to help meet the total water demand. In addition, the amount of unmet demand also is computed. EARCS is an example of a progressive multi-agency cooperative study in the area of applied hydrology and water management. Several cooperating State and Federal agencies are contributing data and expertise to the effort.

- CALIFORNIA: A project to estimate ground-water withdrawals for irrigation based on power-consumption records of wells in the Central Valley of California has resulted in improved estimates of irrigation water use. The Pacific Gas and Electric Company (PG&E) now identifies the specific use of the water and the corresponding power required to pump the water from the well. Records also are kept on the type of irrigation system used, such as sprinkler, flood, or drip. An important finding is that previous estimates of irrigation withdrawals using less detailed methods may have significantly overestimated actual withdrawals. The potential now exists to estimate pumpage from the PG&E power data for the northern two thirds of California.

- CONNECTICUT: The Connecticut Department of Environmental Protection (DEP) has been an active cooperator in the Water-Use Program since it began in 1978. The DEP is concerned with assessing demands placed on all surface- and ground-water resources in Connecticut. Due to an early and heavy reliance on automated data systems to manage and analyze water-use data, the Connecticut Water-Use Program supports projects that promote efficient and cost-effective means to evaluate past, present, and future needs for water. For example, a computerized data system has been developed by DEP for use by State agencies to maintain and share water-use information. The system is integrated with the Connecticut Geographic Information System (GIS) and contains site-specific data. Standard methodologies are used to aggregate the data to meet national needs. The Connecticut Water-Use Program also maintains the following digitized coverages on DEP's GIS at a scale of 1:24,000:

  a. Public supply wells, reservoirs, and watersheds
  b. Public supply existing service areas
  c. Public supply exclusive (future) service areas
  d. Wastewater treatment plants and sewer areas
  e. Water diversions regulated by DEP

  As a result of this active program, many water-use publications, maps, brochures, and posters have been produced to better inform water planners, managers, and the general public on the use of water in Connecticut.

- FLORIDA: Increased water demands created primarily by population growth have caused concern in many areas of Florida about the availability and quality of drinking water. As part of the Water-Use Program with the Florida Department of Environmental Regulation (DER), drinking-water needs for each county in Florida were projected for the next 30 years. Public-supply requirements were estimated for the years 2000, 2010, and 2020 by determining for each county: (1) the projected population; (2) the percentage of projected population to be served by a public-supply water system; (3) the projected demand for domestic water use. These estimates will provide a means for the DER and other water managers to make sound decisions regarding the protection and management of drinking water resources in Florida.

- NEVADA: A demonstration project was completed for the Nevada State Engineer showing a method to generate maps of irrigated areas using Landsat images and a geographic information system. The maps also included the location of wells, water features, roads, and property lines.

- TENNESSEE: The USGS in cooperation with the Upper Duck River Development Agency (UDRDA) and the Tennessee State Planning Office, is conducting a study of water use and availability in the Duck River basin above Columbia, Tennessee. Currently, the Duck River is the main source of water for public supply, industry, commerce, and agriculture in the basin. The members of the UDRDA are concerned that existing water supplies may not meet future water demands without additional surface-water impoundment of the Duck River at Columbia. This study will use a mathematical model to forecast annual water demand for 5, 10, and 25 years, based on anticipated growth in the area. These projections, in conjunction with other flow-duration characteristics, will demonstrate if the Duck River can meet future water-use requirements. Potential ground-water resources also will be examined.

UPDATE ON ACTIVITIES RELATED TO AGRICULTURE

From 1970 through 1988, the Geological Survey conducted more than 250 investigations related to agriculture (Gilbert and Mann, 1989). Of these, about 70 percent were conducted as part of the Federal-State Cooperative Program. Recent information shows that in 1988 and in 1989 approximately 100 investigations related to agricultural activities were underway, with more than 60 percent supported as part of the Cooperative Program. The Geological Survey Federal Program and the Other Federal Agency Program provided support for the remainder.

Appendix C lists selected investigations related to agricultural activities not previously reported in Gilbert and Mann, 1989. These include 1 that started in FY 1982, 10 that started in FY 1988, and 17 that started in FY 1989. Also included are four investigations that began in FY 1990.

With respect to plans for the coming years, it is anticipated that the Geological Survey will increase further its activities related to agriculture. In part this may be expected to support work related to the U.S. Department of Agriculture's Presidential Water Quality Initiative as, for example, in the development of regional and local information about the surface- and ground-water resources in agricultural areas. Such investigations might include:

- Delineation of aquifer recharge areas
- Characterization of ground-water quality
- Identification of sources of contamination
- Design, establishment, and operation of hydrologic monitoring networks
- Evaluation of present and projected water use, and
- Studies of the effects on water quality of various farming systems and practices in selected hydrologic settings.

EXAMPLES OF CURRENT INVESTIGATIONS

Several examples of recent cooperative investigations follow:

- Arizona: Occurrence and Movement of Radionuclides and Other Trace Elements in the Puerco and Lower Colorado River Basins

  This interdisciplinary research effort is examining processes of contaminant movement from uranium mine operations and natural sources in and between ground water and surface water in a water-scarce region that includes a large part of the Navajo Indian Reservation. The objectives of the study include determination of contaminant sources, their rates and mechanisms of movement, and health risks associated with use of selected water resources in the Region. The work is being carried out by the USGS in cooperation with the Arizona Department of Water Resources, the Arizona Department of Environmental Quality, and the Navajo Nation.

- Hawaii: Landslide and Debris-Flow Hazards

  The objective of this study is to develop an understanding of the location, timing, and mechanical behavior of landslide and debris flows in a sub-tropical environment. In cooperation with the City and County of Hawaii, the USGS will use both field and computer-oriented techniques to determine when and where slides are most likely to occur. Large landslides have been a serious problem on Oahu, and costs of damages to homes and agricultural activities have escalated into the millions of dollars.

- Idaho: Effects of Water Use on Recharge/Discharge Relations in the Mud Lake Area, Southeastern Idaho

  The Mud Lake area is surrounded by two Wildlife Management Areas and one National Wildlife Refuge. Wildlife managers are concerned that existing and proposed irrigation practices in their areas could adversely affect the quantity and quality of water needed by flora and fauna. The objectives of this study are to: analyze the potential hydrologic effects of continued and expanded development of local water resources for irrigated agriculture on the area; assess the potential effects of changing irrigation practices outside the study area on ground-water flow into the area; and identify the presence or absence of selected naturally occurring and agricultural chemical constituents in the local water supply and in lake and wetland bottom sediments. The USGS and the Idaho Department of Fish and Game are cooperating on the investigation.

- Illinois: Improved Estimates of Flooding in Urban Areas

  Damage caused by floods is especially acute in highly urbanized watersheds. Yet the predictive tools used to estimate the potential effects of flooding are least accurate in urban areas because of rapidly changing land-use activities. The USGS, in cooperation with DuPage County and the Illinois Department of Water Resources, is improving statistical methods used to estimate peak flood levels and volumes in densely-populated, rapidly-changing areas around Chicago. The methods will provide better information for protecting existing structures and for planning future development.

- Iowa: Analysis of Water Quality and the Flow System in the Big Springs Ground-Water Basin

  The USGS, in cooperation with the Iowa Department of Natural Resources, Geological Survey Bureau, is monitoring changes in the concentration of agricultural chemicals discharging from surface and ground water in the Big Springs basin. Precipitation, surface-water, and ground-water data are being collected to calculate the recharge and discharge from the system. Data also are being collected to study the ground-water/surface-water relations in the basin. The Big Springs basin has become a nationally known demonstration area for improving ground-water quality through the modification of agricultural practices. The results of the study will be useful for evaluating the effectiveness of State and Federal agricultural agencies' efforts in the basin to modify farm practices, to decrease agricultural-chemical use, and for understanding how agricultural chemicals move through unconsolidated materials to streams and to underlying bedrock aquifers.

- Kentucky: Ground-Water Flow and Thermal Transport in the Louisville Alluvial Aquifer with Induced Infiltration

  Energy cost savings are currently being obtained by several large businesses in the downtown Louisville area by pumping cooling water from the Louisville alluvial aquifer for use in ground-water heat pumps. Hot water is then reinjected into the aquifer. The Louisville alluvial aquifer has a limited capacity to assimilate this heated water. The USGS, in cooperation with Jefferson County is developing a comprehensive thermal transport model of the aquifer. The model will be used to investigate the potential for alternative aquifer management strategies to extend the thermal capacity of the aquifer.

- Maryland: Acidification of Small Streams in the Blue Ridge Mountains

  The effects of acid rain on streams have been recognized throughout the world for several decades. During most of this period, researchers assumed that these effects increased gradually over time as pollution in the atmosphere increased. More recently, however, studies indicate that for many small streams, most of the damage from acidification occurs during storms, when the stream's ability to "buffer" the acid rain may be significantly reduced. To explore this possibility, the USGS and the Maryland Department of the Environment are monitoring the changes in water quality of small streams in western Maryland during varying rainfall conditions. The geology of the area, which controls the buffering capacity of the streams, also is being studied. Results of the study are expected to help identify the factors that influence acidification and provide insight into how these factors can be managed to reduce adverse effects on the biological communities supported by the streams.

- Montana: Hydrogeochemistry of Coal-Mine Spoils

  The hydrogeochemical processes that occur in ground water as a result of surface coal mining are being investigated by use of a scanning-electron microscope, X-ray diffraction, and analysis of ground water for common and trace elements, stable and radioactive isotopes, and dissolved gases. Knowledge of the hydrogeochemical processes can help managers and regulators to mitigate the effects of surface coal mining on ground-water quality. The USGS is conducting this study in cooperation with the Montana Department of State Lands and the U.S. Bureau of Land Management.

- New Jersey: Naturally Occurring Radionuclides in Ground Water in Southern New Jersey

  Recently, the U.S. Environmental Protection Agency has postulated that risks to public health from water-borne radionuclides, such as radium, uranium, and radon, may be greater than from all other toxic material in water combined. Also, because radionuclides usually occur naturally in ground water, prevention is not a feasible method of control. The USGS and the New Jersey Department of Environmental Protection are cooperating on a project in southern New Jersey that will help identify the types of geologic formations that contribute to radionuclide contamination. Also, the project will study the processes responsible for the movement and eventual fate of the radionuclides. This information will be used by water-resource planners in predicting locations of probable contamination and in assessing risks to public health from alternative supplies of drinking water.

- New York: Stormwater Detention in Wetlands Near Rochester

  During periods of heavy rain, polluted stormwater often drains from urban areas into nearby streams and lakes, causing a serious deterioration of water quality downstream. Several methods of treating stormwater have been proposed, but most of these methods are costly because of the large volumes of water involved. One possible exception is to use wetland areas as a natural filter for stormwater. Preliminary results of small-scale studies are promising. To determine the feasibility of the method on a larger scale, the USGS, in cooperation with the New York Department of Conservation and the Monroe County Department of Health, is studying the effects of dispersing some of the stormwater from Rochester into a cattail marsh along Lake Ontario. By evaluating the changes in the quality of the stormwater and the changes to the marsh ecosystem, the investigators can determine the efficiency of wetlands in treating stormwater.

- North Carolina: Effects of Land-Management Practices on Sediment and Chemical Transport in Guilford County

  The USGS, in cooperation with Guilford County, is evaluating and quantifying fluvial sediment and associated chemical constituents transported in surface water from selected basins with different land-management practices. Four small basins are being studied: (1) a heavily farmed basin in which best management practices (BMP's) are used; (2) a heavily farmed basin in which poor management practices are used; (3) a basin with mixed rural land uses: and (4) a forested basin. The dispersion and movement of selected chemical constituents from distinct soil horizons in the unsaturated zone and from discrete zones of the unconfined aquifer are being quantified. In the mixed rural land use basin, after an initial period of study, BMP's will be implemented. A follow-up study will then take place for purposes of comparison. The forested basin is to remain unchanged for the duration of the project.

- North Carolina: Estuarine Water Quality and the Management of Artificial Drainage from Wetlands: Albemarle-Pamlico Estuaries

  The USGS, in cooperation with the North Carolina Department of Natural Resources, is investigating the effects on estuarine water quality of artificial wetland drainage for agricultural purposes. One objective is to quantify the effects of water-control structures on runoff rates and volumes, and on sediment and nutrient loads in drainage ditches downstream from drained fields. The effects of variable freshwater inflows on the salinity of "nursery" areas in the estuary, as well as the cumulative effects of artificial drainage activities on these "nursery" areas, also are being studied.

- Oklahoma: Toxic Substances in the Central Oklahoma Aquifer
  Water in the Central Oklahoma aquifer contains naturally occurring toxic substances whose concentrations exceed U.S. Environmental Protection Agency primary drinking-water standards. The USGS, in cooperation with the Association of Central Oklahoma Governments, is investigating the sources of arsenic, chromium, selenium, and uranium in the aquifer, and the processes that mobilize these substances. The areal distribution of these substances is being determined and their occurrence in the ground water is being related to the water chemistry, to the mineralogy, lithology, diagenetic history, depositional environments, and to the geochemistry of the aquifer.

- Oregon: Water-Quality Study of Johnson Creek
  Synoptic assessments by the USGS, in cooperation with the city of Portland, have identified two water-quality problems of considerable significance that were previously unsuspected. First, although Johnson Creek drains only 0.5 percent of the Willamette River basin, it contributes about 10-25 percent of the man-made organic contaminants carried by the Willamette River. Second, metals in bottom material at one location on Johnson Creek are among the highest concentrations observed anywhere in Oregon, yet this point-source contamination was previously undetected by conventional monitoring methods.

- Puerto Rico: Ground-Water System-Management Study, Upper Rio Grande de Loiza Basin
  There is intense competition for ground-water and surface-water resources in the upper Rio Grande de Loiza basin and associated Caguas-Juncos aquifer. The USGS, in cooperation with the Puerto Rico Aqueduct and Sewer Authority, is conducting a study to provide the tools and information needed to determine an optimal water-management scheme for the conjunctive use of ground water and surface water in the area. Ground-water and optimization models will be linked in order to identify alternatives so as to miminize both the movement of contaminants into ground-water pumping centers and the impact of ground-water pumpage on streamflow.

- Wyoming: Determination of Long-Term Atmospheric Deposition Quality and Climatic Changes, Wyoming
  A long-term record of the chemical and isotopic composition of atmospheric deposition is needed to evaluate the possible relation between anthropogenic emissions and their effects on the chemical composition of atmospheric deposition and climate change. Recent studies of wet deposition have used short-term data bases and cannot be related to true baseline conditions present before significant development in the western United States and northern Mexico. In this investigation, the USGS will use variations in concentrations of chemical and isotopic constituents from glacier-ice and tree-ring samples (1) to reconstruct long-term records of the chemical quality of atmospheric deposition, and (2) to reconstruct long-term climatic and annual discharge records. Results obtained from this study are expected to be useful to water-resource planners and managers concerned about the potential effects of anthropogenic inputs to the atmosphere and their effects on water quality, water quantity, and climate change. The work is being done in cooperation with the Wyoming State Engineer's Office, the Wyoming Water Development Commission, and the Arapahoe and Shoshone Indian Tribes.

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 1989, 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 the Cooperative Program in FY 1989 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. 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.

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 1989

Alabama:
- Alabama Department of--
  - Economic and Community Affairs
  - Environmental Management
  - Highways
- Anniston, City of
- Birmingham, Water Works Board
- Butler County Water Authority
- Coffee County Commission
- Dauphin Island Water Authority
- Geological Survey of Alabama
- Greenville Water Works and Sewer Board
- Harvest-Monrovia Water & Fire Protection Authority
- Heflin, City of
- Huntsville, City of, Public Works
- Jefferson County Commission
- Montgomery, City of, Water Works and Sanitary Sewer Board
- Ragland, City of
- State Climatologist
- Sumter County
- Tuscaloosa, City of
- University of Alabama, Tuscaloosa

Alaska:
- Alaska Department of--
  - Fish and Game
  - Military & Veterans Affairs, Division of--
    - Emergency Services
  - Natural Resources, Division of--
    - Geological and Geophysical Surveys
    - Technical Services
  - Transportation and Public Facilities
- Alaska Energy Authority
- Anchorage, Municipality of
- Fairbanks North Star Borough
- Juneau, City and Borough of
- Kenai Peninsula Borough

Alaska--Continued
- Matanuska - Susitna Borough
- Sitka, City and Borough of
- University of Alaska, Fairbanks

Arizona:
- Arizona Department of--
  - Environmental Quality
  - Health Services
  - Transportation
  - Water Resources
- Arizona Municipal Water Users Association
- Arizona State Land Department
- Central Arizona Water Conservation District
- 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 Department of Transportation
- Safford, City of, Water, Gas & Sewer Department
- Salt River Valley Water Users Association
- San Carlos Irrigation and Drainage District
- Scottsdale, City of, Water Resources Department
- Show Low Irrigation Company
- The Navajo Tribal Council, Div. of Water Resources
- Tohono O'dham Nation
- Tucson, City of
- University of Arizona
- Yuma, City of

Arkansas:
- Arkansas Department of--
  - Health
  - Highway and Transportation

Arkansas--Continued
- Pollution Control and Ecology
- Arkansas Game and Fish Commission, Fisheries Division
- Arkansas Geological Commission
- Arkansas-Oklahoma Arkansas River Compact Commission
- Arkansas Soil and Water Conservation Commission
- Independence County
- Little Rock Municipal Water Works

California:
- Alameda County --
  - Flood Control and Water Conservation District, (Hayward)
  - Water District
- Antelope Valley - East Kern Water Agency
- California Department of --
  - Boating and Waterways
  - Health Services
  - Parks and Recreation
  - Transportation
  - Water Resources --
    - Central District (Sacramento)
    - Northern District (Red Bluff)
    - San Joaquin District (Fresno)
- California State Water Resources Control Board
- 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
- Fox Canyon Groundwater Management Agency
- Fresno Metropolitan Flood Control District

California--Continued
- 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, County of, Dept. of Public Works
- Los Angeles Department of Water and Power
- Madera Irrigation District
- Marin County Department of Public Works
- Marin Municipal Water District
- Mendocino County Water Agency
- Merced, City of
- Merced Irrigation District
- Mojave Water Agency
- Mono, County of
- Montecito Water District
- Monterey County Flood Control and Water Conservation District
- Monterey Peninsula Water Municipal District
- Oakdale - South San Joaquin Irrigation District
- Orange County--
  - Environmental Management Agency
  - Water District
- Oroville - Wyandotte Irrigation District
- Pechanga Indian Reservation
- Poway, City of
- Rancho California Water District
- Regional Water Quality-Lahontan Region
- Riverside County Flood Control and Water Conservation District
- 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

California--Continued
- San Bernardino Valley Municipal Water District
- San Diego City Water Utility
- 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, Water Dept. - City Hall
- Santa Cruz County Planning Department
- Santa Maria Valley Water Conservation District
- Santa Ynez River Water Conservation District
- Scotts Valley Water District
- Sonoma County--
  - Planning Department
  - Water Agency
- Tahoe Regional Planning Agency
- Tulare County Flood Control District
- Turlock Irrigation District
- United Water Conservation District
- University of California, Berkley
- Ventura County Public Works Agency
- Westlands Water District
- Woodbridge Irrigation District
- Yolo County Flood Control and Water Conservation District
- Yuba County Water Agency

Colorado:
- Arkansas River Compact Administration

Colorado--Continued
- 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 Pines North Metropolitan District
- Castle Rock, Town of
- Centennial Water and Sanitation
- Cherokee Water and Sanitation District
- Colorado Department of--
  - Health
- Colorado Division of --
  - Mined Land Reclamation
  - Water Resources, Office of the State Engineer
- Colorado River Water Conservation District
- Colorado Springs, City of--
  - Department of Public Utilities
  - Office of the City Manager
- Delts County Board of County Commissioners
- Denver City and County of, 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
- Garfield County
- Glendale, City of
- Glenwood Springs, City of
- Golden, City of
- Grand County Board of Commissioners
- Jefferson, County of, Board of County Commissioners
- Longmont, City of

Cooperators By State -- Continued

Colorado--Continued
- Loveland, City of
- Lower Fountain Water-Quality Management Assoc.
- Metropolitan Denver Sewage Disposal District No. 1
- Moffat County
- Northern Colorado Water Conservancy District
- Northglenn, City of
- Pikes Peak Area Council of Governments
- Pitkin County Board of Commissioners
- Pueblo, City of, Board of Water Works
- Pueblo County Commissioners
- Pueblo County Dept. of Public Safety and Operations
- Pueblo West Metropolitan District
- Rio Blanco, County of
- Rio Grande Water Conservation District
- Southeastern Colorado Water Conservancy District
- Southern Ute Indians
- Southwestern Colorado Water Conservancy District
- St. Charles Mesa Water Association
- Steamboat Springs, City of
- Thornton, City of
- Trinchera Conservancy District
- Uncompahgre Valley Water Users Association
- Upper Arkansas Area Council of Governments
- Upper Arkansas River Water Conservancy District
- Upper Eagle Valley Water and Sanitation District
- Upper Yampa Water Conservancy District
- Urban Drainage and Flood Control District
- Ute Mountain Indian Tribe
- Vail Valley Conservation Water Authority
- 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

Connecticut--Continued
- 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
- Broward County--
  - Environmental Quality Control Board
  - Water Resources Management Division
- Cape Coral, City of
- Cocoa, City of
- Cottondale, City of
- Datona Beach, City of
- Edgewater, City of
- Englewood Water District
- Escambia County, Board of County Commissioners
- Florida Department of--
  - Environmental Regulation, Bureau of Laboratories and Special Programs
  - Natural Resources --
    - Division of Marine Resources
    - Division of Recreation and Parks (Hobe Sound and Tallahassee)
    - Transportation
- Florida Institute of Phosphate Research
- Florida Keys Aqueduct Authority
- Fort Lauderdale, City of
- Fort Walton Beach, City of

Cooperators By State -- Continued

Florida--Continued
- 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 --
  - Courthouse
  - Department of Public Works
- Madison, City of
- Manatee County, --
  - Board of County Commissioners
  - Public Health Unit
- Marion County Board of Commissioners
- Metropolitan Dade County, Department of Environmental Resources Management
- Miami-Dade Water and Sewer Authority
- Northwest Florida Water Management District
- Ocala, City of
- Palm Beach County, Board of County Commissioners
- Perry, City of
- Pinellas County
- Polk County, Board of County Commissioners
- Pompano Beach, City of, Water and Sewer Department
- Port Orange, City of
- Quincy, City of
- Reedy Creek Improvement District
- Sanford, City of
- Sarasota, City of

Florida--Continued
- Sarasota County
- South Florida Water Management District
- South Indian River Water Control 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 (Live Oak)
- Suwannee River Authority (Trenton)
- 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
- Walton County
- West Coast Regional Water Supply Authority
- Winter Park, City of

Georgia:
- Albany, City of
- Albany Water, Gas, and Light Commission
- Bibb County, Board of County Commissioners
- Blairsville, City of
- Brunswick, City of
- California Air Resources Board
- Clayton County Water Authority
- Cobb County
- Covington, City of
- Georgia Department of--
  - Natural Resources--
    - Environmental Protection Division
    - Geological Survey

Georgia--Continued
- Water Management Branch
- Water Quality Support Program
- Transportation

Georgia State University, Dept. of Geology
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
Walton County Board of Commissioners

Hawaii:
County of Hawaii, Department of Water Supply
Hawaii Department of--
- Land and Natural Resources--
  - Division of Water and Land Development
- Transportation

Honolulu Board of Water Supply
Honolulu, City and County of, --
- Department of Public Works

Kauai, County of, Department of Water Supply
Maui, County of, Department of Water Supply

Idaho
Boise, City of
College of Southern Idaho
Idaho Department of--
- Fish and Game
- Health and Welfare
- Water Resources

Shoshone- Bannock Tribes
Shoshone, County of
Sun Valley Water and Sewer District
SW Irrigation District
Teton County, Board of Commissioners

Idaho--Continued
Water District No. 1--Idaho Falls
Water District No. 31 (Dubois)
Water District No. 32D (Dubois)

Illinois:
Bloomington and Normal Sanitary District
Cook County Forest Preserve District
Decatur, City of
De Kalb, City of, Public Works Dept.
Du Page County, --
- Department of Environmental Concerns
- Forest Preserve, Planning and
  - Development Section

Illinois Department of Transportation,
- Division of Water Resources

Illinois Environmental Protection Agency
Illinois State Water Survey, --
- Department of Energy and Natural Resources
- Special Studies

Metropolitan Water Reclamation District of Greater
- Chicago

Springfield, City of

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

Indianapolis Department of Public Works

Iowa:
Carroll County Health Department
Cedar Rapids, City of
Charles City, City of

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

Kansas:
- Arkansas River Compact Administration
- Clay, County of
- Emporia Department of Public Works
- Equus Beds Groundwater Management District No. 2
- Geary, County of
- Hays, City of
- Iowa Tribe of Kansas and Nebraska
- Kansas Department of--
  - Health and Environment
  - Transportation
- Kansas Geological Survey
- Kansas State Board of Agriculture, Division of
  - Water Resources
- Kansas State University
  - Department of Geology
- Kansas University Center for Research, Inc.
- Kansas Water Office
- Kickapoo Tribe of Kansas
- Linn, County of
- Prairie Band of Potawatomi

Kansas--Continued
- Sac and Fox Tribe of Missouri
- Sedgwick County Department of Environmental
  - Resources
- Sumner, County of
- Wichita, City of

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

Louisiana:
- Capital-Area Groundwater Conservation Commission
- East Baton Rouge Parish
- Jefferson Parish Department of Public Utilities
- Louisiana Department of--
  - Environmental Quality
  - Transportation and Development--
    - Materials Lab
    - Office of Public Works
  - Wildlife and Fisheries
- Louisiana Geological Survey, Louisiana State
  - University
- Sabine River Compact Administration
- West Monroe, City of

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

Maine--Continued
- Conservation, Geological Survey
- Environmental Protection
- Inland Fisheries and Wildlife
- Transportation
- North Maine 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, Planning and Zoning
- 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, Waste Treatment Facilities
- Washington Suburban Sanitary Commission

Massachusetts:
- Barnstable County Commissioners
- Massachusetts Department of--
  - Environmental Management, Division of Water Resources
  - Environmental Pollution --
  - Division of Water Pollution Control
  - Division of Water Supply
  - Fisheries, Wildlife and Environmental Law Enforcement
  - Division of Fisheries and Wildlife
  - Public Works
- Hazardous Waste Facility, Site Safety Council
- Massachusetts Water Resources Authority
- Metro District Commission --
  - Watershed Management Division
  - Parks Engineering and Construction Division
- New England Interstate Water Pollution Control Commission
- Woods Hole Oceanographic Institute

Michigan:
- Ann Arbor, City of, Wastewater Treatment Plant
- Battle Creek, City of
- Cadillac, City of, Wastewater Treatment Plant
- Clare, City of
- Coldwater, City of, Board of Public Utilities
- Elsie, Village of, Dept. of Public Works
- Flint, City of, Department of Public Works and Utilities
- Genesee County Drain Commission, Division of Water and Waste Services
- Huron-Clinton Metropolitan Authority
- Huron, County of
- Imlay, City of
- Kalamazoo, City of, Department of Public Utilities
- Lansing, City of, Board of Water and Light, Water and Stream Division
- Macomb, County of
- Mason, City of
- Michigan Department of--
  - Natural Resources
  - Transportation
- Negavnee, City of, Water and Wastewater Treatment Plant

Michigan--Continued
- Norway, City of
- Oakland County Drain Commission
- Otsego County Road Commission
- Portage, City of
- 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, Div. of Resources Management
- Lower Red River Watershed Management District
- Metropolitan Waste Control Commission
- Mille Lacs Reservation Business Commission
- Minneapolis Water Works
- Minnesota Department of--
  - Natural Resources, Division of Waters
  - Transportation
- Red Lake Tribal Reservation Business Committee
- Rochester Public Utilities
- St. Paul Water Utility
- University of Minnesota, Dept. of Soil Science
- 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

Mississippi--Continued
- Natural Resources--
  - Bureau of Geology
  - Bureau of Land and Water Resources
  - Bureau of Pollution Control
- 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
    - Division of Geology and Land Survey
    - Land Reclamation Commission
- Missouri Highway and Transportation Commission
- Springfield City Utilities Engineering Department
- Watershed Commission of the Ozarks
- University of Missouri -- Columbia, Dept. of Geology

Montana:
- Fort Belknap Indian Community
- Fort Peck Tribes
- Helena, City of
- Lower Musselshell Conservation District
- Montana Bureau of Mines and Geology
- Montana Department of--
  - Fish, Wildlife, and Parks
  - Health and Environmental Sciences
  - Highways
  - Natural Resources and Conservation
  - State Lands
- Salish and Kootenai Tribes of Flathead Reservation

Montana--Continued
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 Platte South Natural Resources District
Lower Republican Natural Resources District
Middle Niobrara Natural Resources District
Middle Republican Natural Resource District
Nebraska Department of--
Environmental Control
Water Resources
Nebraska Natural Resources Commission
Nemaha Natural Resources 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 Resources District

Nevada:
Carson City, Department of Public Works
Carson Water Subconservancy District
Clark County --
Regional Flood Control District
Sanitation District
Elko County
Las Vegas, City of
Legislative Counsel Bureau
Mackay School of Mines

Nevada--Continued
Nevada Bureau of Mines and Geology
Nevada Department of--
Conservation and Natural Resources--
Division of Environmental Protection
Division of Water Resources
Transportation
Regional Water Planning and Advisory Board of Washoe County
South Lake Tahoe, California, Public Utility District
Summit Lake Paiute Tribe
Tahoe Regional Planning Agency

New Hampshire:
New Hampshire Department of --
Environmental Services

New Jersey
Bergen County Department of Public Works
Brick Township Municipal Utilities Authority
Bureau of Mines and Mineral Resources
Cape May, City of
Delaware River Joint Toll Bridge Commission
Gloucester County Planning Commission
Lower, Township of, Municipal Utilities Authority
Morris City Municipal Utilities Authority
New Brunswick, City of
New Jersey Department of --
Agriculture
Environmental Protection,
Division of Water Resources
North Jersey District Water Supply Commission
Passaic Valley Water Commission
Pecos River Commission
Somerset County Board of Chosen Freeholders
West Windsor Township
Wildwood, City of

New Mexico:
- Alamogordo, City of
- Alamo Navajo Band
- Albuquerque, City of
- Albuquerque Metropolitan Arroyo Flood Control Authority
- Canadian River Municipal Water Authority
- Costilla Creek Compact Commission
- Council of Bernalillo
- El Paso Water Utility
- Energy and Mineral Dept.
- Gallup, City of
- Highlands University
- Jemez River Indian Water Authority
- Las Cruces, City of
- Los Alamos, County of
- Middle Rio Greater Conservation District
- Navajo Indian Nation
- New Mexico Bureau of Mines and Mineral Resources
- New Mexico Department of Highways
- New Mexico Environmental Improvement Division
- New Mexico Mining and Minerals
- New Mexico State University Agricultural Experiment Station
- Office of State Engineer
- Pecos River Commission
- Pueblo of Acoma
- Pueblo of Laguna
- Pueblo of Zuni
- Raton, City of
- Rio Grande Compact Commission
- Rio San Jose Flood Control District
- Ruidosa, Village of
- San Juan, County of
- Santa Fe Metropolitan Water Board
- Santa Rosa, City of
- Vermejo Conservancy District

New York:
- Amherst, Town of, Engineering Department

New York--Continued
- Auburn, City of
- Brookhaven, Town of
- Chautauqua County Department of Planning and Development
- Cheektowaga, Town of
- Chenango, County of
- Cornell University--
  - Department of Natural Resources
  - Department of Utilities
- Courtland County Planning Dept.
- Dutchess County Environmental Management Council
- Hudson-Black River Regulating District
- Kiryas Joel, Village of
- Long Island Regional Planning Board
- Monroe County Department of Health
- 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
    - Division of Fish and Wildlife
  - Transportation, Bridge and Construction Bureau
- New York State Power Authority
- Nyack, Village of, Board of Water Commissioners
- Onondaga, County of--
  - Department of Drainage
  - Water Authority
- Orange County Water Authority
- Saratoga, County of, Environmental Management Council
- Seneca County Soil Conservation District
- Suffolk, County of--
  - Department of Health Services
  - Water Authority

Cooperators By State -- Continued

New York--Continued
- Temporary State Commission
- 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
- Currituck County
- Durham City Department of Water Resources
- Fayetteville, City of
- Forsyth County
- Greensboro, City of
- Guilford County Soil and Water Conservation District
- High Point, City of
- Lexington, City of
- Mecklenburg County
- North Carolina State Department of --
  - Human Resources
  - Natural Resources and Community Development
  - Transportation, Division of Highways
- Orange Water and Sewer Authority
- Raleigh, City of
- Rocky Mount, City of
- Triangle Area Water Supply Monitoring, Project Steering Committee

North Dakota:
- Dickinson, City of
- Lower Heart River Water Resources District
- Minot, City of, Public Works Dept.
- North Dakota Dept. of --
  - Game and Fish
  - Highways

North Dakota--Continued
  - Parks and Recreation
- North Dakota Geological Survey
- North Dakota State University
- Oliver County Board of Commissioners
- Public Service Commission
- State Water Commission
- Three Affiliated Tribes Natural Resources Dept.

Ohio:
- Akron, City of
- Canton, City Water Department
- Columbus, City of
- Eastgate Development and Transportation Agency
- Freemont, City of
- Lima, City of
- Lucas County
- Miami Conservancy District
- Ohio Department of--
  - Natural Resources
  - Transportation
- Ohio Environmental Protection Agency
- Ohio Water Development Authority
- Ross, County of
- Sandusky, County of, Dept. of Health
- Seneca Soil and Water District
- Toledo Metropolitan Area Council of Governments
- University of Cincinnati, Dept. of Geology
- University of Toledo
- Wood County

Oklahoma:
- Ada, City of
- Altus, City of
- Central Oklahoma Master Conservancy District
- Fort Cobb Reservoir Master Conservancy District
- Lawton, City of
- Lugert-Altus Irrigation District
- Mountain Park Master Conservancy District

Oklahoma--Continued
- Norman, City of, Department of Public Works
- Oklahoma City, 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--
  - Warm Springs Indian Reservation
- Coos Bay-North Bend Water Board
- Eugene City Water and Electric Board
- Jackson, County of
- Klamath Falls, City of
- Klamath Tribe
- McMinnville City Water and Light Department
- Oregon Department of--
  - Fish and Wildlife
  - Human Resources, Health Division, Drinking Water Program
  - Natural Resources, Analysis and Planning Management Services Division
  - Transporation, Highway Division
  - Water Resources
- Portland, City of
  - Bureau of Environmental Services
  - Bureau of Water Works

Pennsylvania:
- Academy of National Sciences of Philadelphia
- Allentown, City of, Engineering Dept.
- Berks, County of
- Bethlehem, City of
- Bucks, County of
- Chester County Water Resources Authority

Pennsylvania--Continued
- Delaware County Solid Waste Authority
- Delaware River Basin Commission
- Erie County Department of Health
- Geological Survey, University of Delaware
- Harrisburg City Department of Public Works
- Indiana, County of
- Joint Planning Commission of Lehigh - Northhampton Counties
- Lancaster County Planning Commission
- Letort Regional Authority
- Media Borough Water Department
- New York State Department of Environmental Conservation
- Oley Township
- Pennsylvania State--
  - Environmental Resources --
    - Bureau of Community Environmental Control
    - Bureau of Mining and Reclamation
    - Bureau of Soil and Water Conservation
    - Bureau of Topographic and Geologic Survey
    - Bureau of Water Quality Management
    - Bureau of Water Resources Management
- Philadelphia City Water Department
- Susquehanna River Basin Commission
- University Area Joint Authority
- Williamsport, City of, Bureau of Flood Control

Rhode Island:
- Governor's Office of Energy Assistance
- 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

South Carolina--Continued
- Cooper River Water Users Association
- Donaldson Development Commission
- Georgetown County Water and Sewer District
- Grand Strand Water and Sewer Authority
- Irmo, Town of
- Lexington County
- Myrtle Beach, City of
- Oconee County Sewer Commission
- Richland County
- South Carolina State--
  - Department of Highways and Public Transportation
  - Geological Survey
  - Health and Environmental Control
  - Public Service Authority
  - Sea Grant Consortium
  - Water Resources Commission
  - Wildlife and Marine Resources Department
- Spartanburg Sanitary Sewer District
- Spartanburg Water System
- 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
- Sioux Falls, City of
- Sisston-Wahpeton Sioux Tribe
- South Dakota Department of--
  - Game, Fish, and Parks
  - Transportation
  - Water and Natural Resources--
    - Geological Survey Science Center
    - Water Development Division
    - Water Quality Division

South Dakota--Continued
  - Water Rights Division
- South Dakota School of Mines and Technology
- Watertown, City of
- West Dakota Water Development District

Tennessee:
- Alcoa, City of
- Bartlett, City of
- Blountville, City of, Utility District
- Dickson, City of
- Eastside Utility District
- Emergency Management Agency
- Germantown, City of
- Gladeville Utility District
- Hamilton, County of
- Hixson Utility District
- Humphreys County Commissioners
- Jackson, City of, Utility Division
- Lawrenceburg, City of
- Lebanon, City of
- Lincoln County Board of Public Utilities
- McMinnville, City of
- Memphis, City of--
  - Light, Gas, and Water Division
  - Public Works Division
- Memphis State University
- Metropolitan Government of Nashville and Davidson County
- Millington, City of
- Murfreesboro Water and Sewer Department
- N. Stewart County Utility District
- Rogersville, Town of
- Sevierville, City of
- Shelby County Public Works
- Tennessee Department of--
  - Agriculture
  - Health and Environment--
    - Construction Grants and Loans

Tennessee--Continued
- Division of Superfund
- Office of Water Programs
- Transportation --
- Division of Structures
- Research Division

Tennessee State Planning Office
Tennessee Wildlife Resources Agency
Union, City of
Upper Duck River Development Agency
Wartrace, City of
Webb Creek Utility District

Texas:
Abilene, City of
Arlington, City of
Austin, City of
Bexar-Medina-Atascosa Counties, Water Improvement District No. 1
Brazos River Authority
Carrollton, City of
Coastal Water Authority
Colorado River Municipal Water District
Corpus Christi, City of
Dallas, City of --
- Public Works Department

Edwards Underground Water District
El Paso City Public Service Board
Fort Worth, City of, Water Dept., Water Pollution Control
Fort Stockton, City of
Franklin County Water District
Gainesville, City of
Galveston County
Garland, City of
Graham, City of
Greenbelt Municipal and Industrial Water Authority
Guadalupe-Blanco River Authority
Harris County Flood Control District

Texas--Continued
Harris-Galveston Coastal Subsidence District
Houston, City of
Lavaca-Navidad River Authority
Lower Neches Valley Authority
Lubbock, City of
Nacogdoches, City of
North Central Texas Municipal Water Authority
Northeast Texas Municipal Water District
North Texas Municipal Water District, Research and Development
Orange County
Pecos River Commission
Red Bluff Water Power Control District
Red River Authority
Runaway Bay, City of
Sabine River Authority of Texas
Sabine River Compact Administration
San Angelo, City of
San Antonio, City of--
- Department of Environmental Management
- Department of Water Resources Management
- Public Service Board
- Water Board

San Antonio River Authority
San Jacinto River Authority
Tarrant County Water Control and Improvement District No. 1
Texas --
- Bureau of Economic Geology
- 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
West Central Texas Municipal Water District
Wichita County Water Improvement District No. 2
Wichita Falls, City of

Utah:
- Bear River Commission
- Ogden River Water Users
- Salt Lake City/County Health Department
- Salt Lake, County of, Division of Flood Control
- Utah Department of--
  - Agriculture, Environmental Quality Section
  - Health, --
    - Division of Environmental Health
  - Natural Resources--
    - Geological and Mineral Survey
    - Oil, Gas, and Mining Division
    - Water Resources Division
    - Water Rights Division
    - Wildlife Resources Division
  - Transportation
- Toole, City of
- Toole, County of
- Weber Basin Water Conservancy District
- Weber River Water Users

Vermont:
Vermont Department of Environmental Conservation

Virginia:
- Accomack, County of
- Alexandria, City of
- Henrico, County of, Department of Public Utilities
- James City, County of,
- James City Service Authority
- Mount Rogers Planning District Commission
- Newport News, City of
- Northampton, County of
- Northern Virginia Planning District Commission
- Prince William Health District
- Roanoke, City of
- Southeastern Public Service Authority of Virginia
- Southeastern Virginia Planning District Commission
- University of Virginia, Department of

Virginia--Continued
- Environmental Sciences
- Virginia Beach, City of, Dept. of Public Utilities
- Virginia Department of Transportation
- Virginia State Water Control Board
- Williamsburg, City of
- York, County of

Washington:
- Bellevue City Public Works Department
- Centralia City Light Department
- Chelan County Public Utilities District #1
- Confederated Tribes of the Umatilla Indian Reservation
- Douglas County Public Utilities District #1
- Hoh Indian Tribe
- King County Department of Public Works
- Kitsap County Public Utility District No. 1
- Lewis County Board of Commissioners
- Pend Oreille, County of
- Pierce, County of
- Portland Bureau of Water Works
- Quinault Business Committee
- Seattle, City of--
  - Department of Lighting
- Skagit County Department of Public Works
- Snohomish, County of
- Tacoma, City of, Dept. of--
  - Public Utilities
  - Public Works
- Thurston County Department of--
  - Health
  - Public Works
- Upper Skagit Indian Tribe
- Washington Department of--
  - Ecology
  - Emergency Management
  - Fisheries

Cooperators By State -- Continued

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

West Virginia:
- Eastern Panhandle Regional Planning and Development Council
- Jefferson County Commission
- Morgantown Utility Board
- Region VII Planning and Development Council
- Research Corporation, Marshall University
- Washington Public Service District
- West Virginia Department of--
  - Health, Office of Environmental Service
  - Highways
  - Natural Resources--
    - Division of Water Resources
- West Virginia Geological and Economic Survey

Wisconsin:
- Balsam Lake Protection and Rehabilitation District
- Beaver Dam, City of
- Big Muskego Dam Drive
- Chippewa County Land Conservation Department
- Dane, County of--
  - Department of Public Works
  - Regional Planning Commission
- Delavan, Town of
- Fond du Lac, City of
- Fowler Lake Management District
- Green Bay Metropolitan Sewage 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

Wisconsin--Continued
- Norway, Town of
- Ocohomowoc Lake, Village of
- Okauchee Lake Management District
- Oneida Tribe of Indians
- Peshtigo, City of
- Powers Lake, District of
- Pretty Lake Protection and Rehabilitation District
- Red Cliff Band of Lake Superior Chippewas
- 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
- Gillette, City of
- Midvale Irrigation District
- Northern Arapahoe Tribe
- Shoshone Tribe, Shoshone Business Council
- Pinedale, City of
- Teton, County of
- Uinta, County of
- Water Development Commission
- Western Wyoming Community College

Cooperators By State -- Continued

Wyoming--Continued
- Wyoming Department of--
  - Agriculture
  - Environmental Quality
- Wyoming State--
  - Attorney General
  - State Engineer
  - Water Research Center

Commonwealth and Territories:
- Government of --
  - American Samoa
  - Guam
  - Northern Mariana Islands, Commonwealth of, Utility Commission
- 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
- Republic of Palau
- Virgin Islands Dept. of Natural Resources
- Virgin Islands Water and Power Authority

Appendix B -- List of Projects Selected and Funded Under the Merit Proposal Process
Fiscal Years 1983-89

State, Year Started, Project Number	Project Title
Alaska AK 83-150	Hydrology and Geochemical Processes at a Sub-Arctic Landfill at Fairbanks
Alaska AK 87-171	Estuarine Hydrodynamics of Turnagain Arm
Arizona AZ 84-078	Distribution and Movement of Trichloroethylene in Ground Water in the Tucson Area
Arizona AZ 87-103	Predictive Accuracy of Ground-Water Models
Arizona AZ 88-107	Flood Frequency and Erosion Potential in Ephemeral-Stream Channels: A Case Study of the Santa Cruz River
California CA 83-426	Ground-Water Investigations in Owens Valley
California CA 84-419	Estimating Tidal and Residual Circulation in San Francisco Bay
California CA 86-459	Investigation of Land Subsidence, Sacramento Valley
California CA 88-467	Optimum Management in a Basin With Changing Water-Supply and Water-Quality Problems
Colorado CO 87-223	Acidification of Lakes Along the Colorado Front Range
Colorado CO 88-225	Hydraulic Characteristics of Confined Clastic Aquifers at Castle Pines
Florida FL 83-400	Saltwater-Intrusion Models for Selected Areas, West-Central Florida
Florida FL 83-405	Sources, Generic Composition, and Mortality of Pathogenic Bacteria in the Apalachicola River and Estuary: Effects of Flooding and Temperature
Florida FL 84-412	Simulation Approaches to Understanding Ground Water-Surface Water Relationships and Water Budgets in Florida Lakes

Appendix B -- List of Projects -- Continued

State, Year Started, Project Number	Project Title
(a) Florida FL 85-438	Tide-Induced Circulation and Flushing Using Tide Gates in Residential Canals at Cape Coral
(a) Florida FL 85-439	Numerical Simulation of the Migration of Landfill Leachate in a Highly Permeable Surficial Aquifer, Palm Beach County
Florida FL 86-449	Simulation of a Saltwater Plume from a Flowing Well in a Surficial Aquifer, Dade County
Florida FL 88-481	Relative Importance of Ground Water to the Chemical Budget of Seepage Lakes
Florida FL 88-482	Fine Sediment Resuspension Processes and Light Attentuation in Shallow Estuarine Environments
Florida FL 89-494	Assessment of Canal-Aquifer Interaction in the Surficial Aquifer System Using a Coupled Surface-Water and Ground-Water Flow Model, Broward County
Georgia GA 84-083	Simulation of Fluid Flow in Fractured Limestone Formations near Brunswick
Georgia GA 84-084	Simulation of Flood Hydrographs for Georgia Streams
Georgia GA 87-091	Hydrology of the Upper Floridan Aquifer in the Albany Area, Georgia -- An Analysis from Digital Modeling
Georgia GA 88-093	Relation of Flow and Transport Processes to Concealed Faults and Fracture Zones in a Multi-layered Carbonate Aquifer System
Hawaii HI 89-160	Landslides and Debris-Flow Hazards in the Honolulu District, Oahu
Iowa IA 86-055	An Accounting of Pesticides in Soil and Ground-Water at Selected Sites in the Iowa River Basin
Kansas KS 83-134	Transit-Loss, Travel-Time, and Related Hydraulic and Hydrologic Characteristics of Selected Stream-Aquifer Systems
Kansas KS 85-139	Relation of Trihalomethane Formation Potential to Physical, Chemical, and Biological Characteristics of Water Supply Lakes in Eastern Kansas

Appendix B -- List of Projects -- Continued

State, Year Started, Project Number	Project Title
(a) Florida FL 85-438	Tide-Induced Circulation and Flushing Using Tide Gates in Residential Canals at Cape Coral
(a) Florida FL 85-439	Numerical Simulation of the Migration of Landfill Leachate in a Highly Permeable Surficial Aquifer, Palm Beach County
Florida FL 86-449	Simulation of a Saltwater Plume from a Flowing Well in a Surficial Aquifer, Dade County
Florida FL 88-481	Relative Importance of Ground Water to the Chemical Budget of Seepage Lakes
Florida FL 88-482	Fine Sediment Resuspension Processes and Light Attentuation in Shallow Estuarine Environments
Florida FL 89-494	Assessment of Canal-Aquifer Interaction in the Surficial Aquifer System Using a Coupled Surface-Water and Ground-Water Flow Model, Broward County
Georgia GA 84-083	Simulation of Fluid Flow in Fractured Limestone Formations near Brunswick
Georgia GA 84-084	Simulation of Flood Hydrographs for Georgia Streams
Georgia GA 87-091	Hydrology of the Upper Floridan Aquifer in the Albany Area, Georgia -- An Analysis from Digital Modeling
Georgia GA 88-093	Relation of Flow and Transport Processes to Concealed Faults and Fracture Zones in a Multi-layered Carbonate Aquifer System
Hawaii HI 89-160	Landslides and Debris-Flow Hazards in the Honolulu District, Oahu
Iowa IA 86-055	An Accounting of Pesticides in Soil and Ground-Water at Selected Sites in the Iowa River Basin
Kansas KS 83-134	Transit-Loss, Travel-Time, and Related Hydraulic and Hydrologic Characteristics of Selected Stream-Aquifer Systems
Kansas KS 85-139	Relation of Trihalomethane Formation Potential to Physical, Chemical, and Biological Characteristics of Water Supply Lakes in Eastern Kansas

Appendix B -- List of Projects -- Continued

State, Year Started, Project Number	Project Title
Kansas KS 85-150	Transport, Occurrence, and Effects of Agricultural Pesticides in the Tuttle Creek Lake/Stream System
Kansas KS 86-151	Movement and Persistence of Agricultural Pesticides in the Saturated and Unsaturated Zones in Kansas
Kansas KS 87-154	Processes Controlling Movement of Leachate from Oil Refinery Wastes in an Alluvial Aquifer System
Louisiana LA 83-077	Transport of Suspended Sediments and Associated Chemical Constituents in the Lower Mississippi River
Louisiana LA 84-084	Containment of Organic Waste in Low Permeability Clays of the Mississippi Embayment, Southwest Louisiana
(a) Louisiana LA 85-088	Determination of Flood Characteristics for Coastal Streams in Louisiana
Massachusetts MA 83-059	Techniques for Estimating Reaeration Coefficients and Travel Times in Massachusetts Streams
Massachusetts MA 83-060	Quality of Precipitation from Air Masses Moving Over Massachusetts
Massachusetts MA 84-068	Hydrology of a Flood-Plain Wetland and Its Influence on Streamwater Quality in Massachusetts
Massachusetts MA 85-071	Effectiveness of Watershed Management for Mitigating Impacts of Acid Rain, Quabbin Reservoir
Massachusetts MA 86-074	Water-Table Mapping with Demonstration of Ground-Penetrating Radar, Cape Cod
Massachusetts MA 86-076	Chemistry of Precipitation During Storm Events
Massachusetts MA 87-078	Physically Based Low-Flow Models and Record Extension for Low-Flow Frequency Studies
Massachusetts MA 88-083	Predicting Wetland Influences on Stream-Water Quality

Appendix B -- List of Projects -- Continued

State, Year Started, Project Number	Project Title
Massachusetts MA 89-090	Effects of a Septage Treatment Plant on Ground-Water Quality, Orleans
Montana MT 88-119	Occurrence and Mobility of Persistent Pesticides in Agricultural Environments in the Northern Great Plains
Nevada NV 86-135	A Gravitational Technique for Monitoring Changes in Ground-Water Levels
Nevada NV 86-140	Investigation of Ground-Water Evapotranspiration Mechanisms and Rates in Southern Nevada
New Jersey NJ 84-072	Atmospheric Deposition Effects on Water Resources in the New Jersey Pinelands
New Jersey NJ 84-078	Lead Contamination of Ground-Water in Ocean County
New Jersey NJ 86-087	Geochemical Effects on the Corrosivity of Ground-Water in the Kirkwood-Cohansey Aquifer in the New Jersey Coastal Plain
New Jersey NJ 87-092	Geochemical Processes Controlling Aluminum and Sulfate Transport in Acidic Surface, Ground, and Soil Waters in a Watershed in the New Jersey Coastal Plain
New Jersey NJ 87-093	Optimal Withdrawals from a Coastal Aquifer Subject to Saltwater Encroachment: Numerical Analysis and Case Study
New Jersey NJ 88-097	Surfactant Sorption to Soil and its Effect on the Distribution of the Anthropogenic Organic Compounds
New Jersey NJ 88-098	Removing Volatile Ground-Water Contaminants by Inducing Air-Phase Transport
New Jersey NJ 88-099	Mobility, Transport and Fate of Naturally Occurring Radionuclides in Ground-Water, Newark Basin
New Jersey NJ 89-106	Modeling and Experimental Investigation of Hydrocarbon Transport and Biodegradation in the Unsaturated Zone
New Mexico NM 83-244	Urbanization Effects Upon Surface and Subsurface Flow to the Rio Grande, Albuquerque Metropolitan Area

Appendix B -- List of Projects -- Continued

State, Year Started, Project Number	Project Title
New Mexico NM 86-258	Investigation of Vertical Ground-Water Flow Rates and Vertical Hydraulic Conductivity from Ground-Water Temperature Gradients
New York NY 85-156	Analysis of Solute Transport in the Upper Glacial and Magothy Aquifers on Long Island
New York NY 86-165	Sorptive and Transport Characteristics of PCB Congeners in the Upper Hudson River
New York NY 87-169	Subsurface Transport of Pesticides and Nitrates in Fields Under Conventional and Conservation Tillage Practices
New York NY 88-170	Fate and Transport of Landfill Leachate in a Phragmites Wetland
New York NY 89-181	Flow Paths of Water in Two Limed Inlet Watersheds at Woods Lake, Herkimer County
North Carolina NC 85-081	Effects of Land-Management Practices on Sediment and Chemical Transport in Guilford County
North Dakota ND 84-125	Hydrochemical Controls on the Mobility of Radiogenic Constituents in Uraniferous Lignite and Ash
North Dakota ND 85-131	Heat and Moisture Transport Model for Seasonally Frozen Soils in North Dakota
Oklahoma OK 83-067	A Method of Evaluating the Severity of Droughts in Oklahoma
Oklahoma OK 86-080	Hydrogeologic Characteristics of Selected Shaley Formations in Oklahoma, With Particular Emphasis on Their Suitability for Containment of Hazardous Wastes
Oklahoma OK 88-087	Improving the Accuracyof Rainfall-Runoff Studies Using NEXRAD Radar
Oregon OR 86-138	Iron Geochemistry of the Dunes Aquifer Near Coos Bay
Oregon OR 88-151	General Purpose Software Interface Between Ground-Water Models and GIS Systems to Facilitate Pre- and Post-Processing of Model-Related Data

Appendix B -- List of Projects -- Continued

State, Year Started, Project Number	Project Title
Pennsylvania PA 85-158	Evaluation of Agricultural Best Management Practices and Other Innovative Methods of Controlling Nutrient Discharges in the Lower Susquehanna River Basin
Pennsylvania PA 85-159	Assessment of Nutrient Sources in the Susquehanna River Basin
Pennsylvania PA 89-185	Use of Multiple Stable Isotopes to Distinguish Sources of Nitrogen Contamination in the Susquehanna River Basin
Puerto Rico PR 88-099	Vertical Continuum of Aquifer Compressional Properties and its Relation to Specific Storage
Puerto Rico PR 89-101	Ground-Water System-Management Study, Upper Rio Grande de Loiza Basin
South Carolina SC 89-079	Bacterial Metabolism and the Origin of High-Iron Ground Water, Florence County
South Carolina SC 89-080	Bacterial Metabolism and the Development of Secondary Porosity Permeability in Clastic and Carbonate Aquifers
South Dakota SD 87-085	Determination of Surface-Water/Ground-Water Relations in an Area of Carbonate Aquifers, by Use of Nitrogen Gas and Stable Isotopes, Eastern Black Hills
Tennessee TN 85-064	Channel Widening Processes, Bank-Slope Development, and Long-Term Channel Geometry in Adjusting Streams in Tennessee
Tennessee TN 86-069	Geohydrology and Pesticide Transport at North Hollywood Dump
Tennessee TN 87-075	Toxic Plume Delineation by Bacterial Bioassay and Unsaturated-Zone Gas Analysis at a Hazardous Waste Site Near Nashville
Tennessee TN 89-087	Hydrogeology and Geochemistry of Deeply Buried Rocks of Low Permeability
Texas TX 89-116	Light Attenuation and Its Effect on the Quality of Water inTurbid Reservoirs
Washington WA 83-286	Stillaguamish River Basin Instream Flow and Water Quality

State, Year Started, Project Number	Project Title
Washington WA 85-303	Rainfall-Runoff Models for Small Basins in Metropolitan Areas of Western Washington
(a) Washington WA 85-305	Crop Water Determination Through Remote Sensing
Wisconsin WI 89-163	Roles of Ground-Water Transport and Lake Sediment Sorption Processes in Mercury Cycling in Northern Wisconsin Lakes
Wyoming WY 86-094	The Occurrence, Mobility, and Geochemical Controls Affecting Selenium Concentrations in Ground Water and Associated Rocks Disturbed by Mining, Powder River Basin

Note: (a) Project not selected through the initial ranking process but subsequently identified by the Region as a "Merit Project."

Appendix C -- List of selected U.S. Geological Survey investigations and research related to agriculture, FY 1988-90.

[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.]

List of selected U. S. Geological Survey Investigations and research related to agriculture

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Arizona					
AZ88-111	Mapping Vegetation Water Use Calculated from Remotely-Sensed Data as a Function of Soil Moisture	6/88 to 9/90	GW - SW	Relation of evapo-transpiration to irrigation and crop type	C
Arkansas					
AR89-064	Hydrologic surveillance of Lakes Maumelle and Winona in central Arkansas	5/89 to 4/92	SW	Effects of sod farming on water quality	C
Colorado					
CO89-236	Irrigation drainage reconnaissance of the Pine River area, Southern Ute Reservation, Southwestern Colorado	10/88 to 9/90	GW - SW	Quality of irrigation drainage water	OFA
CO89-238	Conjunctive water use and canal-seepage losses in an extensive irrigation system, southeastern Colorado	5/89 to 10/92	GW - SW	Use of Water for irrigation	C
Hawaii					
HI88-166	Water Resources on the Island of Kahoolawe	4/88 to 9/93	GW - SW	Effects of grazing on water resources	C
Idaho					
ID89-171	Effects of Water Use of Recharge/Discharge Relations in the Mud Lake area, Southeastern Idaho	1/89 to 9/91	GW - SW	Effects of irrigation on water resources	C
Indiana					
IN89-126	Feasibility of Using Pipe Flowmeter and Time Totalizer Technology	2/89 to 9/90	GW - SW	Testing non-invasive methods of measuring flow in pipes	C

Appendix C -- 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					
KS82-156	Organic Geochemistry of Natural and Polluted Water -- Nonpoint Source Contamination	9/82 to _____	GW - SW	Assessment of herbicides and their degradation products in water resources	F
Minnesota					
MN89-120	Sources and Transport of sediment, nutrients, and oxygen-demanding substances in the Minnesota River	7/89 to 9/94	SW	Effects of agricultural runoff on water quality and sedimentation	C
Montana					
MT88-121	Water Quality in the Powder River, Wyoming, and Montana	7/88 to 9/90	SW	Relation of water supply and irrigation	C
MT89-125	Ground-water hydrology of alluvial deposits on the Fort Belknap Indian Reservation, north-central Montana	10/88 to 9/90	GW	Water supply for irrigation	C
MT89-126	Water Resources of the Upper Pryor Creek Basin, Crow Indian Reservation, south-central Montana	1/89 to 9/92	GW - SW	Water supply for irrigation	C, OFA
New Mexico					
NM88-274	Water Use of Sagebrush and Replacement Grass in Northwest New Mexico	4/88 to 4/91	GW - SW	Water for pasture grass	C
New York					
NY90-186	Probabilistic Assessment of Atrazine Contamination in Ground Water	10/89 to 9/93	GW	Movement of herbicide in the unsaturated zone	F
North Carolina					
NC89-101	Surface-Water Quality Assessment for Region J	10/88 to 9/92	SW	Effects of agricultural chemicals on surface water	C

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Oklahoma					
OK88-091	Source and Movement of Naturally Occurring Toxic Substances in the Central Oklahoma Aquifer	7/88 to 6/90	GW	Suitability of ground water for agricultural uses	C
Oregon					
OR89-157	Role of Disturbed Marshland and Reservoir Regulation in Causing Excessive Nutrient Enrichment in Upper Klamath Lake	2/89 to 9/95	GW - SW	Effects of converting marshland to agricultural land	C
Pennsylvania					
PA90-189	Effectiveness of Agricultural Best Management Practices in Reducing Nutrient Loads to the Conestoga Headwaters, Lancaster County	10/89 to 9/92	GW - SW	Effects of agricultural practices on water quality	C
South Dakota					
SD88-090	Water Quality of Surface and Ground Waters of the Repid Creek Basin	1/88 to 9/91	GW - SW	Effects of irrigation on water quality	C
Tennessee					
TN89-086	Water Quality of Farmstead Wells	3/89 to 3/90	GW	Quality of water in farmstead wells	C
TN89-094	Effects of Agriculture on Water Quality in the Beaver Creek Basin of West Tennessee	8/89 to 9/94	GW - SW	Effects of agriculture on water quality	C
TN90-095	Water Availability and Use in the Duck River Basin above Columbia	10/89 to 9/91	GW - SW	Water supply for agriculture	C
Texas					
TX89-118	Evaluation of methods to calculate irrigated crop acreages using remote-sensing data in Uvalde, Medina, and Bexar Counties	5/89 to 9/90	GW	Remote sensing of crop acreage	C

Project Number	Title	Period of Study	Principal Emphasis	Relation to Agriculture	Source of Funding
Utah					
UT88-196	Ground Water in Southern Utah and Goshen Valleys, Utah County	7/88 to 6/90	GW - SW	Water supply for irrigation	C
UT90-206	Definition of recharge area, physical extent, and quality of water in the principal aquifers of western Kane County	3/90 to 2/91	GW - SW	Potential effects of agriculture on recharge	C
Washington					
WA88-332	Ground-Water Hydrology of North Thurston County	4/88 to 9/91	GW	Effects of irrigated agriculture on ground water	C
WA89-335	Quality of Ground Water in the Toppenish Basin, Yakima Indian Reservation	2/89 to 9/92	GW	Effects of agriculture on ground-water quality	C
Wisconsin					
WI89-166	Evaluating best management practices in Wisconsin	7/89 to 9/94	GW - SW	Effects of agricultural practices on water resources	C
WI89-168	Evaluating best management practices in the Black Earth Creek Basin	5/89 to 9/96	SW	Effects of agricultural practices on water resources	C
Wyoming					
WY88-116	Water Quality of the Powder River, Wyoming and Montana	7/88 to 9/91	SW	Water supply for irrigation	C
WY89-119	Water Resources of Hot Springs County, Wyoming	10/88 to 9/91	GW - SW	Water supply for irrigation	C

Appendix C -- 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
Central Region					
CR88-278	Origin, Fate, and Transport of Organic Compounds in Surface and Ground Waters and their Effect on Water Quality	4/88 to 4/90	GW - SW	Movement of agricultural chemicals in the Mississippi River system	F