

WATER-RESOURCES ACTIVITIES  
OF THE U.S. GEOLOGICAL SURVEY  
Compiled by D. H. Appel

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U.S. GEOLOGICAL SURVEY  
Open-File Report 90-150

Charleston, West Virginia

1990

DEPARTMENT OF THE INTERIOR  
MANUEL LUJAN, JR., Secretary  
U.S. GEOLOGICAL SURVEY  
Dallas L. Peck, Director

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Box 25425, Federal Center, Bldg. 810  
Denver, CO 80225

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#### MESSAGE FROM THE DISTRICT CHIEF

The U.S. Geological Survey has been active in West Virginia since the very early 1900's. In fact, four of the streamflow stations in our current network started in the late 1800's. I am proud of the Survey's accomplishments during these years in West Virginia. Although these are fiscally difficult times in State government, the needs for water-resources data are ever increasing. The Survey will continue to play an important role in fulfilling these water-data needs.

During recent years, the District completed several investigations as well as initiated others. An intense effort has been made to publish our interpretive reports and data on a near-current basis. As a result of this effort, a significant number of water-resources reports were completed and/or published during the 1989 fiscal year. This report contains a complete list of USGS reports addressing West Virginia hydrology as of December 1989.

During the 1990 fiscal year, we will continue to emphasize ground-water studies. People, industry, and government are becoming more aware of the importance of the ground-water resource and its potential for use and contamination. Our projects are oriented toward assessing the data base and answering questions related to contamination and development.

During the next few years, new projects oriented toward assisting the local and Federal agencies manage our finite water resources will be undertaken. I look forward to an active role of the Survey in these activities.

David H. Appel  
District Chief

## ORIGIN OF THE U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific 'classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain. An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

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

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

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing 'Earth Science in the public Service.

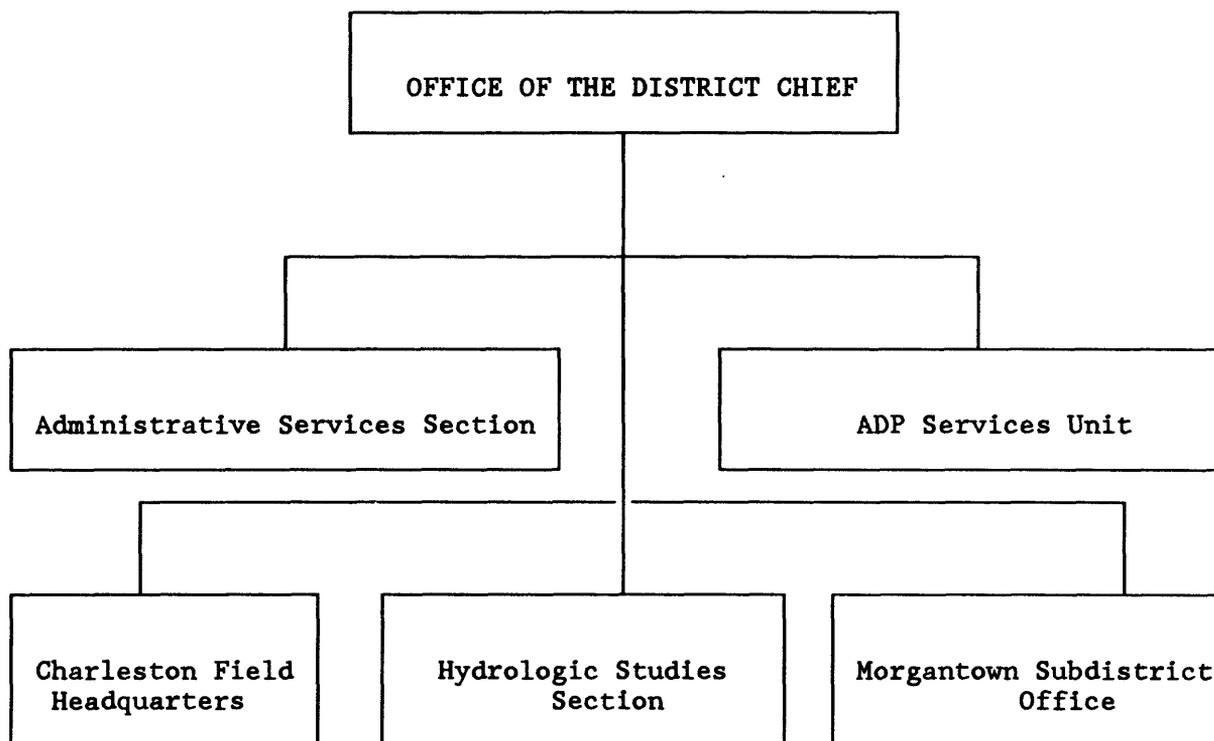
BASIC MISSION AND PROGRAM OF THE  
WATER RESOURCES DIVISION

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people in the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

- ° Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- ° Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground-water.
- ° Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.
- ° Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- ° Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters.
- ° Providing scientific and technical assistance in hydrologic fields to other Federal, State and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.

WEST VIRGINIA DISTRICT ORGANIZATION



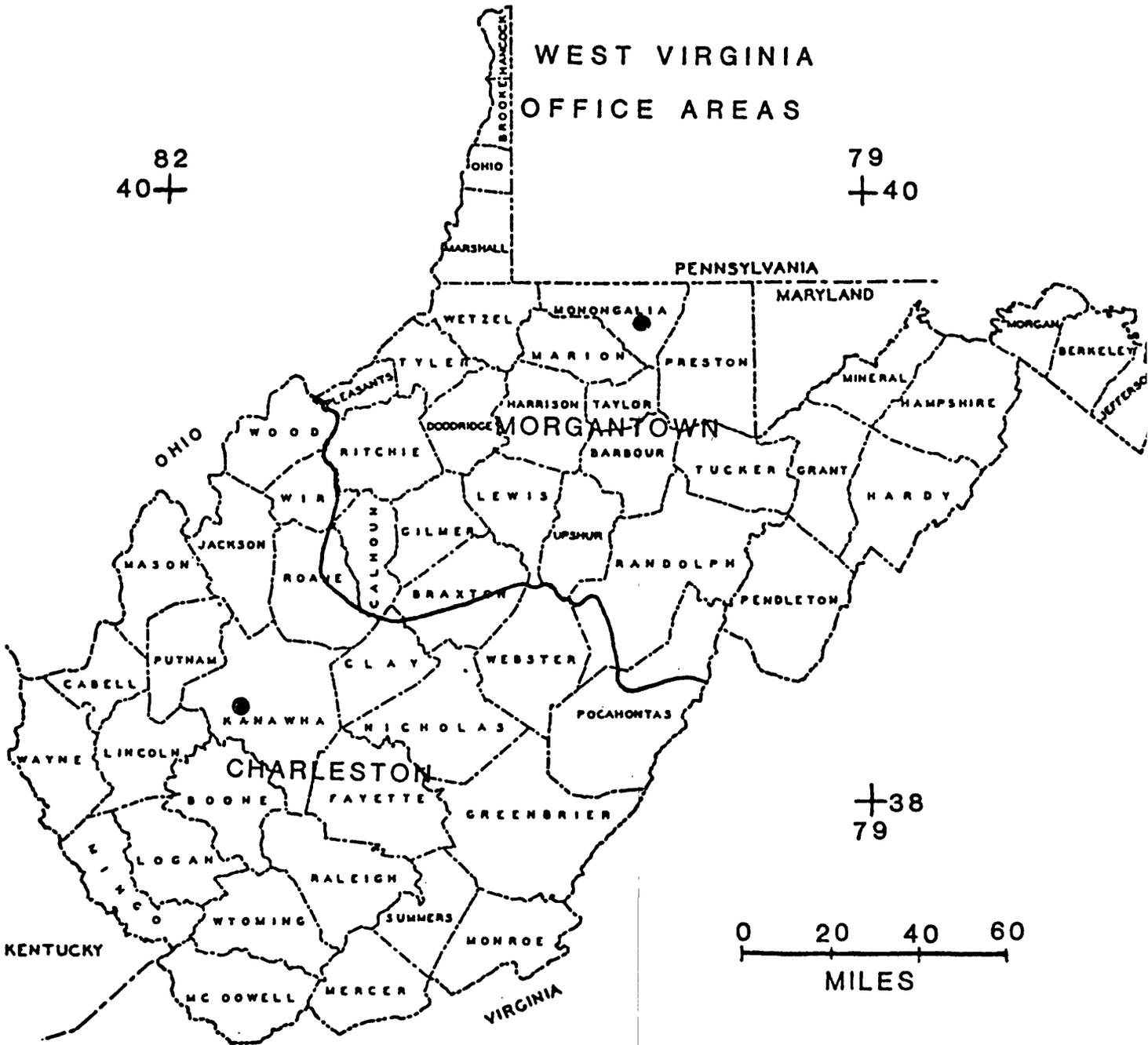
Inquiries regarding activities described in this index may be directed to the District Office or the Subdistrict Office.

District Office David H. Appel, District Chief David P. Brown, Asst. District Chief	(304) 347-5130	U.S. Geological Survey Water Resources Division 603 Morris Street Charleston, West Virginia 25301
Charleston Field Headquarters Stephen M. Ward, Field Headquarters Chief	(304) 347-5289	U.S. Geological Survey Water Resources Division 1334 Smith Street, Room B5 Charleston, West Virginia 25301 (Mailing address same as District Office)
Morgantown Subdistrict Office William A. Hobba, Jr. Subdistrict Chief	(304) 291-4251	U.S. Geological Survey Water Resources Division P.O. Box 1647 Morgantown, West Virginia 26505

WEST VIRGINIA  
OFFICE AREAS

82  
40+

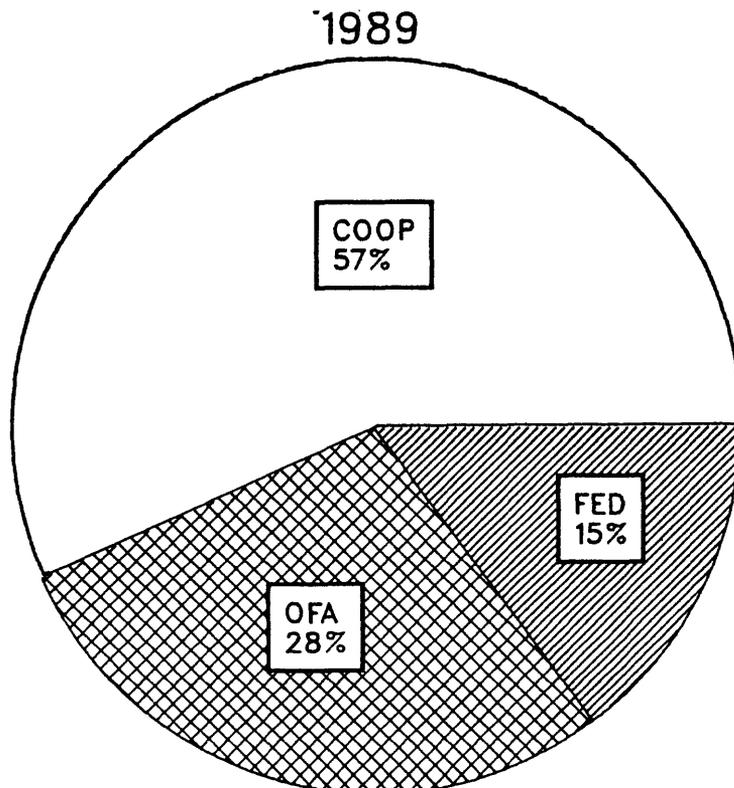
79  
+40



DISTRICT FUNDING

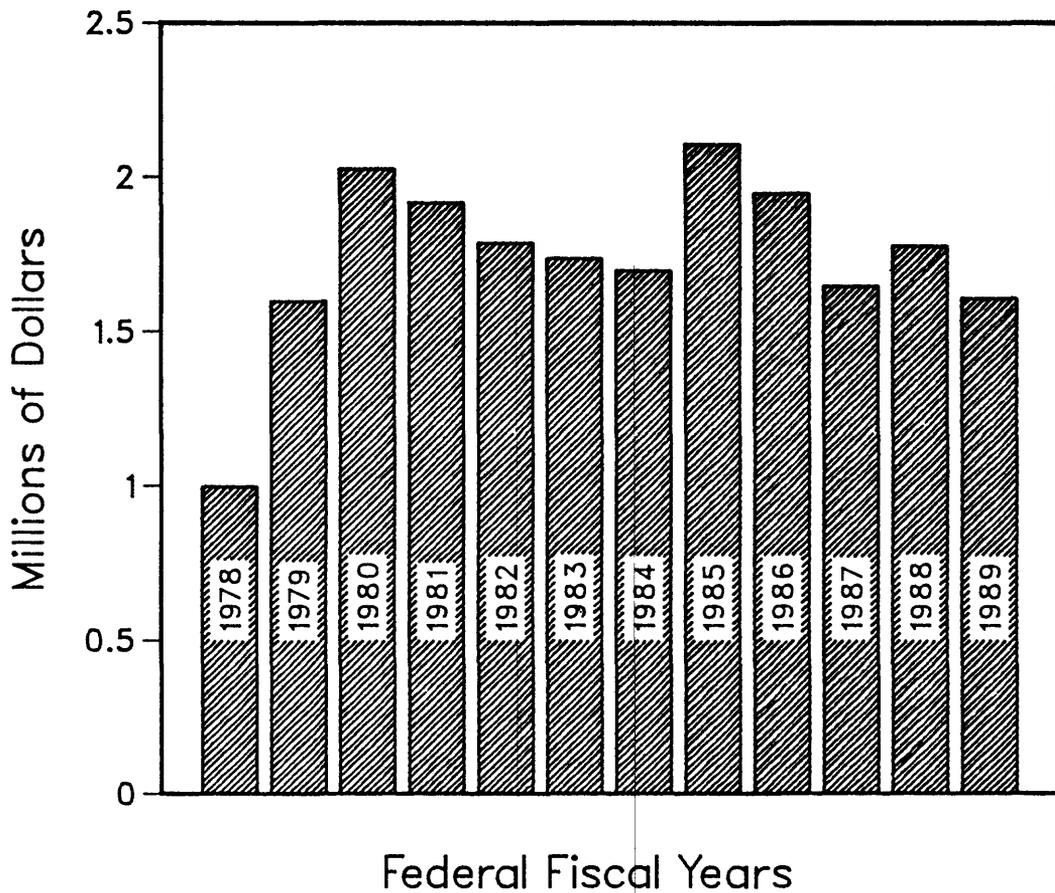
Funds to support the work performed by the West Virginia District, Water Resources Division, are derived from three principal sources:

- o Federal (Fed) Program--Funds for the Federal Program are appropriated by the Congress, and are specifically identified in the annual Geological Survey budget. These funds are used to support research, data collection, high-priority topical programs including energy-related programs, the coordination of all Federal programs related to collection of water data, and internal support services.
- o Federal-State Cooperative (Coop) Program--Federal funds are appropriated by the Congress and used to match those furnished by State and other tax-supported agencies on a 50-50 basis. These funds are used for a variety of hydrologic data-collection activities and water-resources investigations in which the Water Resources Division represents the national responsibilities and the cooperating agencies represent State and local interests.
- o Other Federal Agencies (OFA) Program--In this program the funds are transferred to the Geological Survey as reimbursement for work performed at the request of another Federal agency.

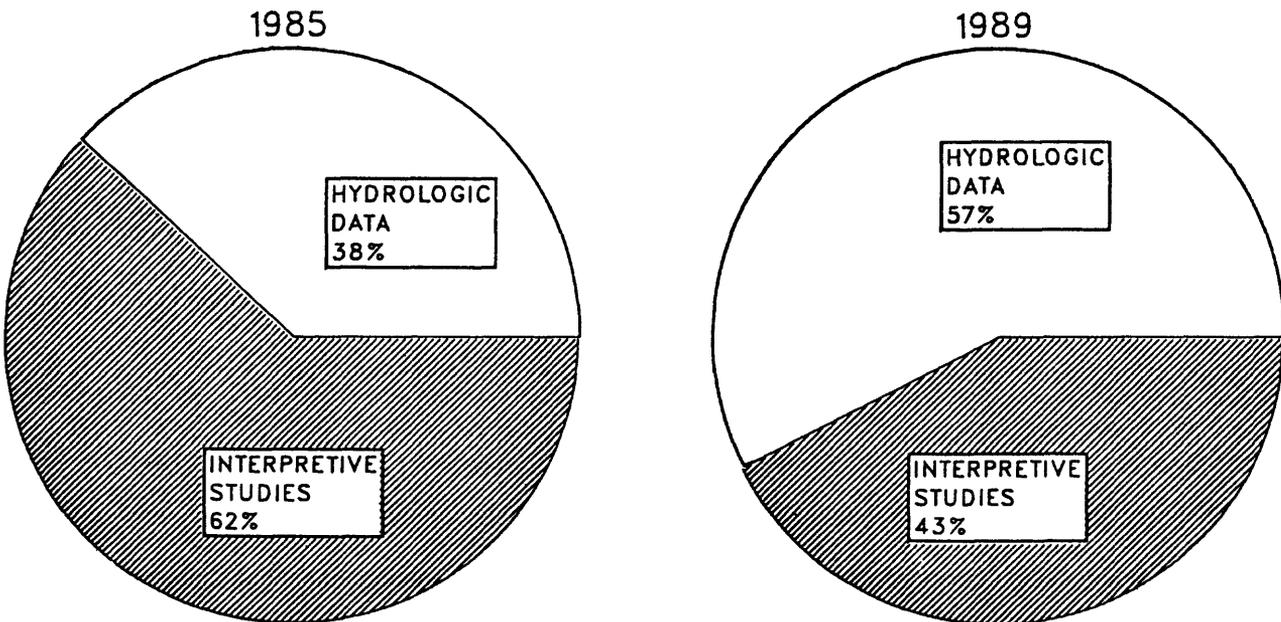


Since a significant portion of our operating funds come from the Federal-State Cooperative Program, our District Program is generally reflective of the State economy. District funds are shown by fiscal year in the following graph:

## West Virginia District Program



Our District Program can be divided into two broad categories:  
1) hydrologic data and 2) areal appraisals and interpretive studies. The reduction in District funds from fiscal years 1985 to 1989 was in response to reducing State resources being used for areal appraisals and interpretive studies. The funding for the hydrologic data program remained fairly constant and therefore, the Data Program became a larger percentage of our overall program during the 1985 to 1989 period as shown below:



AGENCIES SUPPORTING WATER-RESOURCES INVESTIGATIONS  
DURING FISCAL YEARS 1989 AND 1990

State Agencies

West Virginia Department of Commerce  
    Division of Parks and Recreation  
West Virginia Department of Health  
    Division of Environmental Engineering  
West Virginia Department of Highways  
West Virginia Department of Natural Resources  
    Division of Water Resources  
    Division of Wildlife Resources  
West Virginia Geological and Economic Survey

Local Agencies

Jefferson County Commission  
Marshall University Research Corporation  
Morgantown Utility Board  
Region VII Planning and Development Council  
Regional IX Planning and Development Council  
Washington Public Service District

Federal Agencies

Department of the Army  
    Corps of Engineers  
        Baltimore District  
        Huntington District  
        Pittsburgh District  
Federal Emergency Management Agency  
Federal Power Commission  
National Park Service  
Office of Surface Mining  
Soil Conservation Service

## WATER-DATA PROGRAM

Water-data stations at selected locations throughout the nation are used by the U.S. Geological Survey to obtain records on stream discharge (flow) and stage (height), reservoir and lake stage and storage, ground-water levels, well and spring discharge, and the quality of surface and ground water. These data provide a continuing record of the quantity and quality of the Nation's surface- and ground-water resources, and thus provide the hydrologic information needed by Federal, state, and local agencies and the private sector for the development and management of land and water resources. All data collected are stored in the Survey's National Water Data Storage and Retrieval System (see section "WATSTORE" for additional information on this system) and also are published by water year for each state in a publication series entitled "U.S. Geological Survey Water-Data Reports." Information about the Water-Data Program in West Virginia can be obtained from the District Chief of the West Virginia office.

### NAWDEX (NATIONAL WATER DATA EXCHANGE)

The National Water Data Exchange is a confederation of Federal and non-Federal water-oriented organizations working together to improve access to available water data. It is managed by a Program Office, which is administered by the Water Resources Division. Information on sites for which water data are available, the types of data available, and the organizations that store the data are available from NAWDEX. Assistance in identifying, locating, and acquiring data is provided by the Program Office at Reston, Virginia, by NAWDEX Assistance Centers at the Water Resources Division District offices, and by offices of other NAWDEX member organizations. A directory of assistance centers, and more detailed information about services, can be obtained from the NAWDEX Program Office, Branch of Water Information Transfer. The NAWDEX headquarters address is: National Water Data Exchange, U.S. Geological Survey, 421 National Center, Reston, VA 22092. The office may be reached by phone at (703) 648-5677.

### WATSTORE (NATIONAL WATER DATA STORAGE AND RETRIEVAL SYSTEM)

As explained in the section "Water-Data Program," all data collected through that program are stored in WATSTORE, and the data are available on request. These data can be retrieved in machine-readable form or as computer printed tables or graphs, statistical analyses, and digital plots. Local assistance in the acquisition of service or products from WATSTORE can be obtained from the District offices. A pamphlet, "WATSTORE: A WATER Data STORage and RETRIEVAL System," may be obtained from these offices or from the WATSTORE Program office, Branch of Computer Technology, U.S. Geological Survey, 440 National Center, Reston, VA 22092. The office may be reached by phone at (703) 648-5680.

## PUBLIC INFORMATION SERVICE

The results of U.S. Geological Survey investigations are published in its scientific reports and in its topographic, geologic, and hydrologic maps. About 93,000 different maps and books are available for public use. A series of general-interest publications is available to inform the public about U.S. Geological Survey activities. Research results and investigations are also published in journals of technical and scientific organizations and in publications of cooperating Federal and state agencies.

Many hours are spent annually by the West Virginia District responding to data and information requests. These requests are received from public officials at all levels of government, water management personnel, consultants, universities, industry, and the general public. In addition to providing information and materials for specific needs and making distribution of water-resource reports, district staff answer general questions on hydrology, water as a resource, and hydrologic mapping, as well as on the products, projects, and services of the Water Resources Division.

A listing of USGS prepared reports on water resources in West Virginia is included in this report, beginning on page 31.

## CURRENT PROJECTS

### WV001 SURFACE-WATER STATIONS

TITLE: Surface-Water Stations

PROBLEM: Surface-water information is needed for purposes of surveillance, planning, design, hazard, warning, operation, and management in water-related fields such as coal hydrology, water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water resources development. To provide this information, an appropriate data base is necessary.

OBJECTIVE: (1) To collect surface-water data sufficient to satisfy needs for current-purpose uses such as assessment of water resources, operation of reservoirs or industries, forecasting, disposal of wastes and pollution controls, discharge data to accompany water-quality measurements, compact and legal requirements, and research or special studies. (2) To collect data necessary for analytical studies to define for any location the statistical properties of, and trends in, the occurrence of water in streams, lakes, etc., for use in planning and design.

APPROACH: Standard methods of data collection will be used as described in the series, "Techniques of water-resources investigations of the United States Geological Survey." Partial-record gaging will be used instead of complete-record gaging where it serves the required purpose.

GENERAL REMARKS: Existing network includes about 73 continuous-record stations and 7 partial record sites. The District also continued the maintenance of about 90-95 U.S. Army Corps of Engineers (COE) satellite data-collection platforms statewide.

PROJECT CHIEF: Ward, Stephen M.

FUNDED BY: U.S. Geological Survey  
W. Va. Department of Commerce  
Division of Parks and Recreation  
W. Va. Department of Natural Resources  
Division of Water Resources  
Morgantown Utility Board  
Federal Power Commission  
National Park Service  
U.S. Soil Conservation Service  
U.S. Army Corps of Engineers

WV002 GROUND-WATER STATIONS

TITLE: Ground-Water Stations

PROBLEM: Long-term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from the ground-water systems, to provide a data base from which to measure the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resource.

OBJECTIVE: (1) To collect water-level data sufficient to provide a minimum long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses in known and potential problems can be defined enough to allow proper planning and management. (2) To provide a data base against which the short-term records acquired in areal studies can be analyzed. This analysis must (a) provide an assessment of the ground-water resource, (b) allow prediction of future conditions, and (c) provide the data base necessary for management of the resource.

APPROACH: Based on knowledge of regional geologic structure, aquifer systems, and current and potential areal stresses on the ground-water system, a subjective selection of 28 locations was made for observation of long-term system behavior. Activities at the observation wells will include geophysical well logs, daily water-level compilation, and water-quality sampling. Evaluation of network information and availability of detailed study results will be the basis for network modification.

GENERAL REMARKS: Collection of data at 28 observation wells continued. Additional wells will be added to the network in the next year.

PROJECT CHIEF: Taylor, Freda M.

FUNDED BY: U.S. Geological Survey  
W. Va. Geological and Economic Survey

WV003 WATER-QUALITY STATIONS

TITLE: Water-Quality Stations

PROBLEM: Water quality of streams will change with land and industrial use. Water-resources planning and water-quality assessment require a base level of relatively standardized information. The chemical and physical quality of the rivers and streams must be defined and monitored for assessment and planning of the water resource.

OBJECTIVE: To provide water-quality data for general planning and management of inter- and intrastate waters.

APPROACH: Operation of a network of water-quality stations to provide information about chemical concentrations, loads, and temporal trends for use by planning and management agencies.

GENERAL REMARKS: Water-quality data are collected at four National Stream Quality Accounting Network (NASQAN) sites and three Soil Conservation Service (SCS) sites.

PROJECT CHIEF: Waldron, Marcus C.

FUNDED BY: U.S. Geological Survey  
U.S. Army Corps of Engineers  
U.S. National Park Service  
U.S. Soil Conservation Service

WV004 SEDIMENT STATIONS

TITLE: Sediment Stations

PROBLEM: Sediment concentrations and loads change with land use changes. Water resource planning and water-quality assessment require a base level of relatively standardized information. Sediment concentrations and discharges in rivers and streams must be defined.

OBJECTIVE: To define sediment concentrations and discharges in rivers, to provide a bank of sediment data for use in broad state planning and action programs, and to provide data for management of inter- and intrastate waters.

APPROACH: Establish and operate a network of sediment stations to provide spatial and temporal averages and trends of sediment concentration, and sediment discharge.

GENERAL REMARKS: Program has been drastically reduced due to lack of cooperator funding. The West Virginia District collects sediment data at four National Stream Quality Accounting Network (NASQAN) stations and operates a continuous-turbidity monitor on the Coal River.

PROJECT CHIEF: Ward, Stephen M.

FUNDED BY: U.S. Geological Survey  
Washington Public Service District

WV005 PRECIPITATION STATIONS

TITLE: Precipitation Stations

PROBLEM: National and statewide trends in the quantity and quality of precipitation and its impact on streams.

OBJECTIVE: To describe precipitation volume and chemistry at a site in the National Trends Network (NTN) and to relate precipitation chemistry and volume to location and wind patterns.

APPROACH: Maintain and operate sampling station which is part of a national network established to provide information on concentrations, loads, and time trends of chemical constituents in precipitation.

GENERAL REMARKS: Collected qualitative and quantitative data at one site located in Babcock State Park, Fayette County, as part of the U.S. Geological Survey (USGS) National Trends Network (NTN).

PROJECT CHIEF: Mathes, Melvin V.

FUNDED BY: U.S. Geological Survey

WV006 FLOOD INVESTIGATIONS

TITLE: Flood Investigations

PROBLEM: The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provide for the operation of a flood insurance program. The Federal Emergency Management Agency (FEMA) needs flood studies in selected areas to determine applicable flood insurance premium rates.

OBJECTIVE: To conduct the necessary hydrologic and hydraulic evaluations and studies of areas assigned by FEMA and to present the results in an appropriate format.

APPROACH: Conduct the necessary evaluations or conduct surveys by ground or photogrammetric methods. Determine flood-discharge frequency relationships using local historical information, gaging station records, or other applicable information. Determine water-surface profiles using step-backwater models or by other acceptable methods and furnish the results in reports prepared to FEMA specifications.

GENERAL REMARKS: Seventeen Limited Detailed Flood Studies (LDS) were completed in 1989. Three others are in review. Manpower and cost estimates have been submitted for a restudy of Putnam County in 1990.

PROJECT CHIEF: Runner, Gerald S.

FUNDED BY: Federal Emergency Management Agency

WV007 WATER USE

PROJECT TITLE: Water Use

PROBLEM: West Virginia waters are under stress from increasing demands for domestic, industrial, agricultural, and other uses and from demands for greater protection of water quality. Competition for water dictates that available supplies are matched with uses most beneficial to the common good. Information is being collected describing quantity and quality of available water, but relatively little information has been collected describing water use prior to 1978. Without adequate information on uses of water, decision makers cannot resolve many critical water problems related to environmental impact, energy development, and resource allocations.

OBJECTIVE: To provide the water-use information for the optimum utilization and management of the State's water resources for the overall benefit of the people of West Virginia and the United States. This program will collect, store, and disseminate water-use data to complement data on availability and quality of the State's water resources and to develop and operate a system to handle the data. The system will be responsive to the data needs of local users, the U.S. Geological Survey (USGS) and other Federal agencies.

APPROACH: Responsibilities will be divided between the cooperator and the USGS to reflect the most efficient means of meeting the objectives of the program. Direction, management, and standards development to meet the national needs will be the responsibility of the USGS. Field activities for the acquisition and storage of the data will be the primary responsibility of the West Virginia Geological and Economic Survey (WVGES).

GENERAL REMARKS: The national USGS water-use program has been loaded onto the District's PRIME computer, and existing water-use data has been moved from the WVGES computer to the PRIME. The cooperator will attend Water-Use Concepts training. The Regional water-use consultant visited the West Virginia District in late 1989 to assist in setting up a functional water-use data base for West Virginia. Compilation of 1990 water-use data for the 1990 National Water-Use report will begin in 1990.

PROJECT CHIEF: Kozar, Mark D.

FUNDED BY: U.S. Geological Survey  
W. Va. Geological and Economic Survey

WV040 GAULEY RIVER BASIN

TITLE: Water Resources of the Gauley River Basin, West Virginia

PROBLEM: Major water-resource problems in the Gauley River Basin include the following: increased sediment loading due to mining, timbering operations, agriculture, and construction; contamination of surface- and ground-water sources by waste disposal, and mine drainage; and changes in surface-water flow and water temperature due to seepage and reservoir operations.

OBJECTIVE: To provide adequate hydrologic data to document flow, runoff, sediment yield, and flood characteristics of the subbasins; ground-water discharge to streams; the effect of reservoir operation on stream temperature; the chemical and biological quality of surface-water; and time-of-travel on the main stem of the Gauley River.

APPROACH: The study will be a 4-year basin investigation. It will require 14 surface-water stations, 5 sediment stations, 4 observation wells, 6 rainfall stations, seepage runs, time of travel at 3 flow rates, and 250 inventoried wells. Drainage areas will be determined on areas greater than 5 square miles. Long-term discharge and rainfall data will be analyzed using standard programs. Short-term data will be analyzed and evaluated by correlation and regression. Ground-water and water-quality data, made available through the 4-year reconnaissance study, will be shown graphically.

GENERAL REMARKS: Rough draft of the report entitled "Water resources of the Gauley River Basin, West Virginia" has been completed and is being revised. Project is complete except report.

PROJECT CHIEF: Runner, Gerald S.

FUNDED BY: U.S. Geological Survey  
W. Va. Department of Natural Resources  
Division of Water Resources  
W. Va. Geological and Economic Survey

## WV053 HYDROLOGIC CHARACTERISTICS OF STORMS

TITLE: Measurement of Peak-Flow Data for Selected Storms

PROBLEM: Local flooding throughout the State causes considerable property damage, lost time and wages, and inconvenience to the public. Flood-peak, storm-volume, and flood-profile information is needed for assessing damage, for flood-plain planning and management, and for determining the carrying capacity of culverts and bridges.

OBJECTIVE: To provide hydrologic data for documenting storms as they relate to flood-plain utilization, computation of flood discharge, backwater at culverts and small bridges, and frequency-of-storm rainfall and flood peaks. These data should provide an excellent data base for future interpretive flood studies and also for verification of the regression equations presented in the Statewide flood-frequency report (Open-File Report 80-1218, Runner, 1980).

APPROACH: Each year, as hydrologic conditions warrant, peak-flow data will be collected at sites specified by the cooperator by direct measurements, when possible, and by indirect measurements using Techniques of Water Resources Investigations of the U.S. Geological Survey (TWRI) guidelines. High-water marks will be surveyed to determine an appropriate water-surface profile to describe the extent of flood-plain inundation. Bucket rainfall surveys will be made over the storm area to supplement available rain-gage information. Data collected will be compared to previously used frequency data of both flood-peak discharge and total rainfall depth such as Q(25), Q(50), and Q(100), and 1-day-50-year rainfall (1(24)-(50)) to determine if updated frequency studies are needed.

GENERAL REMARKS: No major storm events occurred during 1989. Therefore, no indirect measurements were made during the year.

PROJECT CHIEF: Runner, Gerald S.

FUNDED BY: U.S. Geological Survey  
W. Va. Department of Highways

WV054 WATER FROM SELECTED COAL MINES

TITLE: Availability and Quality of Water from Selected Underground Coal Mines in West Virginia

PROBLEM: Many small communities in the coal areas of West Virginia have had problems of limited water supplies. In some areas, particularly in the southern part of the State, communities, industries, and individuals have turned to abandoned underground coal mines for their water supply. Approximately 70 public water systems pump more than 7 million gallons of water per day from abandoned underground coal mines to supply 82,000 people, various industries and commercial establishments with potable water. An evaluation of the quantity and quality of water in abandoned underground mines is necessary to determine their potential as sources of water.

OBJECTIVE: To evaluate selected abandoned underground mines as potential sources of water for public supply: (1) Determine the recharge, discharge and water storage capacity of selected abandoned underground mines, (2) determine the quality of mine water and its spatial and temporal variability within the mine systems, (3) determine the response of the mine system to pumping and the degree of hydraulic connection within the mines and with other adjacent mines, and (4) estimate the practical sustained yield available from the mines.

APPROACH: An extensive literature and information search will precede a reconnaissance in areas of large-scale underground mining to locate abandoned mines with the capacity to store large quantities of water. Two mines above and two below basin drainage will be selected. Existing hydrologic and geologic data and monitoring programs will aid in describing the geologic and hydrologic setting. Test drilling will be required if existing observation wells are not adequate. Recharge, discharge, storage capacity, and practical sustained yield of the mine systems will be estimated. Sampling will provide information on mine water-quality variability with time, depth, and pumping level.

GENERAL REMARKS: Interpretive report has been completed and is in review. Project is complete except report.

PROJECT CHIEF: Ferrell, Gloria M.

FUNDED BY: U.S. Geological Survey  
W. Va. Geological and Economic Survey  
W. Va. Governor's Office of  
Community and Industrial Development

WV063 RITCHIE COUNTY SEDIMENT

TITLE: Effects of Sediment Control Measures on Soil Erosion and Sediment Transport in Areas of Intensive Oil and Gas Well Development in Ritchie County, West Virginia

PROBLEM: There is about one oil or gas well site for every 60 acres in Ritchie County. Soil erosion and sediment transport in water from these areas are major problems because the soils in this part of the state are highly erodible. The Soil Conservation Service (SCS) and West Virginia Department of Natural Resources (WVDNR), Water Resources Division (WRD) have questioned the reliability of the current method of predicting soil loss from oil and gas well sites. Reclamation procedures may not be adequate.

OBJECTIVE: (1) To evaluate the effectiveness of conservation measures currently being used to control erosion on oil and gas well sites. (2) To evaluate the accuracy of current methods of estimating soil erosion (Universal Soil Loss Equation and Direct Volume Estimates) by comparison of these estimates of soil erosion with the actual measured load.

APPROACH: Two small basins, North Bend Run (90 acres) within State park boundaries and Robinson Run (45 acres) with a reclaimed gas well site and planned drilling for a new well were selected to collect total sediment load. Comparing the control basin to the active basin will address project objectives.

GENERAL REMARKS: Interpretive report has been completed and is in review. Project is complete except report.

PROJECT CHIEF: Ward, Stephen M.

FUNDED BY: U.S. Geological Survey  
U.S. Soil Conservation Service  
W. Va. Department of Natural Resources,  
Division of Water Resources

WV065 NEW RIVER FLOW AND TRANSPORT MODEL

**TITLE:** Application of an Unsteady-Flow Solute-Transport Model to the lower New River in West Virginia

**PROBLEM:** The effects of an accidental spill of a soluble contaminant may potentially be mitigated by releasing water from Bluestone Reservoir and thus affecting traveltime, time of passage, and concentration. A study is needed to determine how changes in flow rate will affect the movement/dispersion of the contaminant. Dispersion characteristics change when flow is increased or decreased, and therefore the computations for estimating traveltime for the leading edge and time of passage of the contaminant cloud need to be adjusted.

**OBJECTIVE:** (1) To test and verify the Unsteady One-Dimensional Flow Model (HYDRAUX) and the One-Dimensional Langrangian Transport Model (LTM) under extreme hydraulic conditions where flows pass through critical depth several times in the study reach, and (2) to define the effects of unsteady flow on the shape of a soluble dye concentration cloud.

**APPROACH:** Time-of-travel data will be collected at one unsteady flow condition--5 to 1 increase in flow. The flow release from Bluestone Reservoir will be changed in order to reach the dye cloud immediately upstream from the Stone Cliff bridge. The HYDRAUX and the LTM models will be utilized to simulate flow and solute movement. Hydraulic data will be collected and used as input to the models. The wave study results from Appel (1983) will be used to calibrate the flow model and flow regulation periods used to verify the model. The steady-flow dye study by Appel and Moles (1987) will be used to calibrate the solute transport model and individual dye measurements used to verify the model.

**GENERAL REMARKS:** Two reports were published: a data report which presented channel characteristics data collected during 1987-88 and a symposium paper on characteristics of the New River National River including river depths. Field work has been completed and digital modeling has begun. The final interpretive report will be written in 1990.

**PROJECT CHIEF:** Wiley, Jeffrey B.

**FUNDED BY:** U.S. Geological Survey  
U.S. National Park Service

WV066 JEFFERSON COUNTY GROUND WATER

TITLE: Ground-Water Flow in Karst Areas of Jefferson County, West Virginia

PROBLEM: Intensive vertical fracturing has occurred in valleys underlain by limestone in Jefferson County. Because of the high degree of solubility of limestone, these fractures have been enlarged through dissolution and karst topography has developed. Individuals and communities obtain water supplies from ground-water sources. Recharge is rapid and occurs through sinkholes, caves, and streams. Sinkholes are commonly used for disposal of wastes. Wells drilled into caves are used as drains permitting direct inflow of contaminants into the ground-water reservoir. Pesticide disposal, spills of petroleum products, and leachate from landfills and impoundments are potential sources of contamination of ground-water resources. Contaminated water will move rapidly through solution channels in limestone formations and contaminate public-supply wells, springs, and streams.

OBJECTIVE: (1) To delineate ground-water flow systems in karst (limestone) areas and describe the hydrogeologic characteristics of various aquifers. (2) To assess the ground-water quality of principal aquifers and identify areas near public supply where changes in water quality have occurred. (3) To develop hydrologic, geologic and geographic data bases that are compatible with geographic information systems.

APPROACH: Existing geologic and hydrologic data will be reviewed and analyzed to describe the hydrogeologic characteristics of aquifers. Major karst features will be mapped, especially those near major transportation arteries, near potential sources of contamination and near public-supply wells or springs. The ground-water flow system in the various aquifers will be delineated by performing dye-tracer studies. The direction and rate of ground-water flow will be defined. Water samples from about 40 wells will be collected and analyzed. Hydrologic, geologic, water-quality, and cultural data will be entered into data bases that are compatible with a geographical information system (GIS).

GENERAL REMARKS: All necessary data have been collected. Five ground-water dye-tracer tests were performed. Seventy ground-water sites were sampled for standard constituents, metals, nutrients and bacteria. Thirty of these seventy sites were also sampled for the organochlorine and organophosphorous classes of pesticides. Approximately 650 sinkholes have been mapped in the study area. Thirteen surface-water sites were measured during base flow and sampled for calcium, magnesium, chloride, and nutrients. Four observation wells, two springs, and two spring-fed streams provided ground-water level or discharge data throughout the study. Seven of these eight sites were sampled quarterly and analyzed for most constituents. Pesticides of the organochlorine, organophosphate and triazine classes were collected at two spring-fed streams. An interpretive report is currently in review. Project is complete except report.

PROJECT CHIEF: Hobba, Jr., William A. and Kozar, Mark D.

FUNDED BY: U.S. Geological Survey  
Jefferson County Commission  
W. Va. Virginia Department of Natural Resources  
Division of Water Resources

## WV068 FLUORIDE IN WEST VIRGINIA

TITLE: Occurrence of Fluoride in West Virginia Ground Water

PROBLEM: Ground water in much of the State has a fluoride concentration less than or equal to 0.1 milligrams per liter (mg/L). However, in some areas fluoride concentrations exceed 12 mg/L. High concentrations of fluoride in drinking water have been found to cause darkening and mottling of children's teeth. When daily intake of fluoride exceeds 15-20 mg over a period of several years, fluorosis may be induced.

OBJECTIVE: (1) To map fluoride concentrations in ground water on a statewide basis. (2) To statistically analyze fluoride concentrations in ground water with respect to geology, well depth, other chemical characteristics of the water, proximity to oil and gas development, and occurrence of atmospheric fluoride deposition. (3) To determine probable mineralogic sources of fluoride, and establish the relationship of high fluoride concentration to geochemical conditions. (4) To compare fluoride concentrations in areas of known atmospheric fluoride deposition with nearby geologically similar areas where deposition of fluorides has not occurred.

APPROACH: Areas having high fluoride concentrations and areas needing additional data will be identified from existing data. A data collection program will be designed concentrating in areas where ground water having high fluoride concentrations is known to occur, and where current data are insufficient to map fluoride concentration. Water samples will be analyzed for fluoride concentration, pH, alkalinity, acidity, specific conductance, and water temperature at all sites. At approximately 50 sites, where fluoride concentrations exceed 3 mg/L, analysis for the inorganic constituents will also be performed. Fluoride concentrations will be statistically analyzed with respect to site characteristics such as geologic unit, geologic structure, mineralogic data, topographic setting, well depth, land use, proximity to oil and gas wells and atmospheric deposition.

GENERAL REMARKS: Existing fluoride data were reviewed. Fluoride data were collected to improve areal coverage. Fluoride data will be analyzed and will be compared statistically to other water-quality and ground-water parameters. Data will be collected in areas of high fluoride concentration to determine sources of high fluoride.

PROJECT CHIEF: Mathes, Melvin V.

FUNDED BY: U.S. Geological Survey  
W. Va. Geologic and Economic Survey

WV069 BERKELEY COUNTY GROUND WATER

TITLE: Ground-Water Flow in Berkeley County, West Virginia

PROBLEM: Berkeley County, West Virginia is experiencing a rapid increase in population - about 30 percent from 1970 to 1980 - and the associated need for dependable water supplies. The western half of the county is underlain by shale, sandstone, and some limestone; the eastern half of the county is underlain by limestone and some shale. Dissolution of the limestone has caused fractures to enlarge, and karst topography has developed. Recharge in these areas is rapid and typically occurs through sinkholes, caves, and streams. If the ground water in a particular area were to become contaminated, it could move rapidly through solution channels in the limestone formations and contaminate public-supply wells, springs and streams.

OBJECTIVE: (1) To describe the hydrogeologic characteristics of and delineate the ground-water flow systems in the karst (limestone) areas. (2) To describe the hydrogeologic characteristics of various shale-sandstone aquifers. (3) To assess the ground-water quality of the principal aquifers and identify areas near public-supply sources where changes in water quality have occurred. (4) To develop hydrologic, geologic, and geographic data bases that are compatible with a county-owned geographic information system (GIS), should the county obtain such a GIS during this investigation.

APPROACH: Existing geologic and hydrologic data will be reviewed and analyzed to describe the hydrogeologic characteristics of aquifers. Information on major karst features near public-supply wells or springs, along major transportation arteries, and near potential sources of contamination will be compiled and mapped. Dye-tracer tests will be used to determine the direction of ground-water flow in the karst areas. A generalized direction and rate of ground-water flow will be defined by the results of these tests. Water samples from about 100 wells tapping limestone aquifers will be collected and analyzed for common indicator constituents. Water samples from about 50 wells tapping shale and sandstone aquifers will be analyzed for common indicator constituents.

GENERAL REMARKS: A water-level observation network has been established - four wells with recorders and 28 monthly wells. Ground-water discharges are being measured at nine springs. Quarterly water-quality samples were collected at seven springs. Water-quality samples were collected at 60 sites during August 1989. District will continue to measure water levels and spring discharges at the observation sites in 1990. Two dye-tracer tests will be made. Flow measurements will be made on three or four streams so that an estimate of the ground-water yield from each geologic formation can be calculated.

PROJECT CHIEF: Shultz, Robert A.

FUNDED BY: U.S. Geological Survey  
Region IX Planning and Development Council

## WV070 KANAWHA RIVER DYE STUDY

**TITLE:** Traveltimes of Dissolved Conservative Contaminants in the Kanawha River, West Virginia

**PROBLEM:** There is a risk of accidental releases of hazardous chemicals into the Kanawha River from the manufacturing, storage, and transportation of chemicals in the valley. Large volumes of raw materials, chemical products, and chemical wastes are transported into and out of the area by water, rail, and highway. Recreation, aquatic life, and water consumption by industry would be adversely affected by accidental spills of contaminants in the river. No reliable methods are currently available to predict or estimate contaminant travel times and concentrations on the Kanawha River. Approximately 90 miles of the river are affected by variable backwater from the three locks and dams on the Kanawha River and one on the Ohio. Major tributary flows are gaged and there are two gages on the mainstem (Kanawha Falls - mile 94 and Charleston - mile 54). The streamflow-gaging station at Charleston is not accurate below 10,000 cubic feet per second (ft<sup>3</sup>/s) because of a very flat water-surface slope and low velocities. The accuracy of this gage must be improved if the river is to be managed more effectively.

**OBJECTIVE:** (1) To improve the accuracy of the Charleston stream-flow measuring station. (2) To determine the time of travel, dispersion, and concentration of fluorescein dye in the Kanawha River between Gauley Bridge and Pt. Pleasant, West Virginia, at approximate minimum sustained flows and average flows under a normal set of dam operating conditions.

**APPROACH:** An ultra-sonic velocity meter (UVM) will be installed at Charleston to improve the determination of low flow. Using techniques described in U.S. Geological Survey TWRI's, time-of-travel measurements will be conducted at flow rates of 3,000 and 15,000 ft<sup>3</sup>/s, which represent approximate minimum sustained flow and average flow, respectively. Dye will be injected at four locations: Hawks Nest Power Plant, London Locks, Marmet Locks, and Winfield Locks. The dye will be injected either into the penstocks at each dam or at the turbine discharge points to insure complete mixing. Samples will be collected by boat where bridges are not available. Maximum distance between sample points will be 10 miles. The most downstream dye cloud will be followed through Gallipolis Lock and Dam on the Ohio River, if possible.

**GENERAL REMARKS:** Rhodamine WT dye was injected at Winfield Lock and Dam in August 1989 at a streamflow of about 5,000 ft<sup>3</sup>/s. The dye cloud was followed and sampled to Pt. Pleasant, West Virginia (31.1 miles). Dye was injected at Hawks Nest Dam, London Lock and Dam, and Marmet Lock and Dam in October 1989. A data report will be written summarizing the August and October injections.

District plans to conduct dye measurements on the Kanawha River at a flow of about 4,000 ft<sup>3</sup>/s in the summer of 1990.

**PROJECT CHIEF:** Appel, David H.

**FUNDED BY:** U.S. Geological Survey  
Marshall University

## WV071 RECHARGE AREA TO PUBLIC-SUPPLY WELLS

TITLE: Determination of aquifer characteristics and recharge areas contributing water to public-supply wells in selected aquifers in West Virginia

PROBLEM: Many of the public-water supplies in the State use ground water from relatively shallow aquifers in the alluvial deposits along the Ohio River and the surficial bedrock aquifers. These aquifers are particularly vulnerable to contamination. The U.S. Environmental Protection Agency is involved in defining public supply wellhead protection strategies. To absolutely protect ground-water quality at an individual well or well field, an entire aquifer and its recharge area would have to be protected from possible sources of contamination. The approximate area of the aquifer and areas adjacent to the aquifer that contribute water to individual supply wells must be defined. Only when the sources of water for a well and the detailed pattern of ground-water flow to the well are fully understood can State and local governmental agencies protect the well, at least to some extent, from contamination.

OBJECTIVE: To describe the sources of water that sustain yields of public-supply wells and analyze factors that affect the size and shape of areas contributing water to supply wells in selected aquifers within the State. This information will be provided to the West Virginia Department of Health for their use in delineating wellhead protection areas around public-supply wells.

APPROACH: Hydrologic information will be collected and analyzed for two public-water supply systems in the alluvial aquifers in the Ohio River valley. The hydrologic information that is needed to determine and analyze the contributing area to a well or wellfield includes: description of aquifer, hydrologic properties of aquifer and its boundary conditions, well inventory, observation-well network for preparing water-table maps, water-use inventory, and wellfield design. The location of existing or potential sources of contamination to the aquifer will be delineated.

GENERAL REMARKS: Existing hydrologic and geologic information on the alluvial deposits and bedrock of the Parkersburg and Follansbee areas has been collected and is being evaluated. Well information has been obtained from computer files. Additional well information has been obtained from the West Virginia Department of Health.

Aquifer characteristics will be determined. Observation-well networks will be established and water-table maps will be completed for Parkersburg and Follansbee areas. A U.S. Geological Survey open-file report describing the hydrogeology and aquifer characteristics of selected areas in the Ohio River alluvium will be prepared.

PROJECT CHIEF: Brown, David P.

FUNDED BY: W. Va. Department of Health

ACTIVE STREAMFLOW STATIONS IN WEST VIRGINIA, IN DOWNSTREAM ORDER

Letter after station name designates type of data: (d) discharge, (e) gage-height, (c) chemical, (sK) conductance, (pH) pH units, (t) temperature, (U) turbidity,

NORTH ATLANTIC SLOPE BASINS

POTOMAC RIVER BASIN

North Branch Potomac River:  
 Stony River near Mount Storm (d,t)  
 Patterson Creek near Headsville (d)  
 South Branch Potomac River at Franklin (d)  
 South Branch Potomac River near Petersburg (d)  
 South Fork South Branch Potomac River at Brandywine (d)  
 South Fork South Branch Potomac River near Moorefield (d)  
 South Branch Potomac River near Springfield (d)  
 Cacapon River near Great Cacapon (d)  
 Opequon Creek near Martinsburg (d)  
 Potomac River at Shepherdstown (d,c)  
 Shenandoah River at Millville (d,c)

OHIO RIVER BASIN

MONONGAHELA RIVER BASIN  
 Tygart Valley River near Dailey (d)  
 Tygart Valley River at Elkins (t)  
 Tygart Valley River near Elkins (d)  
 Tygart Valley River at Belington (d)  
 Middle Fork River near Audra (d)  
 Buckhannon River:  
 Sand Run near Buckhannon (d)  
 Buckhannon River at Hall (d)  
 Tygart Valley River at Philippi (d)  
 Tygart Valley River at Tygart Dam near Grafton (d)  
 Three Fork Creek near Grafton (d, sK, ph, t)  
 Tygart Valley River at Colfax (d)  
 West Fork River at Walkersville (d)  
 West Fork River at Ben Dale (d)  
 West Fork River at Butcherville (d)  
 West Fork River near Mount Clare (d)  
 West Fork River at Enterprise (d)  
 Monongahela River:  
 Buffalo Creek at Barrackville (d)  
 Cobun Creek at Morgantown (d)  
 Dry Fork at Hendricks (d)  
 Blackwater River at Davis (d)  
 Black Fork (continuation of Dry Fork):  
 Shavers Fork at Parsons (d)  
 Cheat River near Parsons (d)  
 Cheat River at Rowlesburg (d)  
 Big Sandy Creek at Rockville (d)  
 Cheat River at Lake Lynn, Pa (t)  
 Ohio River at Martins Ferry, Oh (d)  
WHEELING CREEK BASIN  
 Wheeling Creek at Elm Grove (d)  
 Ohio River at Benwood near Wheeling (c)  
MIDDLE ISLAND CREEK BASIN  
 Middle Island Creek at Little (d)  
 Ohio River near Marietta, Oh (e)

LITTLE KANAWHA RIVER BASIN

Little Kanawha River near Wildcat (d)  
 Little Kanawha River below Burnsville Dam (d)  
 Little Kanawha River at Glenville (d)  
 Little Kanawha River at Grantsville (e)  
 West Fork Little Kanawha River at Rocksedale (e)  
 Little Kanawha River at Palestine (d,c)  
 Hughes River at Cisco (d)

KANAWHA RIVER BASIN

New River  
 Bluestone River near Pipestem (d)  
 East Fork Greenbrier River at Frank (d)  
 Greenbrier River at Durbin (d)  
 Greenbrier River at Buckeye (d)  
 Greenbrier River at Alderson (d)  
 Greenbrier River at Hildale (d)  
 New River at Hinton (d)  
 New River at Thurmond (d)  
 Gauley River:  
 Williams River at Dyer (d)  
 Cranberry River near Richwood (d)  
 Gauley River near Craigsville (d)  
 Gauley River below Summersville Dam (d)  
 Meadow River near Mount Lookout (d)  
 Gauley River above Belva (d)  
 Kanawha River at Kanawha Falls (d)  
 Kanawha River at Glasgow (t)  
 Elk River below Webster Springs (d)  
 Elk River at Sutton (d)  
 Elk River near Frametown (e)  
 Elk River at Clay (e)  
 Elk River at Queen Shoals (d)  
 Kanawha River at Charleston (d)  
 Coal River:  
 Big Coal River at Ashford (d)  
 Coal River at Tornado (d,U)  
 Kanawha River at Poca (t)  
 Kanawha River at Winfield Dam, at Winfield (c)  
 Ohio River at Point Pleasant (e)  
GUYANDOTTE RIVER BASIN  
 Guyandotte River near Baileysville (d)  
 Clear Fork at Clear Fork (d)  
 Guyandotte River below R. D. Bailey Dam (d)  
 Guyandotte River at Logan (d)  
 Guyandotte River at Branchland (d,c)  
 Ohio River at Huntington (e)  
TWELVEPOLE CREEK BASIN  
 East Fork Twelvepole Creek near Dunlow (d)  
BIG SANDY RIVER BASIN  
 Tug Fork at Welch (d)  
 Dry Fork at Beartown (d)  
 Tug Fork at Vulcan (d)  
 Tug Fork at Williamson (d)  
 Tug Fork at Kermit (d)  
 Tug Fork at Welch (d)

## WATER RESOURCES DIVISION PUBLICATIONS

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

The U.S. Geological Survey has published the results of its studies for more than 100 years. The information is multipurpose and, after its initial use, becomes a basis for future resource evaluation and water management decisions. The Water Resources Division releases its information through several publication series, explained below, and through computerized systems, accessible through NAWDEX and WATSTORE (see page 9).

A description of these publications series, the types of information presented in them and ordering information is given below.

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

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

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

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

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

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

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

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

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

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

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

With the exception of the "National water conditions," which is a form of news release, all of the above publication series are listed in three catalogs--"Publications of the Geological Survey, 1879-1961," "Publications of the Geological Survey, 1962-70", and "Publications of the Geological Survey, 1971 through 1981"--and in yearly supplements since 1981.

The U.S. Geological Survey announces all its publications in a monthly report "New publications of the Geological Survey." Subscriptions to this monthly listing are available upon request to the U.S. Geological Survey, 582 National Center, Reston, VA 22092. All publications are for sale unless specifically stated otherwise. Prices that are subject to change are not included here. Prepayment is required and information on price and availability should be obtained before placing an order. The "U.S. Geological Survey yearbook" provides a comprehensive description of the Federal Government's largest earth-science agency; copies may be purchased at the address where professional papers are sold. Summaries of research in progress and results of completed investigations are published each fiscal year in the professional paper series, "Geological Survey Research."

Professional papers, bulletins, water-supply papers, techniques of water-resources investigations, water-resources investigations reports, circulars, publications of general interest (such as leaflets, pamphlets, booklets), single copies of the Earthquake Information Bulletin, Preliminary Determination of Epicenters, and some miscellaneous reports, including some from the foregoing series that have gone out of print at the Superintendent of Documents, are obtainable by mail from U.S. Geological Survey, Books and Open-File Reports, Federal Center, Box 25425, Denver, CO 80225.

Certain U.S. Geological Survey reports, including most of the Water Resources Investigations (WRI) series released before 1982, "Water resources data - [State] water year [year]" beginning with the 1975 issues, and many compilations of data, can be purchased only from the National Technical Information Service (NTIS). New U.S. Geological Survey reports that are available only from NTIS are cited in the monthly list, "New publications of the U.S. Geological Survey." For information on obtaining these reports contact: National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161 (703) 737-4650.

U.S. GEOLOGICAL SURVEY REPORTS THAT ADDRESS WEST VIRGINIA HYDROLOGY

The following list of publications is the most complete compilation of USGS reports addressing West Virginia hydrology that has been published. This list has been computerized and will be updated as new reports become available. A current list may be obtained by writing to the District Office. The list is divided by USGS publication series, cooperator-published reports, and other.

PROFESSIONAL PAPERS

- P 492 Thermal springs of the United States and other countries-a summary, by G. A. Waring, revised by R. R. Blankenship and Ray Bentall, 1965.
- P 813-A Summary appraisals of the Nation's ground-water resources-- Ohio region, by R. M. Bloyd, Jr., 1974.
- P 813-I Summary appraisals of the Nation's ground-water resources-- mid-Atlantic region, by Allen Sinnott and E. M. Cushing, 1977.
- P 924 Hurricane Agnes rainfall and floods, June-July 1972, by J. F. Bailey, J. L. Patterson, and J. L. H. Palhus, 1975.
- P 1044-E Hydrology and geochemistry of thermal springs of the Appalachians, by W. A. Hobba, Jr., D. W. Fisher, F. J. Pearson, and J. C. Chemary, 1979.
- P 1098 Flood of April 1977 in the Appalachian Region of Kentucky, Tennessee, Virginia, and West Virginia, by G. S. Runner, and E. H. Chin, 1980.
- P 1464 Summary of the U.S. Geological Survey and U.S. Bureau of Land Management National coal hydrology program, 1974-84, 1990.

## WATER-SUPPLY PAPERS

- W 1134-A Floods of August 4-5, 1943, in central West Virginia, with a summary of flood stages and discharges in West Virginia, by H. M. Erskine, 1951.
- W 1798-K Fluvial sediment in Salem Fork watershed, West Virginia, by R. F. Flint, 1972.
- W 2055 Stress and recovery of aquatic organisms as related to highway construction along Turtle Creek, Boone County, West Virginia, by J. L. Chisholm, and S. C. Downs, 1978.
- W 2177 Hydrologic effects of stress-relief fracturing in an Appalachian Valley, by G. G. Wyrick, and J. W. Borchers, 1981.
- W 2225 Traveltimes of flood waves on the New River between Hinton and Hawks Nest, West Virginia, by D. H. Appel, 1983.
- W 2250 National water summary 1983--hydrologic events and issues, by U.S. Geological Survey, 1984.
- W 2275 National water summary 1984-hydrologic events, selected water quality trends, and ground-water resources, by the U.S. Geological Survey, 1985.
- W 2298 Simulation of rainfall-runoff response in mined and unmined watershed in coal areas of West Virginia, by Celso Puente and John T. Atkins, 1989.
- W 2300 National water summary 1985--hydrologic events and surface-water resources, by U.S. Geological Survey, 1986.
- W 2325 National water summary 1986--hydrologic events and ground-water quality by U.S. Geological Survey, 1988.

#### HYDROLOGIC INVESTIGATIONS ATLASES

- HA-295 Ground-water resources of the Appalachian Region, by G. G. Wyrick, 1968.
- HA-347 Floods on the Guyandotte River in the vicinity of Logan, Logan County, West Virginia, by E. A. Friel, and G. S. Runner, 1972.
- HA-427 Floods of Martinsburg and vicinity, West Virginia, by G. S. Runner, and E. A. Friel, 1973.
- HA-547 Flood on Buffalo Creek from Saunders to Man, West Virginia, by G. S. Runner, 1974.
- HA-588 Flood of April 1977 on the Tug Fork, Matewan to Williamson, West Virginia, by G. S. Runner, 1978.

#### CIRCULARS

- C 340 Water resources of the Wheeling-Steubenville areas, West Virginia and Ohio, by R. C. Smith, W. L. Doll, and Garland Stratton, 1955.
- C 667 West Virginia's Buffalo Creek flood--a study of the hydrology and engineering geology, by W. E. Davies, J. F. Bailey and D. B. Kelly, 1972.

#### HYDROLOGIC UNIT MAPS

U.S. Geological Survey, 1989, Hydrologic unit map - 1989 State of West Virginia.

## WATER-DATA REPORTS

Streamflow records.--Records of daily flows of streams prior to 1971 were published in the Water-Supply Paper series, "Surface-Water Supply of the United States," which was released in numbered parts as determined by natural drainage basins. Until 1961, this was an annual series; monthly and yearly summaries of these data were compiled in two reports: "Compilation of records of surface waters of the United States through 1950," and "Compilation of records of surface water of the United States, October 1950 to September 1960." For the period 1961-1970, 5-year compilations were published. Data for West Virginia are published in Parts 1 and 3. Daily streamflow records also were published on a State-boundary basis during the period 1961-74.

Ground-water records. Ground-water levels and artesian pressures in observation wells prior to 1975 were reported by geographic areas in a 5-year Water-Supply Paper series. Data for West Virginia are in "Ground-water levels in the United States, Northern States."

Quality-of-water records.--Data on quality of surface water prior to 1971 were published annually in the Water-Supply Paper series, "Quality of surface waters of the United States," which also was released in numbered parts as determined by natural drainage basins. Data for West Virginia are in Parts 1 and 3. For water years 1964-74, these data also were released annually on a State-boundary basis.

Data reports covering the years 1971 through 1974 were published by the Geological Survey and archived by National Technical Information Service, and were retroactively numbered and included in the state water-data report series. Beginning with the 1975 water year, these series were replaced by a new publication series, "U.S. Geological Survey water-data reports." This series combines under one cover streamflow data, water-quality data for surface and ground water, and ground-water level data for each state. For West Virginia the title is "Water resources data for West Virginia--water year (date)," and is published for each water year. A limited supply of current volumes are available from the District Office. Additional volumes may be purchased from:

National Technical Information Service  
U.S. Department of Commerce  
5285 Port Royal Road  
Springfield, VA 22161  
(730) 487-4650  
(FTS) 737-4650

## WATER-RESOURCES INVESTIGATIONS REPORTS

Reports in this series are available for inspection at the West Virginia and Reston, Virginia, offices of the U.S. Geological Survey. Further information about these reports may be obtained from the District Chief, USGS, Water Resources Division, Charleston, W. Va.

- WRI 77-25            Geochemical and hydrologic data for wells and springs in thermal-spring areas of the Appalachians, by W. A. Hobba, Jr., and others, 1977.
- WRI 81-343          Hydrology of Area 4, Eastern Coal Province, Pennsylvania, Ohio, and West Virginia, by D. K. Roth, M.J. Engelke, Jr., and others, 1981.
- WRI 81-538          Hydrology of Area 5, Eastern Coal Province, Maryland, Pennsylvania, and West Virginia, by W. J. Herb, and others, 1982.
- WRI 81-803          Hydrology of Area 9, Eastern Coal Province, West Virginia by T. A. Ehlke, and others, 1982.
- WRI 81-902          Hydrology of Area 12, Eastern Coal Province, West Virginia, by T. A. Ehlke, and others, 1982.
- WRI 82-864          Hydrology of Area 10, Eastern Coal Province, West Virginia, by T. A. Ehlke, and others, 1983.
- WRI 83-33            Hydrology of Area 6, Eastern Coal Province, Maryland, West Virginia, and Pennsylvania, by W. W. Staubitz, and J. R. Sobashinski, 1983.
- WRI 83-4014         A flood model for the Tug Fork basin, Kentucky, Virginia, and West Virginia, by W. Harry Doyle, Jr., Philip B. Curwick, and Kathleen M. Flynn, 1983.
- WRI 83-4040         Suspended-sediment yields in the Taylor Run and Shavers Fork basins, Randolph County, West Virginia, 1973-80, by S. M. Ward, 1985
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