Activities of the Water Resources Division

PREPARED FOR COOPERATING AGENCIES

U.S. Department of the Interior
Geological Survey
Open-File Report 85—570
September 1985 Volume 1, Number 2

Activities of the Water Resources Division

Compiled by C. William Cardin and John E. Moore

U.S. Department of the Interior
Geological Survey
Open-File Report 85—570
September 1985 Volume 1, Number 2

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to :
U.S. Geological Survey
409 National Center
Reston, Virginia 22092

Copies of this report may be obtained from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, Colorado 80225

FOREWORD

This is the second report on activities of the Water Resources Division (WRD). It covers April–July, 1985.

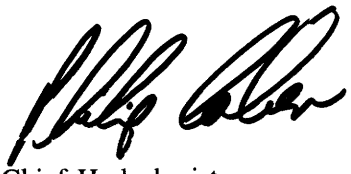
The high point was publication of National Water Summary 1984, featuring State-by-State descriptions of ground-water conditions. Secretary of Interior Hodel announced the publication at a news conference on May 18, 1985.

WRD personnel testified before Congressional Committees or briefed Committee Staff more than a dozen times, to provide scientific information on water resources. We made four presentations just on the selenium situation at Kesterson Wildlife Refuge in the western San Joaquin Valley of California. Contamination of ground water is a matter of great concern to Congress, and we provided lengthy ground-water briefings to Congressional Committees.

Other subjects of concern in the April–July period were acid precipitation, national water-quality assessment (more on that in the first article), and water shortages in the Mid-Atlantic States. New York City was under drought emergency regulations that began in January. The contents of the City's three water-supply reservoirs in the Delaware River basin were at about half of capacity, while average for that time of year is close to 80 percent.

Descriptions of a number of recent publications also are included in this report. These have been grouped into three broad categories—the Federal Program, the Federal-State Cooperative Program, and the program of assistance to other Federal agencies.

Activities of the Water Resources Division is a publication for members of the Association of American State Geologists and other U.S. Geological Survey cooperators. The first issue (April 1985) was limited to information about WRD's Federal Program. This issue treats a wider variety of subjects. Your comments and thoughts on how to make the report more useful will be appreciated, and may be sent to the Chief Hydrologist, U.S. Geological Survey, 409 National Center, Reston, VA 22092.



Chief Hydrologist

CONTENTS

Page

Foreword
Current Issues
National Water-Quality Assessment 1
Priority Issues for the Federal-State Cooperative Program 4
New WRD Investigations (April–July 1985) 6
Evaluation of Controlled Release of Water from Spirit Lake, Washington
Detection of Trends in the Abundance and Composition of Biological Components of San Francisco Bay
Assessment of Potential Landfill Sites in Southern San Diego County, California
Ground-Water Quality in Hawaii
Hydrogeology and Geochemistry of the Roubidoux Aquifer in Northeastern Oklahoma
Geohydrology in Vicinity of New Jersey Fusion Test Reactor
USGS and Army Materials Command Sign Agreement for Survey Assistance at Hazardous Waste Sites
Water Availability for Irrigating Indian Lands in North Dakota
Aquifer Evaluation Near Jackson, Mississippi
Hydrology of Possible Coal-Leasing Area in Colorado
Representative WRD Reports Published April–July 1985
Federal Program 9
National Water Summary 1984
Selected Papers in the Hydrologic Sciences
Effects of Artificial Recharge on the Ogallala Aquifer, Texas
The Hydrogeologic Framework of the Southeastern Coastal Plain Aquifer System
Data on the Distribution and Abundance of Submersed Aquatic Vegetation in the Potomac River
Controls on Phosphorus Mobility in the Potomac River
Design of the National Trends Network for Monitoring the Chemistry of Atmospheric Precipitation
Freshwater Heads and Ground-Water Temperatures in Aquifers of the Northern Great Plains
The Hydrologic Bench-Mark Program: A Standard to Evaluate Water Quality Constituents in Georgia Streams
Federal-State Cooperative Program 12
Test Well Installation and Water Quality, Hollywood Dump Area, Memphis, Tennessee
Aldicarb Pesticide Contamination of Ground Water in Eastern Suffolk County, Long Island, New York
Ground Water Problems in Arkansas
Quality of Arkansas River and Irrigation Return Flows in the Lower Arkansas River Valley, Colorado
Feasibility of Artificial Recharge in the Coastal Plain Near Atlantic City, New Jersey
Ground-Water System and Simulated Effects of Ground-Water Withdrawals in Northern Utah Valley, Utah
Hydrology of Major Estuaries and Sounds of North Carolina
Traveltime and Dispersion in the Potomac River, Cumberland, Maryland, to Washington, D.C.
Geohydrology and Model Analysis of Stream-Aquifer System Along the Arkansas River, Southwestern Kansas
Compilation of Water Resources Development and Hydrologic Data of Saipan, Mariana Islands
Cost Effectiveness of the Stream-Gaging Program in New Jersey
Other Federal Agency Program 16
Simulated Ground-Water Flow in the Potomac Aquifer, New Castle County, Delaware
Ground-Water Availability Along the Blue Ridge Parkway,Virginia
Reconnaissance of Water Quality at a U.S. Department of Energy Site, Pinellas County, Florida
The Ground-Water System and Possible Effects of Underground Coal Mining in Central Utah
Ground-Water Contamination in East Bay Township, Michigan
Geohydrology and Water Resources of the Papago Indian Area in Arizona and Mexico
Water Resources Division Publications, January through July, 1985 19

CURRENT ISSUES

National Water-Quality Assessment

The House Appropriations Bill for Fiscal Year 1986 contains $5 million for the Survey to start a National Water Quality Assessment Program (NAWQAP).

Potential funding for the NAWQAP grew out of a USGS hearing last March before the House Interior Appropriations Subcommittee. More than 2 hours of discussion took place between the Chairman and the Chief Hydrologist on the status of the Nation's water quality. As part of that exchange, the Survey was asked to provide a letter outlining a program which would give definitive information on status and trends of water quality. In response the Survey outlined a plan developed during the past year that would lead to a thorough evaluation of water quality, and a continuing assessment of conditions and trends.

Following is a summary of the NAWQAP proposal provided to the House Interior Appropriations subcommittee.

> The U.S. Geological Survey has been engaged for the past year in an effort to design a scientifically sound approach to a thorough evaluation of the quality of the Nation's water. The proposed program is an effort to provide the information required for understanding and keeping track of the Nation's water quality. Without the understanding that such a program would provide, remedial or protective measures adopted in response to perceived water-quality problems are likely to be excessively costly, ineffective, or unnecessary. Presently, the USGS is involved in a wide range of activities related to water quality. Data collection and analysis, interpretive investigations, and basic research, provide a substantial framework upon which to build a sharply focused "National Water-Quality Assessment," which would provide much of the information needed to evaluate the quality of the Nation's water. Such information is needed by both the public and private sectors to effectively and efficiently develop and manage the Nation's water resources.
>
> The concept of a thorough national assessment of water quality poses numerous significant questions. Some of these arise simply from the vast extent of the Nation's stream and aquifer

systems, and the consequent magnitude of the data-acquisition task. Others arise from the present lack of data on many critical contaminants, and the difficulty and expense of analyzing for those contaminants. Still others arise from our limited understanding of the processes controlling the fate and distribution of contaminants in natural waters.

Through USGS efforts over the past year an approach has been developed which would lead to sound conclusions about the Nation's water quality in a few years and at a reasonable cost. The approach developed addresses three major components of the hydrologic cycle: surface water, ground water, and precipitation. In terms of surface water, the approach will focus on approximately 90 study units, chosen so as to account in aggregate for more than 80 percent of the surface-water withdrawals in the Nation, although incoporating only about 40 percent of the Nation's land area. The investigations in these study units will be conducted in a continuing 9-year cycle. Each unit will be studied intensively for 3 years and then data will be collected at a much lower level of intensity for 6 years; the cycle will then be repeated, beginning with another 3-year period of intensive study. The schedule of investigations will be rotational, so that only one-third of the study units will be under intensive investigation at any one time, and the nationwide effort will remain at a uniform level. Within a given study unit, the 3-year periods of intensive study will utilize both fixed station data collection and synoptic measurement, and will involve extensive scientific analysis and interpretation. The initial intensive phase in each study unit will lead to a characterization of the present state of surface-water contamination; subsequent intensive studies will focus on the changes that are occurring with time, and on the proceses responsible for those changes. During the 6-year intervals between periods of intensive study, data collection will be maintained in each unit at the level required to track significant changes with time.

For ground-water quality, the proposed approach involves the adaptation of iterative search techniques to the location of contaminated ground water. Such techniques have been used successfully in mineral exploration and elsewhere. The iterative search procedure will seek to subdivide the ground-water regime into zones characterized by: (a) known presence of extensive contamination or a high probability of extensive contamination ("probably contaminated" zones); (b) a lower probability of extensive contamination but a high vulnerability to contamination ("vulnerable" zones); or (c) a low probability of extensive contamination and a low vulnerability to contamination. Several types of information will be integrated in applying the iterative search techniques: data on land use, particularly as related to potential sources of contamination; information on the geohydrologic characteristics of subsurface materials,

particularly those characteristics which determine vulnerability to contamination; actual data on ground-water quality in the files of public or private groups; and the data collected during the search procedure itself. The collection of new data as well as the assembly of some of the preliminary information will be carried out according to iterative procedures, in which the activities in each stage are guided by information assembled in previous stages. As the iterative search progresses, a program of intensive hydrologic investigations will be initiated in individual zones which have been classified either as "probably contaminated" or "vulnerable."

The third major hydrologic component, precipitation, is presently addressed through the interagency National Acid Precipitation Assessment Program. Under the USGS's proposed approach, this effort would be augmented to include increased data collection for metals and organics in precipitation; and it would be complemented by a program of interpretive studies addressing the effects of acid precipitation in various geohydrologic settings.

An extensive research effort would be required in support of any national water-quality assessment program; this research would address the geochemical factors controlling the movement and fate of contaminants, and would seek to develop improved sampling strategies and analytical techniques. Any attempt at a national water-quality assessment program would also require extensive laboratory support, well beyond the capacity of the present USGS Central Laboratory System. A National Water Quality Assessment Program of the type envisioned would require close consultation and coordination with numerous local, State, and other Federal agencies. The USGS is convinced that a national water-quality assessment is needed and that it can mount and lead such an effort.

Priority Issues for the Federal-State Cooperative Program

The key issues for the Federal-State Cooperative Program in the coming fiscal year have been defined into two groups. Group I includes four issues that are of major national concern and should be considered of highest priority in developing the Fiscal Year 1986 Cooperative Program. The issues in Group I are: Ground-Water Contamination, Stream Quality, Water Supply and Demand, and Hydrologic Hazards. Group II includes three issues that are considered to have high priority for new work, but the importance of these issues may differ from Region to Region. The issues in Group II are: Hydrologic Effects of Fossil Fuel and Mineral Extraction; Wetlands, Lakes, Estuaries; and Acid Rain.

Group I

Ground-Water Contamination.--Studies are needed of the movement and behavior of contaminants, including toxic wastes, in the ground-water system. There is a particular need for investigations of the impacts of waste disposal, for studies of contamination by nonpoint sources such as urban runoff and agricultural practices, and for evaluation of salt-water encroachment induced by pumping. Studies should address flow dynamics, solute transport processes, chemical and biological processes, and the evaluation of baseline water quality against which to compare future changes. Emphasis should be placed on studies which advance knowledge on controlling processes such as solute transport, organic biodegradation, and contaminant movement between ground- and surface-water environments. Expanded participation in these activities in the Federal-State Cooperative Program will make the Division's skills and knowledge available to our cooperators as a means of aiding in local ground-water protection strategies.

Stream Quality.--There is an increasing need for appraisals of the water quality of stream systems, particularly with respect to the occurrence and movement of toxic substances, and the impact of contamination on stream ecology. To better understand the movement and concentration changes of undesirable materials, investigations need to emphasize assessments of stream quality, including sedmiment chemistry, as related to land use, stream biota, ground-water contribution, and overland runoff. Particular emphasis should be placed on process-related studies.

This topic includes expanding the data base on chemical properties and on the processes governing erosion, sediment transport and deposition; measuring the impacts of land-use changes, including urban development; studying the effects on land and water resources of suspended and deposited sediments; and understanding the transport of toxic substances and other constituents sorbed or attached to sediment.

Water Supply and Demand.--Increasing diversion, withdrawal, and use of water, stress both the quantity and quality of existing supplies, thus raising costs of both delivery and treatment, and

presenting ever more difficult problems of allocation and quality management. Information defining present water use is required to quantify stresses both spatially and temporally. Flow system simulation is essential to anticipate stress response, especially for stream-aquifer systems. Topics for study should include streamflow response to drought conditions, and system response both to projected uses and supply-augmentation schemes. The foundation for understanding problems of supply and demand is a well designed and carefully evaluated data-collection and analysis program.

Hydrologic Hazards.--Annual economic losses from floods, mudflows, debris flows, sedimentation, and other hydrologic hazards continue to amount to billions of dollars. These hazards are related not only to meteorological conditions but 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 better understand the processes by which they occur. Hazard studies in urban environments and flood-risk analyses associated with hydrologic-structure design should be included in this category.

Group II

Hydrologic Effects of Fossil Fuel and Mineral Extraction.--The extractive industries, whether oil and gas producing and processing, solid-fuel mining and processing (such as coal and oil shale), or metallic and nonmetallic mining, are pervasive in their influence on hydrologic systems. Impacts may relate to a wide spectrum of hydrologic phenomena, including interaction of subsurface fluids with contrasting chemical and physical characteristics, large-scale aquifer dewatering to permit mining, disruption of surface drainage, and disturbance of geochemical equilibria. Studies of such problems need to be pursued using high technology interpretive methods. They are important because of insidious and long-lasting effects of mineral, solid-fuel, and fluid hydrocarbon extraction, and the large areas affected. Investigations should include studies of the hydrologic effects of land reclamation, mining, and waste disposal.

Wetlands, Lakes, Estuaries.--Because of their importance to fish and wildlife resources, wetlands, lakes, and estuaries deserve special attention. These areas are especially sensitive to man's encroachment. Studies should address the availability, movement, and quality of water, emphasizing physical, chemical, and biological processes. Studies should include the interaction between surface-water bodies and aquifers, as well as the design of improved networks for baseline data collection.

Acid Rain -- Interpretive studies of the effects of precipitation chemistry on water quality and the interaction of acid rain with biological systems should receive priority attention in terranes that have limited ability to buffer ground and surface waters, and in urban settings that produce large loads of atmospheric pollutants.

NEW WRD INVESTIGATIONS (APRIL-JULY 1985)

Evaluation of Controlled Release of Water from Spirit Lake, Washington.--The eruption of Mount St. Helens caused a massive blockage of Spirit Lake. The possibility of a sudden catastrophic breaching of the blockage has been a cause for alarm. The sudden release of lake water would sharply increase both the discharge of South Fork Coldwater Creek and the erosive capacity of the stream. The latter would increase sediment loads which could have drastic effects on downstream developments. The Corps of Engineers recently constructed a tunnel through the volcanic-ash blockage which will be used to control releases of lake water and thereby control the lake level. This will reduce the possibility of a catastrophic breaching of the blockage. The USGS will study the effects of the release of water from Spirit Lake by making a detailed sediment analysis of the erosion in South Fork Coldwater Creek. This will include testing existing and proposed models of sediment transport, assessing impact of release on the long-term stability of the lake blockage, and documenting rates and types of sediment entrainment and selective transport and sorting of materials that accompany the predicted erosion.

Detection of Trends in the Abundance and Composition of Biological Components of San Francisco Bay, California.--At the request of the Water Resources Control Board in California, the USGS has started a long-term data collection and analysis program to detect and characterize trends in the abundance and composition of key biological components including plankton, benthic fauna, and macroalgae. Ongoing monitoring of selected chemical and physical properties will support the biological work.

Assessment of Potential Landfill Sites in Southern San Diego County, California.--In cooperation with San Diego County, the USGS has begun a 2-year program to develop procedures for the selection and evaluation of potential landfill sites in the southeastern part of the county. The first phase of the study is designed to identify 12 potential sites, two of which the county will select for final consideration. The second phase of the study will consist of detailed surface geophysics surveys, well drilling and testing, water sampling, and chemical analyses to define the volume, structure, lithology, and hydraulic characteristics at the two selected sites.

Ground-Water Quality in Hawaii.--The USGS and the Hawaii Department of Health signed a new cooperative agreement to study organic constitutents of ground water in Hawaii. This will be a statewide reconnaissance of ground water in order to assess the degree of organic contamination of the resource. Six drinking-water wells on Oahu were recently shut down as a result of high concentrations of organic compounds that are associated with pesticides. The study will help to delineate sources of contamination and to identify appropriate remedial measures.

Hydrogeology and Geochemistry of the Roubidoux Aquifer in the Vicinity of the Picher Mining Field, Northeastern Oklahoma.--Most of the water supply for extreme northeastern Oklahoma comes from the Roubidoux aquifer and associated formations of the Cambrian and Ordovician ages. At the request of the Oklahoma Water Resources Board, the USGS has started an investigation to determine the geologic, hydraulic, and chemical characteristics of the aquifer and of the overlying formations that separate it from abandoned mines of the Picher Field. Contaminated water could be migrating from the mines to the Roubidoux via abandoned water wells. A multi-agency effort to locate and plug all such wells began in late 1984. In this investigation, data from a variety of logs will be used to help determine rates of leakage between the Roubidoux and overlying formations. Analyses for isotopes of carbon, hydrogen, and sulfur will provide useful information on chemical reactions occurring in the Roubidoux aquifer and on the age of its water. This should aid in determining what the effects of migration of mine water might be.

Geohydrology in Vicinity of New Jersey Fusion Test Reactor.--The USGS entered into an agreement with the U.S. Department of Energy to assess the potential consequences of an instantaneous release of 45,000 gallons of reactive water on the surrounding ground-water system in the vicinity of their fusion test reactor in New Jersey. The reactor is located in a highly complex geohydrologic setting in which little is known about the water-bearing properties of the underlying geologic materials or about the nature of geohydrologic boundaries (lateral or vertical) in the area. The objectives of the study are to define the aquifer characteristics of the site, and the hydraulic boundaries of the overburden and bedrock; to develop predictive ground-water flow and transport models; and to design and establish a ground-water monitoring program.

USGS and Army Materials Command Sign Agreement for Survey Assistance at Hazardous Waste Sites.--The USGS signed a Memorandum of Understanding (MOU) with the U.S. Army Materials Command (AMC) which outlines the nature of the work which the Survey may be requested to undertake at hazardous waste sites on AMC property. The MOU supports activities required by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). When requested, the Survey will conduct hydrogeologic investigations at designated AMC installations, normally beginning with a presurvey to determine the nature, concentration, extent, direction, and rates of movement of contaminant plumes. The USGS may also assist by reviewing reports prepared by commercial contractors, commenting on emergency response actions, or providing an expert witness in litigation or administrative proceedings.

Water Availability for Irrigating Indian Lands in North Dakota.-- The U.S. Bureau of Indian Affairs has requested the USGS to evaluate the hydrology of the Warwick aquifer in North Dakota. A plan has been developed to use the Warwick aquifer to irrigate land on the Fort Totten Indian Reservation. However, it is not known if the aquifer can sustain the required withdrawals. The study will involve the use of existing data, supplemented by data from several wells to be installed, to determine relations between surface-water features and the aquifer. The combined information will be used to develop a simple ground-water flow model to evaluate irrigation potential.

Aquifer Evaluation Near Jackson, Mississippi.--At the request of the Mississippi Bureau of Land and Water Resources, the USGS has begun a study to develop an understanding of the Cockfield and Sparta aquifers near Jackson, Mississippi. Significant cones of depression have developed in the potentiometric surfaces of the aquifer as a result of long-term concentrated pumping. Consequently, the State is concerned about the ability of the ground-water system to sustain current water yields. As part of the study, the Survey will use extensive field data to construct a three-dimensional digital model of the flow system that can be used by the State to test alternative management strategies and determine where and how much ground water can be withdrawn.

Hydrology of Possible Coal-Leasing Area in Colorado.--The Survey and the Bureau of Land Management agreed to a study of the hydrology of the Hart Syncline Area, Northwest Colorado. The area is being evaluated for potential coal leasing. The need for a hydrologic analysis is to facilitate the decisionmaking process which includes whether or not to lease, type of mining to permit, and the degree of control for handling waste discharge and overburden material. The hydrologic analysis will include description of the existing ground- and surface-water systems in terms of water availability, flow characteristics, and quality.

REPRESENTATIVE WRD REPORTS PUBLISHED APRIL-JULY 1985

Federal Program

National Water Summary 1984--Hydrologic Events, Selected Water-Quality Trends, and Ground-Water Resources is the second in the USGS series of major annual reports on the condition of United States water resources. The assessment includes a State-by-State summary of the distribution, availability, and use of the ground water found in more than 350 aquifers and aquifer systems--the most comprehensive State-by-State ground-water information yet assembled. The 467-page summary also highlights trends of selected water-quality constituents in the Nation's major rivers and major hydrologic events of 1984.
Water Supply Paper 2275.

Selected Papers in the Hydrologic Sciences is a new journal-type publication that provides timely results of hydrologic studies derived from the Federal Research and the Federal-State Cooperative programs of the Geological Survey. Also included will be results of some studies done on behalf of other Federal agencies. The second volume, just released, contains nine topical papers that address an array of topics, including model simulation of ground- and surface-water systems, hydrogeochemistry, biochemistry of aquatic environments, and selected physical and chemical techniques on hydrologic studies. The release is designed to meet a widespread public and professional interest in the hydrologic sciences.
Water Supply Paper 2270.

Effects of Artificial Recharge on the Ogallala Aquifer, Texas describes four recharge tests that involved injecting water from playa lakes through wells into the Ogallala Formation. Artificial recharge is a means of extending the "life" of the Ogallala which is essential to the agricultural economy of the Southern High Plains of Texas. The technique is used extensively to place surface water into ground-water storage, where it is not subject to evaporation, and where contamination from surface sources is less likely. Where geologic conditions are not suitable for recharge from spreading basins, recharge by injection of water through wells has been used. The four recharge tests had varying degrees of success, primarily as a result of differences in aquifer lithology, the concentration of suspended solids in recharge water, and the injection technique.
Water Supply Paper 2251.

The Hydrogeologic Framework of the Southeastern Coastal Plain Aquifer System of the United States describes the hydrogeology of the water-bearing system that is the principal source of water for parts of Mississippi, Alabama, Georgia, Florida, and North and South Carolina. It describes the configuration and overall character of the sand and clay bodies which form regionally extensive aquifers and confining beds within the Southeastern United States Coastal Plain. The report is a product of the Geological Survey's Regional Aquifer-Systems Analysis Program that involves a series of investigations to present a systematic, unified, regional overview and assessment of the hydrogeologic and geochemical conditions of unique, multi-state aquifer systems. A major objective of the program is to examine the pattern of ground-water flow within regional aquifers and to develop mathematical models of the systems.
Water Resources Investigation 84-4243.

Data on the Distribution and Abundance of Submersed Aquatic Vegetation in the Potomac River and Transition Zone of the Potomac Estuary, Maryland, Virginia, and the District of Columbia, 1983 and 1984 concentrates on the tidal Potomac River but extends the survey into the transition zone and part of the estuary. A 1978-1981 survey showed that the tidal river was nearly devoid of submersed aquatic plants, and that the greatest abundance and diversity was found in the transition zone of the estuary. In 1983, several species of submersed aquatic plants returned to the tidal river, giving scientists reason to believe that environmental conditions and water quality have improved.
Water Supply Paper 2234-A.

Controls on Phosphorus Mobility in the Potomac River near the Blue Plains Wastewater Treament Plant summarizes the results of part of the river-quality assessment program for the Potomac River. The Blue Plains wastewater treatment plant is the largest source of phosphorus in the Potomac River basin. The transport of phosphorus near the treatment plant was found to be affected by the circulation regime, by inorganic adsorption reactions with sediments, and by metabolic uptake and release by phytoplankton. Analyses of bottom sediments indicate that about 13 percent of the phosphorus discharged between September 1977 and August 1980 has been retained in the embayment on the eastern side of the river. Measurements of the linear decay constant for the removal of dissolved phosphorus from the water column reveal a diurnal cycle corresponding to the metabolic utilization of phosphorus by phytoplankton.
Water Supply Paper 2231.

Design of the National Trends Network for Monitoring the Chemisty of Atmospheric Precipitation describes the development of the National Trends Network for monitoring the chemistry of atmospheric preciptiation. The network, which will ultimately consist of 151 sites, will monitor precipitation at sites representing broad regional characteristics for a minimum of 10 years. The basic elements of the design are: assurance that all areas of the country are represented in the network on the basis of regional ecological properties (96 sites); placement of additional sites east of the Rocky Mountains to better define high deposition gradients; placement of sites to assure that potentially sensitive regions are represented (15 sites); and placement of sites to allow for other considerations, such as urban effects (5 sites), in comparison with Canada (3 sites), and apparent disparities in regional coverage (5 sites). The U.S. Geological Survey is lead agency of the Deposition Monitoring Task Group of the Interagency Task Force on Acid Preciptiation. Circular 964.

Freshwater Heads and Ground-Water Temperatures in Aquifers of the Northern Great Plains in Parts of Montana, North Dakota, South Dakota, and Wyoming uses water-level measurements and ground-water temperatures to map the heads and temperature variations in the several aquifers in the Northern Great Plains. Water temperatures, in formations that range in depth from land surface to as much as 15,000 ft, are estimated to range from about 7 degrees to about 174 degrees C based on an assumed gradient of 1 degree C per 90 feet of depth. Temperature variations are large enough to warrant this mapping in order to correct heads for density and transmissivities for viscosity so that effective modeling of the regional-aquifer systems may be accomplished. Professional Paper 1402-D.

The Hydrologic Bench-Mark Program: A Standard to Evaluate Time-Series Trends in Selected Water-Quality Constituents for Streams in Georgia examines the usefulness of USGS Hydrologic Bench-Mark Data in evaluating changes in surface-water-quality conditions in basins modified by human activity. The Survey began the Hydrologic Bench-Mark Program in 1958 to provide a hydrologic data-base on stream basins which are minimally affected by human impact. Comparison of temporal trends in various water-quality constituents from several streams in Georgia, including those for several bench-mark stations, indicate basin responses to changes in the chemical quality of atmospheric deposition, as well as various land uses and water uses associated with agricultural and urban land, or to changes in specific uses. Hydrologic bench-mark data bases make such analyses possible.
Water Resources Investigation 84-4318.

Federal-State Cooperative Program

Test Well Installation and Water Quality, Hollywood Dump Area, Memphis, Tennessee, was prepared in cooperation with the City of Memphis, Tennessee. Ground water is the sole source of potable water currently being used for municipal and industrial supplies in the Memphis area. The possibility that leachates from landfills and dumps known to contain hazardous substances might threaten this water source is a subject of public concern. For the study, monitor wells were installed and water samples collected and analyzed to determine if contaminants have entered the shallow unconfined aquifer. The shallow aquifer is underlain by a clay layer that provides protection for the deeper Memphis Sand, which is the principal source of potable water. High concentrations of synthetic organics have been found in the shallow aquifer, but no traces of the organic compounds have been found in the Memphis Sand. Other constitutents and properties were found to be at levels that are normal for this aquifer.
Water Resources Investigation 84-4214.

Aldicarb Pesticide Contamination of Ground Water in Eastern Suffolk County, Long Island, New York was prepared in in cooperation with the Suffolk County Department of Health Services, and the Suffolk County Water Authority. Aldicarb, a highly toxic pesticide, was used to control insect infestations in potato farms over large areas of eastern Long Island during the period 1975-1979. The pesticide was believed to have a short half-life and small soil penetration, and therefore was considered incapable of causing ground-water contamination. However, widespread contamination of ground water by aldicarb was confirmed by extensive sampling during 1979-80 in the upper glacial aquifer, the principal source of drinking water in the area. The recently released report describes results of further studies which indicate that aldicarb concentrations will not be less than 7 ug/L, the established drinking-water standard for the pesticide, before 1990 or later.
Water Resources Investigation 84-4251.

Ground-Water Problems in Arkansas was prepared in cooperation with several agencies of the State of Arkansas, and in line with the "Water Quality Management Plan" developed by the Arkansas Department of Pollution Control and Ecology. A principal objective of the plan is to develop and establish a systematic approach to the protection of the State's ground-water quality. The report provides information on the occurrence, problems, and potential problems of ground water in Arkansas as a step in meeting that objective. The problems include contamination, poor natural quality, overdraft, and low yields. Contamination of surficial aquifers has been attributed to human and animal wastes, industrial wastes, and saline-water encroachment in areas of ground-water overdraft.
Water Resources Investigation 85-4010.

Quality of Arkansas River and Irrigation Return Flows in the Lower Arkansas River Valley, Colorado, prepared in cooperation with the Southeastern Colorado Water Conservancy District, describes the quality of the Arkansas River and irrigation return flows in the Lower Arkansas River Valley, Colorado. Fifty-nine irrigation return flows from just below Pueblo Reservoir to the Colorado-Kansas State line, were sampled once during the 1976 and 1977 irrigation seasons. Water-quality standards at about one-third of the sites were exceeded for one or more constituents, mostly manganese. Concentrations of trace elements were not determined in this study.
Water Resources Investigation 84-4273.

Feasibility of Artificial Recharge to the 800-Foot Sand of the Kirkwood Formation in the Coastal Plain Near Atlantic City, New Jersey was prepared in cooperation with the New Jersey Department of Environmental Protection, to evaluate a principal and practical approach to providing a dependable water supply for the Atlantic City area. Renewed economic development in the area has increased demand for water, resulting in greater pumpage from the 800-foot sand of the Kirkwood formation. Greater ground-water withdrawals not only reduce the quantity of water in storage, but also increase the potential for saltwater intrusion. The report (1) provides a review of methods for artificial recharge with emphasis on operational problems, (2) describes the local hydrogeological conditions, and (3) presents and interprets the water-quality data collected during the investigation. The major problem with artificial recharge is related to the quality of the recharge water.
Water Resources Investigation 85-4063.

The Ground-Water System and Simulated Effects of Ground-Water Withdrawals in Northern Utah Valley, Utah, prepared in cooperation with the Utah Department of Natural Resources, Division of Water Rights, evaluated the ground-water resources of northern Utah Valley. The valley is one of the fastest growing areas in the United States, as evidenced by the growth of urban population from about 72,000 in 1960 to about 164,000 in 1980. In order to meet water needs of the increased population, annual ground-water withdrawals for public supply increased from about 5,000 acre-feet to about 20,000 acre-feet during the late 1970's. The report describes the hydraulic properties and recharge to and discharge from the ground-water system in the valley and projects the effects of potential increases in withdrawals on ground-water levels. This involved the use of a three-dimensional digital model. Water-level declines of as much as 25 feet are foreseen for the 20-year period 1980-2000. The model indicates that in addition to increased ground-water withdrawals, changes in recharge to the principal ground-water reservoir are a major cause of variations in water levels.
Water Resources Investigation 85-4007.

Hydrology of Major Estuaries and Sounds of North Carolina, prepared in cooperation with the North Carolina Department of Natural Resources and Community Development, presents a basic picture of the major water features in terms of fresh water inflow, tide-affected flow, water levels, fresh water quality, salinity, and sedimentation--utilizing USGS data where available, and filling gaps when possible with information from other agencies. The summary of current basic knowledge of the hydrology of the estuaries and sounds is valuable for management decisions and for use in planning future estuarine studies. The investigation identified contamination by municipal and industrial wastes, excessive shoaling in some navigation channels, salt-water intrusion into usually fresh estuarine reaches, too-high or too-low salinity nursery areas for various estuarine species, and flood damage due to hurricanes. Water Supply Paper 2221.

Traveltime and Dispersion in the Potomac River, Cumberland, Maryland, to Washington, D.C. was prepared in cooperation with the District of Columbia Department of Environmental Services; the Fairfax County, Virginia, Water Authority; the Interstate Commission on the Potomac River Basin; the Maryland Department of Natural Resources; and the Washington Suburban Sanitary Commission. It presents results of a study to describe the movement of soluble material in the river and to present techniques for predicting traveltimes and concentration attenuation at downstream locations resulting from spillage of any amount of soluble contaminant at any point along the river. The flow during the study was at approximately the 90-percent flow duration level. Data from this study were combined with those from an earlier study to develop the described general procedure for predicting traveltime and concentration. Techniques are of particular use and apply to almost any spillage problem that occurs during periods of relatively steady flow of between 50- and 95-percent flow duration. Water Supply Paper 2257.

Geohydrology and Model Analysis of Stream-Aquifer System Along the Arkansas River in Kearny and Finney Counties, Southwestern Kansas was published in cooperation with the Division of Water Resources, Kansas State Board of Agriculture (KSBA). The report was requested because of concern over decreasing streamflow and declining water levels in wells, and the need for a better understanding of ground- and surface-water interaction along the Arkansas River. In 1977, the Chief Engineer of the Division of Water Resources, KSBA, declared a moratiorium on approval of applications for permits to appropriate water from an area of 500 square miles along the Arkansas River in southwest Kansas. The report provides information on the hydrologic relationships between the Arkansas River and water levels in the unconsolidated aquifer system, and the extent to which diversion from either source might impair water use under existing rights. Water Supply Paper 2253.

Compilation of Water Resources Development and Hydrologic Data of Saipan, Mariana Islands, was prepared by the USGS in cooperation with the Commonwealth of the Northern Mariana Islands. The report summarizes the history of water-resources development on Saipan and presents all available hydrologic data. The data include rainfall records since 1901 from German, Japanese, and U.S. sources; streamflow records since 1968; and an almost complete compilation of drilling logs, pumping tests, chemical analyses, and production figures for the 180 test holes and wells drilled on the island. Ground water is the main source of water for the island, and production reached more than four million gallons per day in September 1983.
Water Resources Investigation 84-4121.

Cost Effectiveness of the Stream-Gaging Program in New Jersey, prepared in cooperation with the New Jersey Department of Environmental Protection, Division of Water Resources, is the latest of the series of periodic and systematic evaluations of the streamflow program by the USGS which is doing a nationwide analysis of its streamflow information program over the 5-year period 1983-1987. The New Jersey study shows that minor changes can be made in the mix of station types (currently 101 continuous, 73 crest-stage and stage-only), and that, by and large, the program is meeting its objectives and the expressed water data needs in a cost-effective manner.
Water Resources Investigation 84-4108.

Other Federal Agency Program

Simulated Ground-Water Flow in the Potomac Aquifer, New Castle County, Delaware, prepared in cooperation with the U.S. Army Corps of Engineers and the Delaware Department of Natural Resources and Environmental Control, presents an evaluation of Delaware ground water. The report gives the results of computer simulations and evaluates effects of future ground-water withdrawals from the Potomac aquifers. The Potomac Formation is a major source of water for the towns and industries of New Castle county. A steady increase in pumping since the mid-1900's has created both regional and local areas of depression centered about well fields in the county, and water levels have been drawn down about 200 feet below sea level. The decline near brackish estuaries and man-made sources of contamination has caused concern about future increased withdrawal from the Potomac aquifer. A model was developed, calibrated, and used to evaluate changes in water levels from several scenarios of future pumpage. Major declines in water level are projected from 1980-2005 for the various proposed increased rates of pumpage. Even if no change in pumpage were to take place, water levels would continue to decline in the order of 25 feet.
Water Resources Investigation 84-4007.

Ground-Water Availability along the Blue Ridge Parkway, Virginia, prepared in cooperation with the National Park Service, describes the geohydrologic conditions along the parkway which covers 220 miles from Rockfish Gap, Augusta County, central Virginia, to the North Carolina border. Its principal purpose was to identify favorable areas for future ground-water development along the parkway. The Blue Ridge Parkway traverses an area having numerous overlooks, hiking trails, and recreational facilities that are visited by an increasing number of people each year. The Park Service has developed long-range plans to meet increasing public demand. These plans include expansion of existing recreational facilities as well as development of new facilities at selected sites along the parkway. Water supplies for these facilities will be derived from drilled wells and (or) springs. However, wells are preferred because they are less susceptible to surface contamination than are springs.
Water Resources Investigation 84-4168.

Reconnaissance of Water Quality at a U.S. Department of Energy Site, Pinellas County, Florida, prepared for the Department of Energy (DOE), summarizes the surface-water and ground-water quality conditions at the site to detect impacts, if any, of treatment and disposal activities. The DOE plant has been in operation since 1956. The facility, operated by General Electric, treated combined sanitary and industrial wastes by extended aereation and chlorination with ultimate disposal by spray injection on a 10-acre tract within the plant site and discharge into two ponds on the site. Water samples from specially constructed wells and the two ponds were analyzed for a number of priority and nonpriority pollutants.
Water Resources Investigation 85-4062.

The Ground-Water System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah, prepared in cooperation with the Bureau of Land Management, provides hydrologic information needed to assess the hydrologic effects of coal mining. Trail Mountain was selected for the study because of its geologic and hydrologic similarities to much of the Wasatch Plateau. Hydrogeologic evaluations and computer simulations of the study area indicate that future underground mines may require dewatering of inflows of as much as several hundred gallons per minute. Subsidence will occur above future underground mines, and subsidence fractures possibly would extend from the mine roof to a shallow perched aquifer several hundred feet above. Such fractures would increase downward percolation of water and increase inflows to underground mines. Water Supply Paper 2259.

Ground-Water Contamination in East Bay Township, Michigan, prepared in cooperation with the U.S. Coast Guard, describes results of a study to document the occurrence, extent, and movement of contaminated ground water from the U.S. Coast Guard Air Station to the East Arm Grand Traverse Bay. Chemical analyses located a plume of organic chemicals that follows ground-water flow lines. The plume, estimated to range from 180 to 400 feet wide, is in glacial deposits that comprise the principal aquifer tapped for water by all wells in the area. Sources of contamination were traced to the vicinity of past drum storage, aircraft maintenance operations, and fuel storage and dispensing facilities on the Air Station property. Water Resources Investigation 85-4064.

Geohydrology and Water Resources of the Papago Farms-Great Plain Area, Papago Indian Reservation, Arizona, and the Upper Rio Sonoyta Area, Sonora, Mexico was prepared in cooperation with the Bureau of Indian Afffairs. The appraisal was prompted by the increased demand for ground water to meet the growing irrigation and public supply requirements in the study area. Water in the aquifer is moderate-to-poor in chemical quality for irrigation and public supply use. High concentrations of sodium and bicarbonate present potential hazards to most crops, and the use of the waters requires careful farm management practices. Water Supply Paper 2258.

WATER RESOURCES DIVISION PUBLICATIONS, JANUARY THROUGH JULY, 1985

PROFESSIONAL PAPERS

PP 1258-E, Rasmussen, L. A.,and Meier, M. F., 1985, Surface topography of the lower part of Columbia Glacier, Alaska, 1974-1981, 63 p.

PP 1258-F, Meier, M. F., Rasmussen, L. A., Krimmel, R. M., Olsen, R. W., and Frank, D., 1985, Photogrammetric determination of surface altitude, terminus position, and ice velocity of Columbia Glacier, Alaska, 41 p.

PP 1273-B, Brown, D. L., Blankennagel, R. K., MacCary, L. M., and Peterson, J. A., 1984, Correlation of paleostructure and sediment deposition in the Madison limestone and associated rocks in parts of Montana, North Dakota, South Dakota, Wyoming, and Nebraska, 24 p.

PP 1307, Lindskov, K. L., and Kimball, B. A., 1984, Water resources and potential hydrologic effects of oil-shale development in the southeastern Uinta basin, Utah and Colorado, 32 p.

PP 1331, Mongan, C. E., 1985, Validity of Darcy's law under transient conditions, 16 p.

PP 1333, Burkham, D. E., 1985, An approach for appraising the accuracy of suspended-sediment data, 18 p.

PP 1402-D, Lobmeyer, D. H., 1985, Freshwater heads and ground-water temperatures in aquifers of the northern Great Plains in parts of Montana, North Dakota, South Dakota, and Wyoming, 11 p.

BULLETINS

Bulletin 1642, Newton, G. D., 1985, Computer programs for common map projections, 33 p.

WATER-SUPPLY PAPERS

WSP 1757-P, Groller, M. J., 1984, A qualitative appraisal of the hydrology of the Yemem Arab Republic from landsat images, 70 p.

WSP 2185-F, Crawford, J. K., 1985, Water quality of North Carolina streams--water-quality characteristics for selected sites on the Cape Fear River, North Carolina, 1955-80--variability, loads, and trends of selected constituents, 44 p.

WSP 2192, Goodwin, C. R., and Michaelis, D. M., 1984, Appearance and water quality of turbidity plumes produced by dredging in Tampa Bay, Florida, 66 p.

WSP 2196-C, Mattraw, H. C., Jr., 1984, Nutrient and detritus transport in the Apalachicola River, Florida, 62 p.

WSP 2206, Hearne, G. A., 1985, Simulation of an aquifer test on the Tesuque Pueblo Grant, New Mexico, 24 p.

WSP 2209, Guswa, J. H., and LeBlanc, D. R., 1985, Digital models of ground-water flow in the Cape Cod aquifer system, Massachusetts, 112 p.

WSP 2212, Setmire, J. G., 1984, Water quality in the New River from Dalexico to the Salton Sea, Imperial County, California, 42 p.

WSP 2215, Burkart, M. R., 1984, Availability and quality of water from the Dakota aquifer, northwest Iowa, 65 p.

WSP 2217, Takasaki, K. J., and Mink, J. F., 1985, Evaluation of major dike-impounded ground-water reservoirs, Island of Oahu, 77 p.

WSP 2218, LeBlanc, D. R., 1984, Sewage plume in a sand and gravel aquifer, Cape Cod, Massachusetts, 28 p.

WSP 2219, Delin, G. N., and Woodward, D. G., 1984, Hydrogeologic setting and the potentiometric surfaces of regional aquifers in the Hollandale embayment, southwestern Minnesota, 1970-80, 56 p.

WSP 2221, Giese, G. L., Wilder, H. B., and Parker, G. G., Jr., 1985, Hydrology of major estuaries and sounds of North Carolina, 108 p.

WSP 2222, Dugan, J. T., 1984, Hydrologic characteristics of Nebraska soils, 19 p.

WSP 2224, Lindskov, K. L., and Kimball, B. A., 1984, Quantity and quality of flow in the southeastern Uinta basin, Utah and Colorado, 72 p.

WSP 2228, Peters, N. E., 1984, Evaluation of environmental factors affecting yields of major dissolved ions of streams in the United States, 39 p.

WSP 2230, Leenheer, J. A., and Noyes, T. I., 1984, A filtration and column adsorption system for onsite concentration and fractionation of organic substances from large volumes of water, 16 p.

WSP 2231, Hearn, P. P., Jr., 1985, Controls on phosphorus mobility in the Potomac River near the Blue Plains wastewater treatment plant, 46 p.

WSP 2233, Callander, E., Carter, V., Hahl, D. C., Hitt, K., and Schultz, B. I., Eds., 1984, A water-quality study of the tidal Potomac River and estuary - an overview, 46 p.

WSP 2234-A, Carter, V., Paschal, J. E., Jr., and Bartow, N., 1985, Distribution and abundance of submersed aquatic vegetation in the tidal Potomac River and estuary, Maryland and Virginia, May 1978 to November 1981, 46 p.

WSP 2238, Dunlap, L. E., and Spinazola, J. M., 1984, Interpolating water-table altitudes in west-central Kansas using kriging techniques, 19 p.

WSP 2239, Slagle, S. E., Lewis, B. D., and Lee, R. W., 1985, Ground-water resources and potential hydrologic effects of surface coal mining in the northern Powder River basin, southeastern Montana, 34 p.

WSP 2241, Aldridge, B. N., 1984, Floods of November 1978 to March 1979 in Arizona and west-central New Mexico, 149 p.

WSP 2245, Engberg, R. A., 1984, Appraisal of data for ground-water quality in Nebraska, 54 p.

WSP 2251, Brown, R. F., and Keys, W. S., 1985, Effects of artificial recharge on the Ogallala aquifer, Texas, 56 p.

WSP 2252, Jobson, H. E., and Rathbun, R. E., 1984, Use of the routing procedure to study dye and gas transport in the West Fork Trinity River, Texas, 21 p.

WSP 2253, Dunlap, L. E., Lindgren, R. J., and Sauer, C. G., 1985, Geohydrology and model analysis of stream-aquifer system along the Arkansas River in Kearny and Finney Counties, southwestern Kansas, 52 p.

WSP 2255, Meisler, H., Leahy, P. P., and Knobel, L. I., 1984, Effect of eustatic sea-level changes on saltwater-freshwater in the northern Atlantic coastal plain, 28 p.

WSP 2256-A, Stamer, J. K., Yorke, T. H., and Pederson, G. L., 1985, Distribution and transport of trace substances in the Schuylkill River basin from Berne to Philadelphia, Pennsylvania, 45 p.

WSP 2257, Taylor, K. R., James, R. W., Jr., and Helinsky, B. M., 1985, Traveltime and dispersion in the Potomac River, Cumberland, Maryland, to Washington, D. C., 20 p.

WSP 2258, Hollett, K. J., 1985, Geohydrology and water resources of the Papago Farms-Great Plain area, Papago Indian Reservation, Arizona, and the upper Rio Sonoyta area, Sonora, Mexico, 44 p.

WSP 2259, Lines, G. C., 1985, The ground-water system and posaible effects of underground coal mining in the Trail Mountain area, central Utah, 32 p.

WSP 2260, Parrett, C., and Hull, J. A., 1985, Streamflow characteristics of mountain streams in western Montana, 58 p.

WSP 2261, Merritt, M. L., 1985, Subsurface storage of freshwater in south Florida: A digital model analysis of recoverability, 44 p.

WSP 2264, Jobson, H. E., 1985, Simulating unsteady transport of nitrogen, biochemical oxygen demand, and dissolved oxygen in the Chattahoochee River downstream from Atlanta, Georgia, 36 p.

WSP 2270, U.S. Geological Survey, 1985, Selected papers in the hydrologic sciences, 119 p.

WSP 2275, U.S. Geological Survey, 1985, National Water Summary 1984--Hydrologic events, selected water-quality trends, and ground-water resources, 467 p.

CIRCULARS

Circular 883, Sun, J. T., 1985, USGS Coastal Research, studies, and maps--a source of information for coastal decisionmaking, 80 p.

Circular 904-B, Sargent, K. A., and Bedinger, M. S., 1985, Geologic and hydrologic characterization and evaluation of the Basin and Range Province relative to the disposal of high-level radioactive waste--Part II, Geologic and hydrologic characterization, 30 p.

Circular 904-C, Bedinger, M. S., Sargent, K. A., and Brady, B. T., 1985, Geologic and hydrologic characterization and evaluation of the Basin and Range Province relative to the disposal of high-level radioactive waste--Part III, Geologic and hydrologic evaluation, 27 p.

Circular 926, Taylor, T. A., and Dey, J. A., 1985, Bibliography of borehole geophysics as applied to ground-water hydrology, 62 p.

Circular 964, Robertson, J. K., and Wilson, J. W., 1985, Design of the national trends network for monitoring the chemistry of atmospheric precipitation, 46 p.

HYDROLOGIC INVESTIGATIONS ATLASES

HA 662, Brackley, R. A., and Hansen, B. P., 1985, Hydrology and water resources of tributary basins to the Merrimack River from Salmon Brook to the Concord River, Massachusetts, 2 sheets.

HA 674, Lewis, B. D., and Jensen, R. G., 1985, Hydrologic conditions at the Idaho National Engineering Laboratory, Idaho, 1979-1981 update, 2 sheets.

WATER-RESOURCES INVESTIGATIONS REPORTS

WRIR 82-4050, Colon-Dieppa, E., and Quinones-Marquez, F., 1985, A reconnaissance of the water resources of the central Guanajibo Valley, Puerto Rico, 47 p.

WRIR 82-4088, Bradley, M. W., 1984, Ground water in the Dickson area of the western highland rim of Tennessee, 42 p.

WRIR 82-4102, Schemel, L. E., 1984, Seasonal patterns of alkalinity in the San Francisco Bay Estuarine System, California, during 1980, 54 p.

WRIR 82-4114, Crouch, T. M., Abbott, P. O., Penley, R.D ., Hurr, R. T., and Cain, D., 1984, Water-resources appraisal of the upper Arkansas River basin from Leadville to Pueblo, Colorado, 123 p.

WRIR 83-4015, Swift, C. H., 1985, Phase I summary and Phase II plan for comparing regulated with unregulated streamflow in the Yakima River at Union Gap, Washington, 21 p.

WRIR 83-4045, Ruhl, J. F., Wolf, R. J., and Adolphson, D. G., 1983, Hydrogeologic and water-quality characteristics of the Prairie Du Chien-Jordan aquifer, southeast Minnesota, 2 plates.

WRIR 83-4049, Showalter, P., Akers, J. P., and Swain, L. A., Design of a ground-water-quality monitoring network for the Salinas River Basin, California, 74 p.

WRIR 83-4055, McKinley, P. W., 1985, Surface water data network analysis for Puerto Rico, 14 p.

WRIR 83-4059, Schemel, L. E., 1984, Salinity, aklalinity, and dissolved and particulate organic carbon in the Sacramento River water at Rio Vista, California, and at other locations in the Sacramento-San Joaquin Delta, 1980, 45 p.

WRIR 83-4080, Templin, W. E., 1984, Ground-water-quality monitoring network design for the San Joaquin Valley ground-water basin, California, 133 p.

WRIR 83-4082, Freiwalt, D. A., 1984, Ground-water resources of Lanfair and Fenner Valleys and vicinity, San Bernardino County, California, 60 p.

WRIR 83-4102, Ebbert, J. C., 1984, The quality of ground water in the principal aquifers of northeastern-north central Washington, 112 p.

WRIR 83-4114-A, Bedinger, M. S., Anderson, T. W., and Langer, W. H., 1984, Ground-water units and withdrawal, Basin and Range Province, Arizona, 7 p.

WRIR 83-4114-B, Langer, W. H., Mulvihill, D. A., and Anderson, T. W., 1984, Maps showing ground-water levels, springs, and depth to water, Basin and Range Province, Arizona, 7 p.

WRIR 83-4114-C, Thompson, T. H., Nuter, J., and Anderson, T. W., 1984, Map showing distribution of dissolved solids and dominant chemical type in ground water, Basin and Range Province, Arizona, 7 p.

WRIR 83-4114-D, Johnson, W. D., Jr., and Scarborough, R. B., 1984, Map showing outcrops of granitic rocks, Basin and Range Province, Arizona, 33 p.

WRIR 83-4114-E, Johnson, W. D., Jr., 1984, Map showing outcrops of thick, dominantly argillaceous sedimentary and metasedimentary rocks, Basin and Rance Province, Arizona, 11 p.

WRIR 83-4114-F, Jenness, J. E., Lopez, D. A., and LaFortune, J. R., 1984, Map showing outcrops of pre-Quaternary ash-flow tuffs and volcaniclastic rocks, Basin and Range Province, Arizona, 19 p.

WRIR 83-4114-G, Johnson, W. D., Jr., and Scarborough, R. B., 1984, Map showing outcrops of pre-Quaternary basaltic rocks, Basin and Range Province, Arizona, 19 p.

WRIR 83-4115-A, Reed, J. E., Bedinger, M. E., Langer, W. H., Ireland, R. L., and Mulvihill, D. A., 1984, Maps showing ground-water units, withdrawal, and levels, springs, and depth to ground water, Basin and Range Province, northern California, 6 p.

WRIR 83-4115-B, Thompson, T. H., and Chappell, R., 1984, Maps showing distribution and dissolved solids and dominant chemical type in ground water, Basin and Range Province, northern California, 5 p.

WRIR 83-4115-C, Hills, F. A., Grose, T. L. T., and Lopez, D. A., 1984, Map showing outcrops of granitic rocks and silicic, shallow-instrusive rocks, Basin and Range Province, northern California, 1 sheet.

WRIR 83-4115-D, Jenness, J. F., Grose, T. L. T., and Lopez, D. A., 1984, Map showing outcrops of pre-Quaternary ash-flow tuffs and volcaniclastic rocks, Basin and Range Province, northern California, 1 sheet.

WRIR 83-4115-E, Hills, F. A., Grose, T. L. T., and Lopez, D. A., 1984, Map showing outcrops of Tertiary basaltic rocks, Basin and Range Province, northern California, 10 p.

WRIR 83-4116-A, Bedinger, M. S., Langer, W. H., and Moyle, W. R., 1984, Maps showing ground-water units and withdrawal, Basin and Range Province, southern California, 5 p.

WRIR 83-4116-B, Langer, W. H., Moyle, W. R., Woolfenden, L. R., and Mulvihill, D. A. 1984, Maps showing ground-water levels, springs, and depth to ground water, Basin and Range Province, southern California, 5 p.

WRIR 83-4116-C, Thompson, T. H., Nuter, J., Moyle, W. R., Jr. and Woolfenden, L. R. 1984, Maps showing distribution of dissolved solids and dominant chemical type in ground water, Basin and Range Province, southern California, 7 p.

WRIR 83-4116-D, Hills, F. A., 1984, Map showing outcrops of granitic rocks and silicic, shallow-intrusive rocks, Basin and Range Province, southern California, 1 sheet.

WRIR 83-4116-E, Johnson, W. D., Jr., 1984, Map showing outcrops of thick, dominantly argillaceous sedimentary and metasedimentary rocks, Basin and Range Province, southern California, 6 p.

WRIR 83-4116-F, Jenness, J. E., and Lopez, D. A., 1984, Map showing outcrops of pre-Quaternary ash-flow tuffs, Basin and Range Province, southern California, 7 p.

WRIR 83-4117-A, Reed, J. E., Bedinger, M. S., Langer, W. H., Mulvihill, D. A., and Mason, J. L., 1984, Maps showing ground-water units, ground-water levels, springs, and depth to ground water, Basin and Range Province, Idaho, 5 p.

WRIR 83-4117-B, Thompson, T. H., and Chappell, R., 1984, Maps showing distribution of dissolved solids and dominant chemical type in ground water, Basin and Range Province, Idaho, 5 p.

WRIR 83-4117-C, Sargent, K. A., and Jenness, J. E., 1984, Map showing outcrops of granitic rocks, ash-flow tuff, and laharic breccia, Basin and Range Province, Idaho, 7 p.

WRIR 83-4117-D, Johnson, W. D., Jr., 1984, Map showing outcrops of thick, dominantly argillaceous sedimentary and metasedimentary rocks, Basin and Range Province, Idaho, 7 p.

WRIR 83-4118-A, Brady, B. T., Bedinger, M. S., and Hart, D. L., 1984, Maps showing ground-water units and withdrawal, Basin and Range Province, New Mexico, 1 sheet.

WRIR 83-4118-F, Jenness, J. E., Roggensack, K., and Lopez, D. A., 1984, Map showing outcrops of pre-Quaternary ash-flow tuff and laharic breccia, Basin and Range Province, New Mexico, 1 sheet.

WRIR 83-4119-A, Bedinger, M. S., Harrill, J. R., and Thomas, J. M., 1984, Maps showing ground-water units and withdrawal, Basin and Range Province, Nevada, 10 p.

WRIR 83-4119-B, Bedinger, M. S., Harrill, J. R., Langer, W. H., Thomas, J. M., and Mulvihill, D. A., 1984, Maps showing ground-water levels, springs, and depth to water, Basin and Range Province, Nevada, 11 p.

WRIR 83-4119-C, Thompson, T. H., and Chappell, R., 1984, Maps showing distribution of dissolved solids and dominant chemical type in ground water, Basin and Range Province, Nevada, 9 p.

WRIR 83-4119-D, Sargent, K. A., and Roggensack, K., 1984, Map showing outcrops of granitic rocks, Basin and Range Province, Nevada, 2 sheets.

WRIR 83-4119-F, Roggensack, K., and Sargent, K. A., 1984, Maps showing outcrops of early Quarternary and Tertiary age, Basin and Range Province, Nevada, 19 p.

WRIR 83-4120-A, Reed, J. E., Bedinger, M. S., Gonthier, J. E., Langer, W. H., and McFarland, W. D., 1984, Maps showing ground-water units and number of large capacity wells, Basin and Range Province, Oregon, 1 sheet.

WRIR 83-4120-B, Reed, J. E., Bedinger, M. S., Gonthier, J. B., Langer, W. H., McFarland, W. D., and Mulvihill, D. A., 1984, Maps showing ground-water levels, springs, and depth to ground water, Basin and Range Province, Oregon, 1 sheet.

WRIR 83-4120-E, Jenness, J. E., Sargent, K. A., and Lopez, D. A., 1984, Map showing outcrops of pre-Quarternary basaltic rocks, Basin and Range Province, Oregon, 8 p.

WRIR 83-4121-A, Brady, B. T., Bedinger, M. S., and Mikels, J., 1984, Maps showing ground-water units and withdrawal, Basin and Range Province, Texas, 1 sheet.

WRIR 83-4121-B, Brady, B. T., Bedinger, M. S., Mulvihill, D. A., Mikels, J., and Lander, W. H., 1984, Map showing ground-water levels, springs, and depth to ground water, Basin and Range Province, Texas, 7 p.

WRIR 83-4121-C, Thompson, T. H., and Nuter, J., 1984, Maps showing distribution of dissolved solids and dominant chemical type in ground water, Basin and Range Province, Texas, 5 p.

WRIR 83-4121-D, Henry, C. D., and Fisher, G. L., compilers, 1984, Map showing outcrops and lithology of instrusive rocks, Basin and Range Province and vicinity, Trans-Pecos, Texas, 3 sheets.

WRIR 83-4121-E, Henry, C. D., and Fisher, G. L., compilers, 1984, Map showing outcrops of ash-flow tuffs, Basin and Range Province and vicinity, Trans-Pecos, Texas, 3 sheets.

WRIR 83-4121-F, Henry, C. D., and Fisher, G. L., 1984, Map showing outcrops of basaltic rocks, Basin and Range Province and vicinity, Trans-Pecos, Texas, 2 sheets.

WRIR 83-4122-A, Bedinger, M. S., Gates, K. S., and Stark, K. R., 1984, Maps showing ground-water units and withdrawal, Basin and Range Province, Utah, 1 sheet.

WRIR 83-4122-B, Bedinger, M. S., Mason, J. L., Lander, W. H., Gates, J. S., Stark, J. R., and Mulvihill, D. A., 1984, Map showing ground-water levels, springs, and depth to ground water, Basin and Range Province, Utah, 12 p.

WRIR 83-4122-E, Johnson, W. D., Jr., 1984, Map showing outcrops of thick, dominantly argillaceous and metasedimentary rocks, Basin and Range Province, Utah, 9 p.

WRIR 83-4122-F, Roggensack, K., and Jenness, J. E., 1984, Map showing outcrops of pre-Quaternary ash-flow tuffs and volcaniclastic rocks, Basin and Range Province, Utah, 1 sheet.

WRIR 83-4122-G, Jenness, J. E., 1984, Map showing outcrops of pre-quaternary basaltic rocks, Basin and Range Province, Utah, 5 p.

WRIR 83-4125, Foster, J. B., Erickson, J. R., and Healy, R. W., 1984, Hydrogeology of a low-level radioactive-waste disposal site near Sheffield, Illinois, 83 p.

WRIR 83-4135, Ryals, G. N., 1984, Regional geohydrology of the northern Louisiana salt-dome basin, Part II, geohydrologic maps of the tertiary aquifers and related confining layers, 6 p.

WRIR 83-4199, Gomez-Gomez, F., 1984, Water resources of the lower Rio Grande de Manati Valley, Puerto Rico, 42 p.

WRIR 83-4222, Woodward, D. G., 1985, Trends in municipal-well installations and aquifer utilization in southeastern Minnesota, 1880-1980, 99 p.

WRIR 83-4249, Swayze, L. J., and Miller, W. L., 1984, Hydrogeology of a zone of secondary permeability in the surficial aquifer of eastern Palm Beach County, Florida, 39 p.

WRIR 83-4250, Wandle, S. W., Jr., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--Hudson River basin, 24 p.

WRIR 83-4254, Darden, D., 1984, Potentiometric map of the Gordo aquifer in northeastern Mississippi, November and December 1982, 1 sheet.

WRIR 83-4259, Lum, W. E., II, and Cline, D. R., 1985, Test wells in central Washington, 1977 to 1979: Description and results, 48 p.

WRIR 83-4261, Henderson, S. E., Hayes, R. D., and Stoker, Y. E., 1985, Hydrology of Lake Carroll, Hillsborough County, Florida, 1 sheet.

WRIR 83-4262, Page, R. W., Anttila, P. W., Johnson, K. L., and Pierce, M.J. 1984, Ground-water conditions and well yields in fractured rocks, southwestern Nevada County, California, 38 p.

WRIR 83-4268, Edelmann, P., 1984, Effects of irrigating with wastewater on ground-water quality at Fort Carson Military Reservation golf course near Colorado Springs, Colorado, 32 p.

WRIR 83-4278, Sherwood, D. A., 1984, Assessment of nonpoint-source nutrient discharges from the Switzer Creek Basin, Steuben County, New York, 24 p.

WRIR 83-4280, Kapple, G. W., Mitten, H. T., Durbin, T. J., and Johnson, M.J., 1984, Analysis of the Carmel Valley alluvial ground-water basin, Monterey County, California, 45 p.

WRIR 83-4287, Wells, F. and Sejertz, T. L., 1984, Computation and use of volume-weighted-average concentrations to determine long-term variations of selected water-quality constituents in lakes and reservoirs, Texas, 8 p.

WRIR 84-4006, Elder, J. F., 1985, Wastewater application by spray irrigation on a field southeast of Tallahassee, Florida: Effects on ground-water quality and quantity, 1980-1982, 41 p.

WRIR 84-4007, Martin, M. M., 1984, Simulated ground-water flow in the Potomac aquifers, New Castle County, Delaware, 85 p.

WRIR 84-4010, Burns, A. W., 1984, Simulated effects of an artificial-recharge experiment near Proctor, Logans County, Colorado, 17 p.

WRIR 83-4013, Arnston, A. D., and Tornes, L. H., 1985, Rainfall-runoff relationships and water-quality assessment of Coon Creek watershed, Anoka County, Minnesota, 97 p.

WRIR 84-4017, Briggs, J. C., and Silvey, W. D., 1984, Source, movement, and effects of nitrogen and phosphorus in three ponds in the headwaters of Hop Brook, Marlborough, Massachusetts, 55 p.

WRIR 84-4022, Boyle, J. M., Covay, K. J., and Bauer, D. P., 1984, Quantity and Quality of Streamflow in the White River basin, Colorado and Utah, 84 p.

WRIR 84-4023, de Lima, V., and Olimpio, J. C., 1984, Ground-water resources of the Mattapoisett River aquifer, Plymouth County, Massachusetts, Executive summary and summary for water-resources managers, 49 p.

WRIR 84-4028, Patterson, G. G., and Padgett, G. G., 1984, Quality of water from bedrock aquifers in the South Carolina piedmont, 24 p.

WRIR 84-4029, Reynolds, R. J., and Brown, G. A., 1984, Hydrogeologic appraisal of a stratified-drift aquifer near Smyrna, Chenango County, New York, 53 p.

ORIR 84-4030, Hamilton, L. J., 1985, Water resources of Aurora and Jerauld Counties, South Dakota, 58 p.

WRIR 84-4031, Reynolds, R. J., 1985, Hydrologeology of the Clifton Park area, Saratoga County, New York, 6 plates.

WRIR 84-4033, Avery, C., and Pettijohn, R. A., 1984, Generalized potentiometric-surface map of the High Plains aquifer in Wyoming, 1981, 1 sheet.

WRIR 84-4035, Schneider, V. R., and Futrell, J. C., II, 1984, Performance of ice meter and weight assemblies, 26 p.

WRIR 84-4043, Olimpio, J. C., and de Lima, V., 1984, Ground-water resources of the Mattapoisett River Valley, Plymouth County, Massachusetts, 83 p.

WRIR 84-4044, Wolansky, R. M., and Corral, M. A., Jr., 1985, Aquifer tests in west-central Florida, 1952-76, 127 p.

WRIR 84-4045, Kume, J., 1984, Geohydrology and chemical quality of water in middle and upper Jurassic and lower Cretaceous rocks, western Kansas, 54 p.

WRIR 84-4049, Lumia, R., 1984, Flood-discharge profiles of selected streams in Rockland County, New York, 33 p.

WRIR 84-4050, Jarrett, R. D., and Veenhuis, J. E., 1984, An evaluation of rainfall-runoff data for the Denver Federal Center, Lakewood, Jefferson County, Colorado, 29 p.

WRIR 84-4053, Wolcott, S. W., 1984, Streamflow routing in the Schoharie Creek Basin near north Blenheim, New York, 20 p.

WRIR 84-4057, Mull, D. S., and Lyverse, M. A., 1984, Ground water hydrology of the Elizabethtown area, Kentucky, 59 p.

WRIR 84-4058, Blodgett, J. C., Oltmann, R. N., and Poeschel, K. R., 1984, Estimating of streamflow for selected sites on the Carson and Truckee Rivers in California and Nevada, 1944-80, 223 p.

WRIR 84-4059, Grove, D. B., and Stollenwerk, K. G., 1984, Computer model of one-dimensional equilibrium controlled sorption processes, 58 p.

WRIR 84-4062, McAda, D. P., 1984, Projected water-level declines in the Ogallala aquifer in Lea County, New Mexico, 84 p.

WRIR 84-4065, Moffatt, R. L., and Jones, M. L., 1984, Availability and chemistry of ground water on the Bruneau Plateau and adjacent eastern plain in Twin Falls County, south-central Idaho, 43 p.

WRIR 84-4066, Field, S. J., and Lidwin, R. A., 1984, An assessment of nonpoint-source discharges, streamflow and water quality in Onion River, Wisconsin, 78 p.

WRIR 84-4068, Causaras, C. R., 1985, Geology of the surficial aquifer system, Broward County, Florida, 167 p.

WRIR 84-4070, Hall, A. P., and Holland, T. W., 1984, Water use in Arkansas, 1981, 1 sheet.

WRIR 84-4072, Ellis, S. R., and Mustard, M. H., 1985, A summary of urban runoff studies in the Denver metropolitan area, Colorado, 31 p.

WRIR 84-4078, Kuiper, L. K., 1984, Appraisal of the water resources of the eastern part of the Tulare aquifer, Beadle, Hand, and Spink Counties, South Dakota, 52 p.

WRIR 84-4080, Myette, C. F., 1984, Ground-water-quality appraisal of sand-plain aquifers in Hubbard, Morrison, Otter Tail, and Wadena Counties, Minnesota, 49 p.

WRIR 84-4082, Dunlap, L. E., Lindgren, R. J., and Carr, J. E., 1984, Projected effects of ground water withdrawals in the Arkansas River Valley, 1980-99, Hamilton and Kearney Counties, southwestern Kansas, 168 p.

WRIR 84-4086, Soukup, W. G., Gillies, D. C., and Myette, C. F., 1984, Appraisal of the surficial aquifers in the Pomme de Terre and Chippewa River Valleys, western Minnesota, 63 p.

WRIR 84-4087, McClymonds, N. E., 1984, Potential effects of surface coal mining on the hydrology of the West Otter area, Ashland and Birney-Broadus Coal Fields, southeastern Montana, 70 p.

WRIR 84-4088, Gaggiani, N. G., 1984, Nitrogen, sulfate, chloride, and maganese in ground water in the alluvial deposits of the South Platte River Valley near Greeley, Weld County, Colorado, 2 sheets.

WRIR 84-4098, Engel, G. B., Wahl, K. L., and Boohar, J. A., 1984, Cost-effectiveness of the stream-gaging program in Nebraska, 76 p.

WRIR 84-4099, Fisher, G. T., and Katz, B. G., 1984, Analysis of urban storm-water runoff characteristics of four basins in the Baltimore metropolitan area, Maryland, 51 p.

WRIR 84-4104, Parks, W. S., Carmichael, J. K., and Graham, D. D., 1985, Preliminary assessment of ground-water resources of Lauderdale County, Tennessee, 35 p.

WRIR 84-4105, Laenen, A. and Hansen, R. P., Preliminary study of the water-temperature regime of the North Santiam River downstream from Detroit and Big Cliff Dams, Oregon, 45 p.

WRIR 84-4107, Medina, K. D., and Geiger, C. D., 1984, Evaluation of the cost effectiveness of the 1983 stream-gaging program in Kansas, 57 p.

WRIR 84-4108, Schopp, R. D., and Ulery, R. L., 1984, Cost-effectiveness of the stream-gaging program in New Jersey, 97 p.

WRIR 84-4110, Neely, B. L., Jr., 1984, Flood frequency and storm runoff of urban area of Memphis and Shelby County, Tennessee, 51 p.

WRIR 84-4114, Grannemann, N. G., 1984, Hydrogeology and effects of tailings basins on the hydrology of Sands Plain, Marquette County, Michigan, 98 p.

WRIR 84-4121, van der Brug, O., 1985, Compilation of water resources development and hydrologic data of Saipan, Mariana Islands, 578 p.

WRIR 84-4123, Mades, D. M., and Oberg, K. A., 1984, Cost effectiveness of the U.S. Geological Survey's stream-gaging program in Illinois, 107 p.

WRIR 84-4127, Hoffard, S. H., Pearce, V. F., Tasker, G.D., and Doyle, H. W., Jr., 1984, Cost effectiveness of the stream-gaging program in northeastern California, 110 p.

WRIR 84-4129, Moore, R. B., and Staubitz, W. G., 1984, Distribution and source of barium in ground water, Cattaraugus Indian Reservation, southwestern New York, 17 p.

WRIR 84-4132, Harenberg, W. A., Moffatt, R. L., and Harper, R. W., 1985, Cost effectiveness of the stream-gaging network in Idaho, 109 p.

WRIR 84-4133, Ackerman, D. J., and Rush, F. E., 1984, Hydrogeologic reconnaissance of the San Miguel River basin, southwestern Colorado, 25 p.

WRIR 84-4135, Planert, M., and Aucott, W. R., 1985, Water-supply potential of the Florida aquifer in Osceola, eastern Orange, and southwest Brevard Counties, Florida, 69 p.

WRIR 84-4152, Hamlin, S. N., 1985, An investigation of ground-water recharge by injection in the Palo Alto Baylands, California: Hydraulic and chemical interactions--final report, 61 p.

WRIR 84-4159, Ellis, S. R., Doerfer, J. T., Mustard, M. H., Blakely, S. R., and Gibb, J. W., 1984, Analysis of urban storm-runoff data and the effects on the South Platte River, Denver metropolitan area, Colorado, 66 p.

WRIR 84-4160, Oakley, W. T., 1984, The ground-water resources in the Ross Barnett Reservoir Area, Mississippi, 32 p.

WRIR 84-4162, Stullken, L. E., 1984, Hydrology of the Prairie Dog Creek Valley, Norton Dam to State line, north-central Kansas, 49 p.

WRIR 84-4164, Perry, C. A., 1984, A method of estimating volumes in western Kansas, 18 p.

WRIR 84-4166, Pollock, S. J., 1984, Effectiveness of highway drainage systems in preventing salt contamination of ground water, Route 25 from East Wareham to the Cape Cod Canal, Massachusetts, 22 p.

WRIR 84-4168, Hopkins, H. T., 1984, Ground-water availability along the Blue Ridge Parkway, Virginia, 153 p.

WRIR 84-4171, Burmeister, I. L., and Lara, O. G., 1984, Cost-effectiveness of the stream-gaging program in Iowa, 68 p.

WRIR 84-4175, Brown, R. G., 1984, Hydrologic effects of impoundments in Sherburne National Wildlife Refuge, Minnesota, 20 p.

WRIR 84-4177, Nichols, W. J., Jr., Sowles, J. W., and Lobao, J. J., 1984, Phosphorus loading to McGrath and Ellis Ponds, Kennebec County, Maine, 20 p.

WRIR 84-4178, Cary, L. E., 1984, Application of the U.S. Geological Survey's precipitation-runoff modeling system to the Prairie Dog Creek basin, southeastern Montana, 95 p.

WRIR 84-4179, Hindall, S. M., 1984, Effects of surface coal-mine reclamation on stream quality in a small watershed near Nelsonville, southeastern Ohio, 28 p.

WRIR 84-4180, Voelker, D. C., 1984, Quality of water in the alluvial aquifer, American bottoms, East St. Louis, Illinois, 51 p.

WRIR 84-4181, Cannon, M. R., 1984, Potential effects of surface coal mining on the hydrology of the Circle West Coal Tracts, McCone County, eastern Montana, 46 p.

WRIR 84-4183, Foster, J. B., Garklavs, G., and Mackey, G. W., 1984, Hydrogeologic setting east of a low-level radioactive-waste disposal site near Sheffield, Illinois, 20 p.

WRIR 84-4184, Curtis, R. E., Jr., 1985, Floods of April 18, 1983, on St. Thomas and St. John, U.S. Virgin Islands, 6 p.

WRIR 84-4193, Weeks. E. P., and Wilson, W. E., 1984, Preliminary evaluation of hydrologic properties of cores of unsaturated tuff, test well USW H-1, Yucca Mountain, Nevada, 30 p.

WRIR 84-4197, Robison, J. H., 1984, Ground-water level data and preliminary potentiometric surface maps, Yucca Mountain and vicinity, Nye County, Nevada, 8 p.

WRIR 84-4199, Davis, R. E., 1984, Example calculations of possible ground-water inflow to mine pits at the West Decker, East Decker, and proposed North Decker Mines, southeastern Montana, 31 p.

WRIR 84-4200, Lambing, J. H., 1984, Sediment yields in eastern Montana, summary of data and proposed techniques for estimating sediment yields from small, ungaged water sheds, 45 p.

WRIR 84-4203, James, R. W., Jr., and Helinsky, B. M., 1984, Time of travel and dispersion in the Jones Falls, Baltimore, Maryland, 29 p.

WRIR 84-4206, Rutledge, A. T., 1985, Ground-water hydrology of Volusia County, Florida, with emphasis on occurrence and movement of brackish water, 84 p.

WRIR 84-4207, Holtschlag, D. J., and Croskey, H. M., 1984, Statistical models for estimating flow characteristics of Michigan streams, 80 p.

WRIR 84-4210, Healy, H. G., and Hunn, J. D., 1984, Occurrence of beds of low hydraulic conductivity in surfician deposits of Florida, 1 sheet.

WRIR 84-4211, Whiteman, C. D., Jr., and Martin, A., Jr., 1984, Geohydrologic sections, northern Louisiana, 1 sheet.

WRIR 84-4212, Childress, C. J. O., 1985, Classification to stream basins in Ohio according to extent of surface coal mining, 83 p.

WRIR 84-4214, Graham, D. D., 1985, Test well installation and water quality, Hollywood dump area, Memphis, Tennessee, 35 p.

WRIR 84-4218, Carey, W. P., and Simon, A., 1984, Physical basis and potential estimation techniques for soil erosion parameters in the precipitation-runoff modeling system (PRMS), 32 p.

WRIR 84-4220, Ruddy, B. C., 1984, Streamflow gain and loss and suspended-sediment characteristics of the South Platte River and three irrigation canals near Fort Morgan, Colorado, 82 p.

WRIR 84-4222, Knutilla, R.L., and Corral, M. A., Jr., 1984, Impacts on the Tampa Bypass Canal System on the areal hydrology, Hillsborough County, Florida, 65 p.

WRIR 84-4225, Rogers, R. J., 1984, Chemical quality of the Saw Mill River, Westchester County, New York, 1981-83, 51 p.

WRIR 84-4232, Foose, D. W., 1984, Drainage basins in St. Johns County, Florida, 1 sheet.

WRIR 84-4233, Franklin, M. A., 1984, Magnitude and frequency of flood volumes for urban watersheds in Leon County, Florida, 20 p.

WRIR 84-4235, Adamik, J. T., 1984, Present and proposed ground-water-level program in Maine, 37 p.

WRIR 84-4237, Miller, R. L., and Sutcliffe, H., Jr., 1985, Occurrence of natural radium-226 radioactivity in ground water of Sarasota County, Florida, 34 p.

WRIR 84-4238, de Roche, J. T., and Rozem, A. C., 1984, Water quality of a stream-aquifer system, southern Franklin County, Ohio, 44 p.

WRIR 84-4239, McClymonds, N. E., 1985, Potential effects of surface coal mining on the hydrology of the Horse Creek area, Sheridan and Moorhead coal fields, southeastern Montana, 61 p.

WRIR 84-4242, Miller, T. L., and Gonthier, J. B., 1984, Oregon ground-water quality and its relation to hydrogeologic factors--a statistical approach, 88 p.

WRIR 84-4243, Renken, R. A., 1984, The hydrogeologic framework for the southeastern Coastal Plain aquifer system of the United States, 26 p.

WRIR 84-4244, Evensen, K. D., 1985, Chemical quality of ground water in Yolo and Solans Counties, California, 50 p.

WRIR 84-4246, Snavely, D. S., and Williams, J., 1985, Estimated public-water supply and industrial-commercial ground-water withdrawals and returns in Nassau County, Long Island, New York, 1973-79, 16 p.

WRIR 84-4247, Parks, B., and Madison, R. J., 1985, Estimation of selected flow and water-quality characteristics of Alaskan streams, 64 p.

WRIR 84-4248, Craig, R. W., and Robison, J. H., 1984, Geohydrology of rocks penetrated by test well UE-25#1, Yucca Mountain area, Nye County, Nevada, 57 p.

WRIR 84-4249, Burnett, R. D., 1984, Predictive simulation of alternatives for managing the water resources of North Fork Solomon River Valley between Kirwin Dam and Waconda Lake, north-central Kansas, 34 p.

WRIR 84-4250, Wandle, S. W., Jr., 1984, Gazetteer of hydrologic characteristics of streams in Massachusetts--Hudson River basin, 24 p.

WRIR 84-4251, Soren, J., and Stelz, W. G., 1984, Aldicarb-pesticide contamination of ground water in eastern Suffolk County, Long Island, New York, 34 p.

WRIR 84-4253, Lahoud, R. G., Lobmeyer, D. H., and Whitfield, M. S., Jr., 1984, Geohydrology of volcanic tuff penetrated by test well UE-25#1, Yucca Mountain, Nye County, Nevada, 44 p.

WRIR 84-4254, Johnston, H. E., and Dickerman, D. C., 1985, Hydrology, water quality, and ground-water-development alternatives in the Chipuxet ground-water reservoir, Rhode Island, 100 p.

WRIR 84-4255, Risser, D. W., Davis, P. A., Baldwin, J. A., and McAda, D. P., Aquifer tests at the Jackpile-Paguate uranium mine, Pueblo of Laguna, west-central New Mexico, 26 p.

WRIR 84-4264, Edds, J., and Fitzpatrick, D. J., 1984, Maps showing altitude of the potentiometric surface and changes in water levels in the alluvial aquifer in eastern Arkansas, spring 1983, 1 sheet.

WRIR 84-4265, Edds, J., and Fitzpatrick, D. J., 1984, Maps showing altitude of the potentiometric surface and changes in water levels of the Sparta sand and Memphis sand aquifers in eastern Arkansas, spring 1983, 1 sheet.

WRIR 84-4267, Waddell, R. K., Robison, J. H., and Blankennagel, R. K., 1984, Hydrology of Yucca Mountain and vicinity, Nevada-California--investigative results through mid-1983, 72 p.

WRIR 84-4268, Gold, R. L., 1985, Potential incremental seepage losses in an alluvial channel in the Rio Grande basin, New Mexico, 22 p.

WRIR 84-4269, Young, H. W., 1984, Water-table contours, direction of ground-water movement, and measurements of inflow to American Falls Reservoir, southeastern Idaho, April 1984, 1 sheet.

WRIR 84-4272, Thordarson, W., Rush, F. E., and Waddell, S. J., 1985, Geohydrology of test well USW H-3, Yucca Mountain, Nye County, Nevada, 38 p.

WRIR 84-4273, Cain, D., 1985, Quality of the Arkansas River and irrigation return flows in the lower Arkansas River Valley, Colorado, 85 p.

WRIR 84-4274, Nelson, G. H., Jr., 1984, maps to estimate average streamflow and headwater limits for streams in U.S. Army Corps of Engineers, Mobile District, Alabama and adjacent states, 2 sheets.

WRIR 84-4276, Bartlett, W. P., and Sherwood, J. M., 1984, Flood-profile analysis, Big Darby Creek at State Route 762, Orient, Ohio, 12 p.

WRIR 84-4278, Sorey, M. L., and Ingebritsen, S. E., 1984, Quantitative analysis of the hydrothermal system in Lassen Volcanic National Park and Lassen known geothermal resource area, 80 p.

WRIR 84-4281, Wandle, S. W., Jr., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Coastal river basins of the North Shore and Massachusetts Bay, 60 p.

WRIR 84-4282, Wandle, S. W., Jr., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Connecticut River basin, 110 p.

WRIR 84-4283, Wandle, S. W., Jr., and Keezer, G. R., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Taunton and Ten Mile River basins and coastal river basins of Mount Hope Bay, Narragansett Bay, and Rhode Island Sound, 38 p.

WRIR 84-4284, Wandle, S. W., Jr., and Fontaine, R. A., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Merrimack River basin, 54 p.

WRIR 84-4285, Wandle, S. W., Jr., and Lippert, R. G., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Housatonic River basin, 30 p.

WRIR 84-4286, Wandle, S. W., Jr., and Phipps, A. F., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Blackstone River basin, 26 p.

WRIR 84-4287, Wandle, S. W., Jr., and LeBlanc, Denis R., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Thames River basin, 27 p.

WRIR 84-4288, Wandle, S. W., Jr., and Morgan, M. A., 1984, Gazetteer of hydrologic characteristics of streams in Masssachusetts--Coastal river basins of the South Shore and Buzzards Bay, 30 p.

WRIR 84-4289, Causseaux, K. W., 1985, The surficial aquifer in Pinellas County, Florida, 26 p.

WRIR 84-4290, Steele, T. D., 1985, Harmonic analyses of stream temperatures in the upper Colorado River basin, 51 p.

WRIR 84-4292, Hart, R. J., and Stiles, T. C., 1984, Availability of natural and regulated streamflow for instream uses during historical droughts, lower Neosho Rivers, southeastern Kansas, 42 p.

WRIR 84-4293, Nelson, L. M., 1985, Water-surface elevations for the high tide of December 15, 1977, in the Puget Sound region, Washington, 15 p.

WRIR 84-4294, Whitehead, R. L., and Lindholm, G. F., 1985, Results of geohydrologic test drilling in the eastern Snake River plain, Gooding County, Idaho, 30 p.

WRIR 84-4295, Harbaugh, A. W., and Tilley, C. L., 1984, Steady-state computer model of the water-table aquifer of the Mullica River basin, The Pine Barrens, New Jersey, 38 p.

WRIR 84-4297, Kuhn, G., and Ellis, S. R., 1984, Simulated effects of proposed reservoir-development alternatives on streamflow quantity in the White River, Colorado and Utah, 59 p.

WRIR 84-4298, Stephens, D. W., 1984, Water-quality investigations of the Jordan River, Salt Lake County, Utah, 1980-82, 45 p.

WRIR 84-4299, Hammett, K. M., 1985, Low-flow frequency analyses for streams in west-central Florida, 116 p.

WRIR 84-4301, Fernandez, M., Jr., 1985, Salinity characteristics and distribution and effects of alternative plans for freshwater withdrawal, Little Manatee River estuary and adjacent areas of Tampa Bay, Florida, 45 p.

WRIR 84-4305, Barr, D. E., Hayes, L. R., and Kwader, T., 1985, Hydrology of the southern parts of Okaloosa and Walton Counties, northwest Florida, with special emphasis on the upper limestone of the Floridan aquifer, 66 p.

WRIR 84-4306, Livingston, R. K., and Medina, K. D., 1984, Water-data program of the U.S. Geological Survey in Kansas, fiscal year 1983, 33 p.

WRIR 84-4308, Eddins, W. H., and Crawford, J. K., 1984, Reconnaissance of water-quality characteristics of streams in the city of Charlotte and Mecklenburg County, North Carolina, 105 p.

WRIR 84-4309, Rutledge, A. T., 1985, Use of double-mass curves to determine drawdown in a long-term aquifer test in north-central Volusia County, Florida, 29 p.

WRIR 84-4310, Cole, E. F., 1985, Effects of coal mining on the water quality and sedimentation of Lake Tuscaloosa and selected tributaries, North River basin, Alabama, 53 p.

WRIR 84-4311, Allen, H. E., Jr., and Cowan, E. A., 1985, Low-flow characteristics of streams in the Kishwaukee River basin, Illinois, 35 p.

WRIR 84-4312, Koch, N. C., 1984, Simulated artificial recharge in the Big Sioux acquifer in Minnehaha County, South Dakota, 8 p.

WRIR 84-4314, Breen, K. J., Angelo, C. G., Masters, R. W., and Sedam, A. C., 1985, Chemical and isotopic characteristics of brines from three oil and gas-producing sandstones in eastern Ohio, with applications to the geochemical tracing of brine sources, 58 p.

WRIR 84-4317, Gates, J. S., White, D. E., and Leggat, E. R., 1984, Preliminary study of the aquifers of the lower Mesilla Valley in Texas and New Mexico by model simulation 21 p.

WRIR 84-4318, Buell, G. R., and Grams, S. C., 1985, The hydrologic bench-mark program: A standard to evaluate time-series trends in selected water-quality constituents for streams in Georgia, 36 p.

WRIR 84-4320, Fratwell, J. D., 1985, Water resources and effects of development in Hernando County, Florida, 83 p.

WRIR 84-4323, Bohman, L. R., 1984, Floodflow characteristics of Filbin Creek at proposed interstate highway 526, north Charleston, South Carolina, 20 p.

WRIR 84-4325, Schroder, L. J., and Brennan, J. O., 1985, Precision of the measurement of pH and specific conductance at National Atmospheric Deposition Program Monitoring sites, October 1981-November 1983, 9 p.

WRIR 84-4328, Spaulding W. G., Robinson, S. W., and Paillet, F. L., 1984, Preliminary assessment of climatic change during late Wisconsin time, southern great basin and vicinity, Arizona, California, and Nevada, 40 p.

WRIR 84-4330, McCutcheon, S. C., Jobson, H. E., and Rathbun, R. E., 1985, Water quality and streamflow data for the West Fork Trinity River in Fort Worth, Texas, 101 p.

WRIR 84-4336, Helsel, D. R., 1985, Contributions of suspended sediment from highway construction and other land uses to the Olentangy River, Columbus, Ohio, 31 p.

WRIR 84-4343, Summer, D. M., and Wasson, B. E., 1984, Summary of results of an investigation to define the geohydrology and simulate the effects of large ground-water withdrawals on the Mississippi River alluvial aquifer in northwestern Mississippi, 17 p.

WRIR 84-4344, Czarnecki, J. B., 1985, Simulated effects of increased recharge on the ground-water flow system of Yucca Mountain and vicinity, Nevada-California, 33 p.

WRIR 84-4345, Montazer, P., and Wilson, W. E., 1984, Conceptual hydrologic model of flow in the unsaturated zone, Yucca Mountain, Nevada, 55 p.

WRIR 84-4349, Czarnecki, J. B., and Waddell, R. K., 1984, Finite-element simulation of ground-water flow in the vicinity of Yucca Mountain, Nevada-California, 38 p.

WRIR 84-4351, Lum, W. E., II, and Turney, G. L., 1984, A preliminary evaluation of hydrology and water quality near the Tacoma landfill, Pierce County, Washington, 35 p.

WRIR 84-4355, Voelker, D. C., 1985, A Gazetteer of surface-mine lakes, eastern Interior Coal Province, Illinois, 93 p.

WRIR 84-4357, Pabst, M. E., and Dague, B. J., 1984, Percentage change in saturated thickness of the High Plains aquifer, west-central Kansas, 1950 to average 1982-84, 1 sheet.

WRIR 84-4368, Yotsukura, N., Steadfast, D. A., and Jirka, G. H., 1985, Assessment of a steady-state propane-gas tracer method for determining reaeration coefficients, Chenango River, New York, 69 p.

WRIR 85-4000, Mack, F. K., Wheeler, J. C., and Curtin, S. E., 1985, The potentiometric surface of the Magothy aquifer in southern Maryland, September 1983, 1 sheet.

WRIR 85-4001, Hutchinson, C. B., 1985, Hydrogeology of the Cross Bar Ranch well-field area and projected impact of pumping, Pasco County, Florida, 89 p.

WRIR 85-4003, Carswell, W. J., Jr., and Hart, R. J., 1985, Transit losses and travel times for reservoir releases during drought conditions along the Neosho River from Council Grove Lake to Iola, east-central Kansas, 40 p.

WRIR 85-4006, Elder, J. F., Hunn, J. D., and Calhoun, C. W., 1985, Wastewater application by spray irrigation on a field southeast of Tallahassee, Florida: Effects on ground-water quality and quantity, 1980-82, 41 p.

WRIR 85-4007, Clark, D. W., 1984, The ground-water system and simulated effects of ground-water withdrawals in northern Utah Valley, Utah, 56 p.

WRIR 85-4009, Pabst, M. E., and Stullken, L. E., 1984, Altitude and configuration of the water table in the High Plains aquifer in Kansas, 1980, 1 sheet.

WRIR 85-4010, Bryant, C. T., Ludwig, A. H., and Morris, E. E., 1985, Ground-water problems in Arkansas, 24 p.

WRIR 85-4011, Thompson, K. R., 1984, Annual suspended-sediment loads in the Colorado River near Cisco, Utah, 1930-82, 19 p.

WRIR 85-4012, Houghton, R. L., 1985, Use of chemical test papers to semi-quantitatively determine mercury-vapor concentrations, 15 p.

WRIR 85-4016, Houghton, R. L., Koob, R. D., and Groenwold, G. H., 1985, Progress report on the geochemistry of the sulfur cycle in northern Great Plains coal mines, 70 p.

WRIR 85-4054, Sikonia, W. G., 1985, Impact on the Columbia River of an outburst of Spirit Lake, 55 p.

WRIR 85-4055, Nelson, G. H., Jr., Ming, C. O., and Psinakis, W. L., 1985, Investigation of selected streamflow characteristics of the Alabama River upstream from Selma, Alabama, 44 p.

WRIR 85-4057, Bridges, W. C., 1985, Analysis of water-level fluctuations of the U.S. Highway 90 retention pond, Madison, Florida, 19 p.

WRIR 84-4058, Pope, L. M., Arruda, J. A., and Vahsholtz, A. E., 1985, Water-quality reconnaissance of selected water-supply lakes in eastern Kansas, 47 p.

WRIR 85-4061, Wright, W. C., 1985 Effects of fracturing on well yields in the coalfield areas of Wise and Dickenson Counties, southwestern Virginia, 21 p.

WRIR 85-4062, Fernandez, M., Jr., 1985, Reconnaissance of water quality at a U.S. Department of Energy site, Pinellas County, Florida, 49 p.

WRIR 85-4063, May, J. E., 1985, Feasibility of artificial recharge to the 800-foot sand of the Kirkwood formation in the Coastal Plain near Atlantic City, New Jersey, 24 p.

WRIR 85-4064, Twenter, F. R., Cummings, T. R., and Grannemann, N. G., 1985, Ground-water contamination in East Bay Township, Michigan, 63 p.

WRIR 85-4067, Schroder, L. J., and Bricker, A. W., 1985, Preparation of polyethylene sacks for collection of precipitation samples for chemical analysis, 9 p.

WRIR 85-4071, Parrett, C., and Hull, J. A., 1985, A method for estimating mean and low flows of streams in the National Forest of Montana, 13 p.

WRIR 85-4083, Planert, M., and Sparkes, A. G., 1985, Estimation of vertical hydraulic conductivity of the clay layer between the Eutaw and Gordo aquifers in the vicinity of Faunsdale, Marengo County, Alabama, 23 p.

WRIR 85-4085, Staubitz, W. W., and Wolcott, S. W, 1985, Hydraulic and sediment characteristics at the North Channel Bridge, Jamaica Bay, New York, 32 p.

WRIR 85-4097, Robbins, C. H., 1985, Hydrology of the Reelfoot Lake basin, Obion and Lake Counties, northwestern Tennessee, 29 p.

WRIR 85-4111, Kilpatrick, F. A., Kaehrle, W. R., Hardee, J., Cordes, E. H., and Landers, M. N., 1985, Development and testing of highway storm-sewer flow measurement and recording system 98 p.

Send requests for publications to the Chief Hydrologist, U.S. Geological Survey, Water Resources Division, 409 National Center, Reston, Virginia 22092. Include the publication series, number, and title.