ACTIVITIES OF THE UNITED STATES GEOLOGICAL SURVEY IN PENNSYLVANIA

COMPILED BY CHARLES R. WOOD

U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 97-640

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1997

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, SECRETARY

U.S. GEOLOGICAL SURVEY
MARK SCHAEFER, ACTING DIRECTOR

Cover: Sections of Walnut Street Bridge, Harrisburg, Pa., broken loose by ice-affected flood of January 1996. Photo courtesy of Suzanne Yenchko, 1996.

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MESSAGE FROM THE STATE REPRESENTATIVE

Since the late 1800's, when the U.S. Geological Survey first established a presence in Pennsylvania, the focus of our work has changed—from general hydrologic and geologic appraisals to issue-oriented investigations; from predominantly data collection to a balanced program of data collection, interpretation, and research; and from traditional, hand-drawn mapping to digitally produced coverages with specialized themes. Yet our basic mission has not changed. It is as relevant to the resource issues of today as it was when our geologists first arrived in western Pennsylvania in 1884.

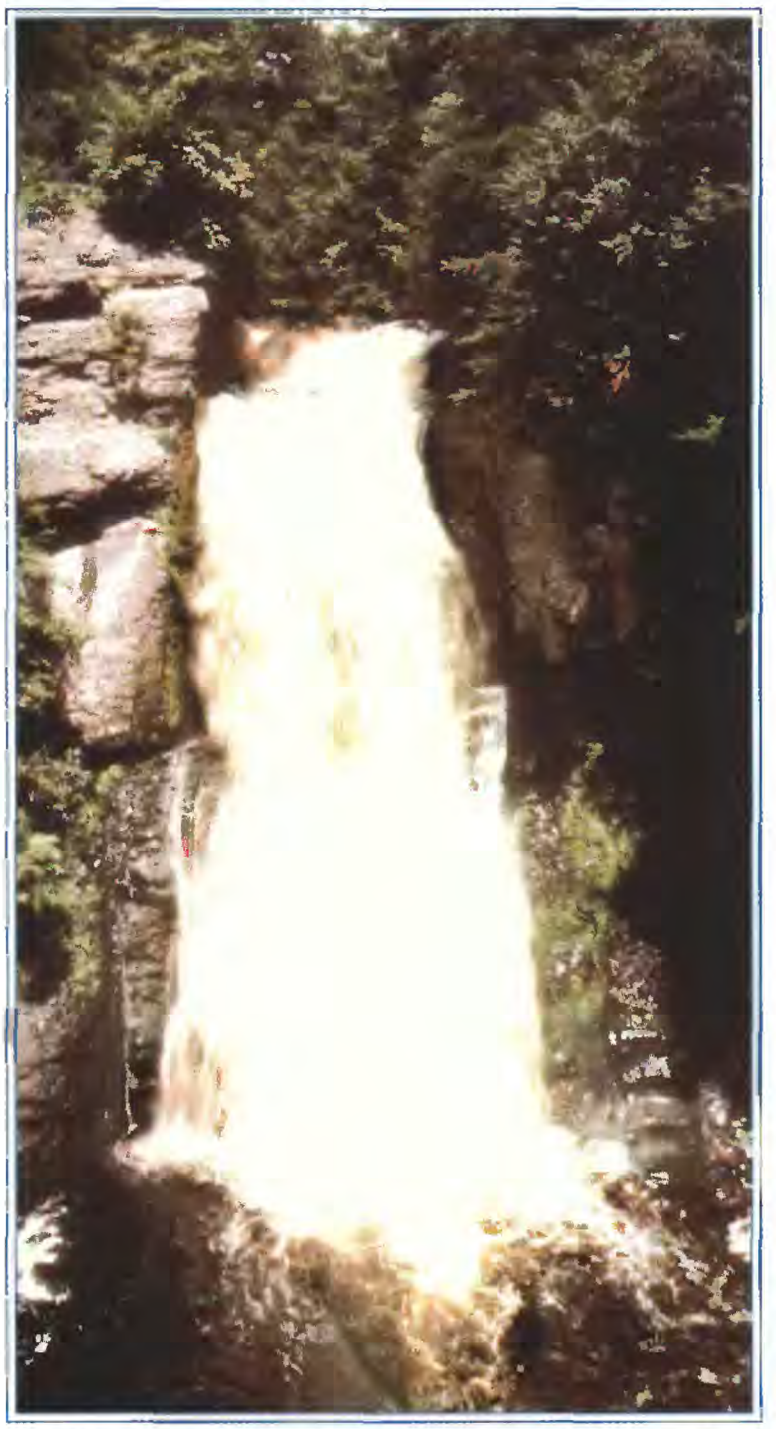
Continuing in this proud heritage and tradition, the U.S. Geological Survey is moving confidently toward the next century, evolving organizationally and technologically to better meet the needs of our many constituencies. One major organizational change is the recent accession of employees from the former National Biological Service, who now form the Survey's fourth program division, the Biological Resources Division. These employees join forces with colleagues in our other three divisions: Water Resources, Geologic, and National Mapping. More than any other change in decades, the addition of this biological expertise creates new and exciting opportunities for scientific research and public service.

This report provides an overview of recent activities in Pennsylvania conducted by the four program divisions and is intended to inform those interested in U.S. Geological Survey products and services. Additional information is available on our home page (at *http://wwwpah2o.er.usgs.gov/*). Together with numerous Federal, State, and local agencies and organizations who are our customers and partners, we at the U.S. Geological Survey look forward to providing continued scientific contributions and public service to Pennsylvania and the Nation.

Gary N. Paulachok

Knox Covered Bridge over Valley Creek, Valley Forge National Historical Park, Valley Forge, Pennsylvania.

CONTENTS



Bushkill Falls near Bushkill, Pennsylvania (photograph courtesy of the Charles E. Peters Estate).

The technical, manuscript-preparation, editing, drafting, and computer expertise of many employees in the Water Resources, Biological Resources, Geologic, and National Mapping Divisions enhanced the content and quality of this publication. Their contributions are greatly appreciated.

INTRODUCTION

An act of Congress on March 3, 1879, established the U.S. Geological Survey (USGS) as part of the U.S. Department of the Interior. The USGS mission is to provide the nation with reliable, impartial information to describe and understand the Earth. This information is used to:

- minimize loss of life and property from natural disasters;
- manage water, biological, energy, mineral, and land resources;
- enhance and protect the quality of life; and
- contribute to wise economic and physical development.

For more than 100 years, the USGS has provided the earth-science information on which many decisions about Pennsylvania's natural resources have been based. Some USGS activities, such as preparation of topographic maps, touch a broad spectrum of the public, while other services, such as assessment of county water resources or investigation of flood hazards, benefit a more limited group of customers. Regardless of the activity or service, the USGS strives to produce data, reports, and maps that are technically sound, unbiased, timely, quality assured, and cost effective.

The various programs of the USGS in Pennsylvania respond to many needs for scientific and technical information. The USGS conducts much of its work through cooperative programs in which the diverse interests of Federal, State, and local agencies are accommodated through joint planning and funding. The USGS provides up to 50 percent of the funding for these programs with the remainder provided by the cooperating agencies. Other USGS programs are supported entirely by federal funds, either directly through appropriations to the USGS or by funds from other Federal agencies. The USGS, Water Resources Division, is the principal program division in Pennsylvania and has an annual budget of more than $10 million (fig. 1).

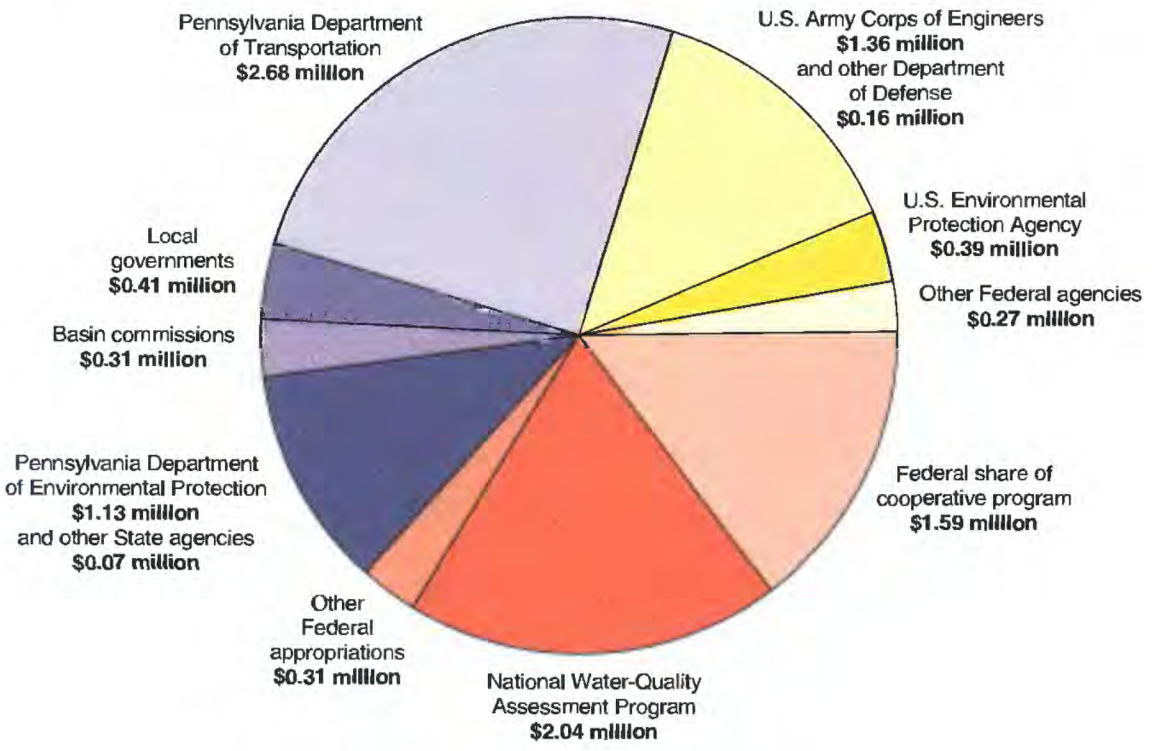


Figure 1. Sources and amounts of funds for the U.S. Geological Survey, Water Resources Division, Pennsylvania District, for Fiscal Year 1997.

WATER-DATA COLLECTION, STORAGE, AND DISSEMINATION

Historical records of water-resources data provide a foundation for investigations and a basis for decision making by resource managers and officials.

The quantity, quality, and distribution of water resources are critical to Pennsylvania's economy, the health and welfare of its citizens, and the management of its many resources. Among the many issues of concern to agencies and the public alike are the increasing water-supply needs associated with urban and suburban growth, the effects of land use and water use on water quality, and the protection of lives and property from the effects of floods and droughts.

The USGS, in cooperation with other Federal, State, and local agencies, is the primary agency that collects, stores, and disseminates water-resources data for Pennsylvania. Through offices in Lemoyne, Malvern, Milford, Pittsburgh, and Williamsport, the Water Resources Division of the USGS operates and maintains statewide networks of monitoring stations to collect and record surface-water, water-quality, and ground-water data. These data, collected and processed using nationally standardized techniques, can be readily combined with USGS data for other areas to evaluate hydrologic conditions over broader geographic regions.

The USGS uses several special purpose data-storage and data-transmission instruments: mechanical and electronic water-level sensors, water-quality monitors, electronic data-collection platforms, and satellite telemetry. In addition, the USGS maintains three nationally standardized hydrologic databases and a home page on the World-Wide Web. The combination of 273 data-collection platforms, satellite telemetry, and the home page is now delivering most of Pennsylvania's hydrologic data on a near real-time basis. Also, the data are published annually in a report series entitled, "Water Resources Data - Pennsylvania." In addition to the statewide networks, the USGS operates several special-purpose networks at the county scale.

SURFACE-WATER DATA-COLLECTION NETWORK

In Pennsylvania, the USGS network of surface-water sites at which data are continuously recorded includes 220 streamflow-gaging stations and 22 reservoir stations (fig. 2). The data collected at these stations are used for water-supply management, hydroelectric power generation, flood control and forecasting, bridge and culvert repair and replacement, wildlife- and park-resource management, pollution abatement, implementation of interstate compacts, and water-resources development, among other uses.

WATER-QUALITY DATA-COLLECTION NETWORK

The USGS water-quality data-collection network consists of 19 continuous-record, multi-parameter monitor stations and 16 additional sites where only water temperature is measured (fig. 2). These data are used primarily to manage hydropower releases, maintain aquatic habitats, control saltwater intrusion in estuaries, dilute acidic mine drainage, and maintain dissolved-oxygen levels.

GROUND-WATER DATA-COLLECTION NETWORKS

The USGS operates two ongoing ground-water networks in Pennsylvania—one is statewide and the other is entirely within Chester County (fig. 3). The statewide network consists of continuous water-level recorders on 51 wells in 50 counties. The Chester County network consists of 23 wells in which ground-water levels are measured once monthly. Data from wells in both networks are used to monitor droughts (fig. 4) and change in ground-water storage and to provide a long-term reference frame for ground-water investigations.

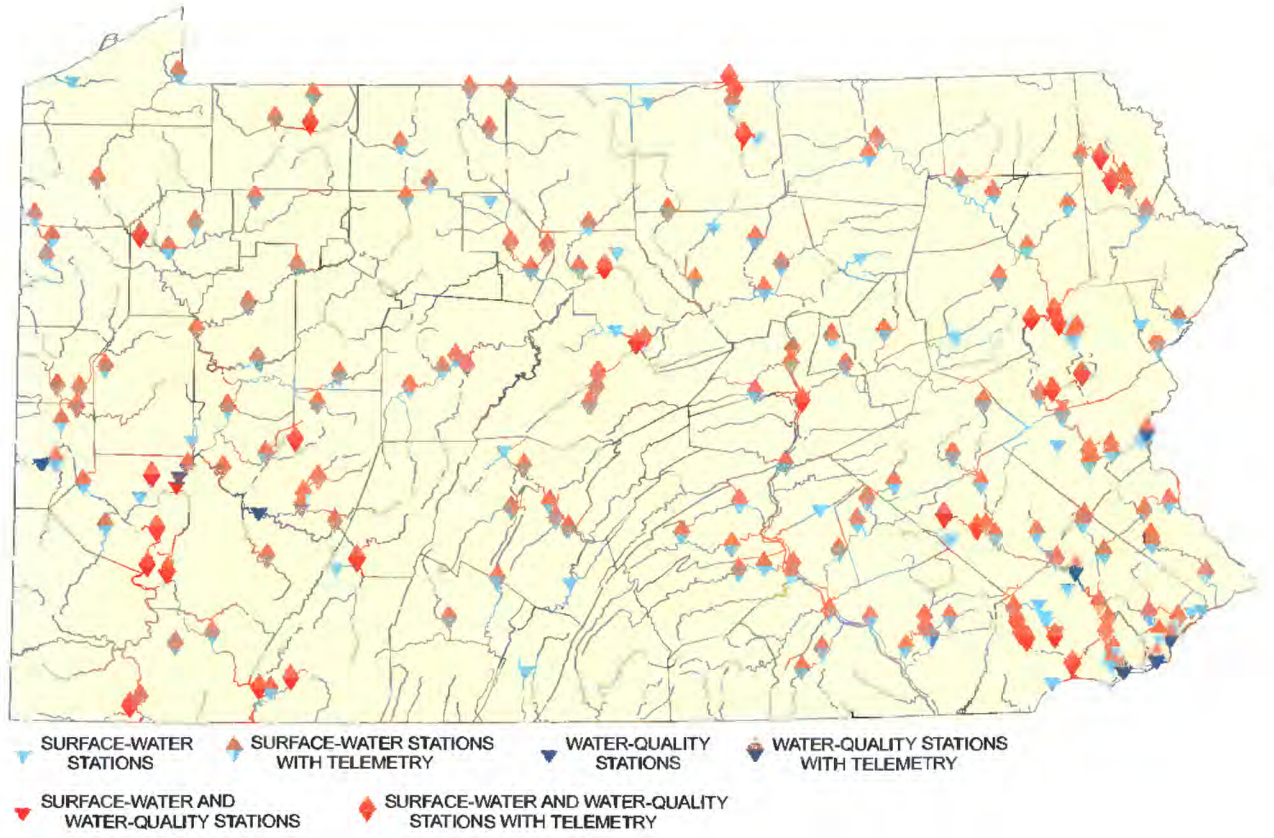


Figure 2. Location of U.S. Geological Survey continuous-record, surface-water stations and water-quality stations.

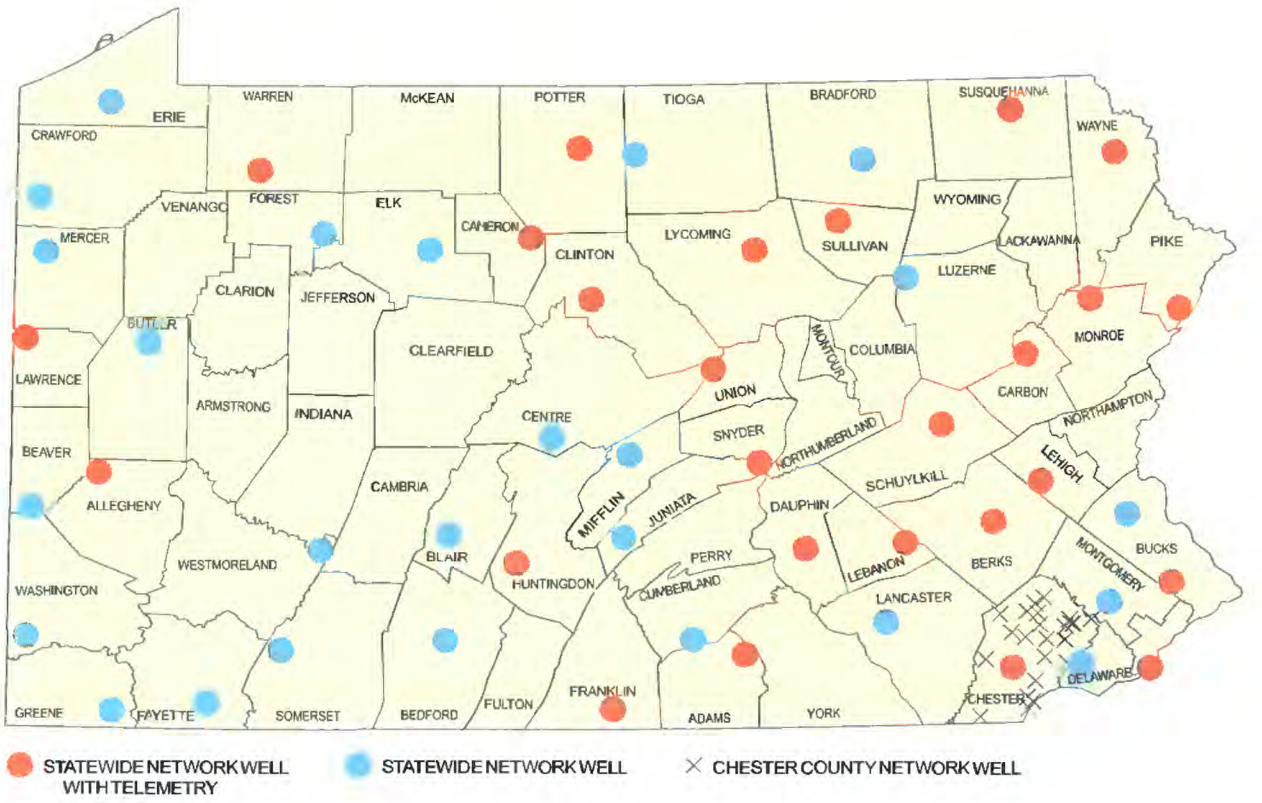


Figure 3. Location of U.S. Geological Survey ground-water observation wells.

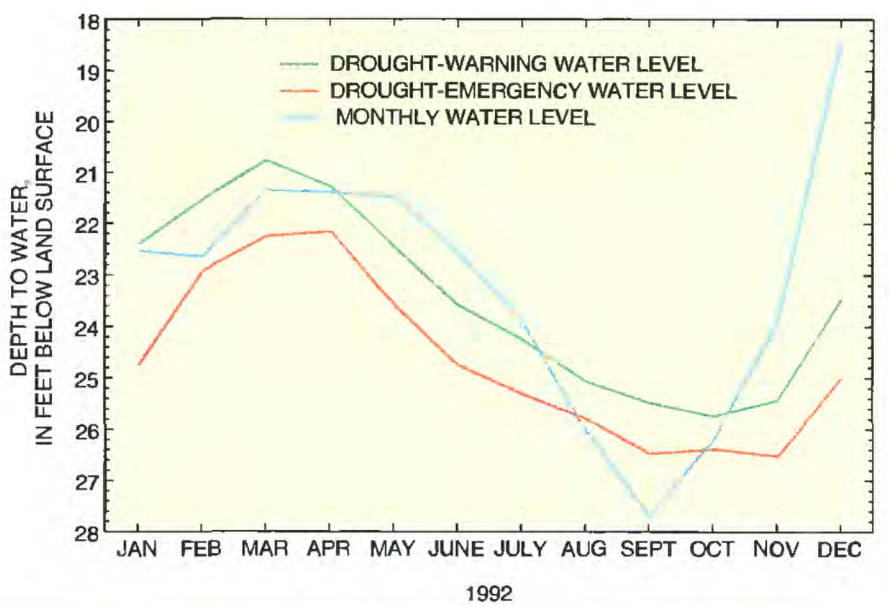


Figure 4. Drought-warning, drought-emergency, and monthly water levels during 1992 for well CH-3289, Tredyffrin Township, Chester County. (Water levels fell below the drought-emergency levels from late July to late September.)

HYDROLOGIC HAZARDS

Accurate hydrologic assessments of floods and droughts provide information needed by Federal, State, and local officials to protect lives and property and to plan, develop, and manage water and land resources.

FLOOD HAZARDS

Flooding is a recurring problem in Pennsylvania. Although the flooding caused by Tropical Storm Agnes in 1972 (fig. 5) was the worst ever recorded for many sites in the Commonwealth, several serious floods have occurred since 1972. During January 1996, for example, flood stages (water-surface heights) and discharges (flows) at 11 key streamflow-gaging stations in Pennsylvania's major drainage basins (fig. 6) approached or exceeded record levels established during previous floods (table 1).

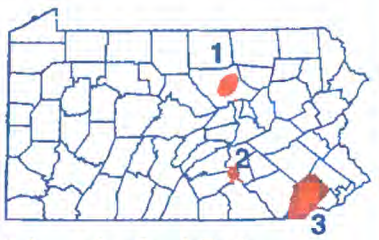
Six people died as a result of the 1996 flooding in the Lycoming Creek Basin near Williamsport, and five people barely escaped the breakup of sections of the Walnut Street Bridge (cover photo and fig. 7) spanning the Susquehanna River between Harrisburg and Wormleysburg. After the flood waters receded, the Federal Emergency Management Agency tasked the USGS with five assignments to conduct or update Flood Insurance Studies in various parts of central and northeastern Pennsylvania.

DROUGHT HAZARDS

The USGS operates 220 long-term streamflow-gaging stations and 51 water-level observation wells that provide the Pennsylvania Department of Environmental Protection (PaDEP) with hydrologic data needed to monitor droughts in the Commonwealth. Satellite telemetry on most of the streamflow-gaging stations and on 26 of the wells provides near real-time hydrologic information. The value of these real-time data was demonstrated during the severe drought of 1995, when daily updates were made available to water managers and citizens alike.

PaDEP evaluates the streamflow and ground-water data, along with other information on recurrence frequency, and recommends to the Pennsylvania Emergency Management Council whether to declare a drought watch, warning, or emergency. The drought watch level is determined by observing hydrologic measurements that are expected to occur less than 25 percent of the time. Drought-warning levels are determined by hydrologic conditions that are expected to occur less than 10 percent of the time.

The Chester County observation-well network consists of 23 wells at which the USGS measures ground-water levels monthly. Drought-warning and drought-emergency declarations are based on statistical correlations of water-level data for these wells to water levels in an index well in Chester County that has 40 years of record. The USGS, in cooperation with the Chester County Water Resources Authority, currently is updating the ground-water-level records on which the county bases its drought declarations.



1 Lycoming Creek Basin near Williamsport
2 Harrisburg and Wormleysburg
3 Chester County

Figure 5. Flooding caused by Tropical Storm Agnes at Harrisburg, Pa., June 23, 1972.

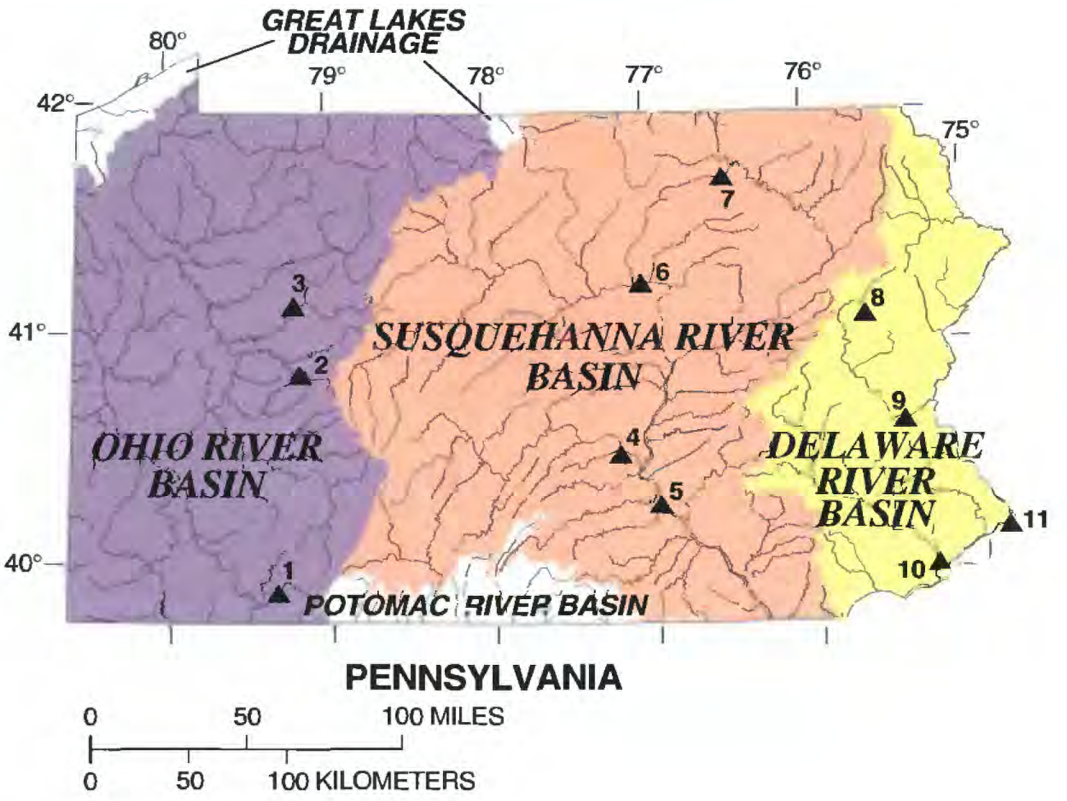


Figure 6. Major drainage basins in Pennsylvania. (Symbol ▲ designates location of U.S. Geological Survey streamflow-gaging station; number is site number listed in table1.)

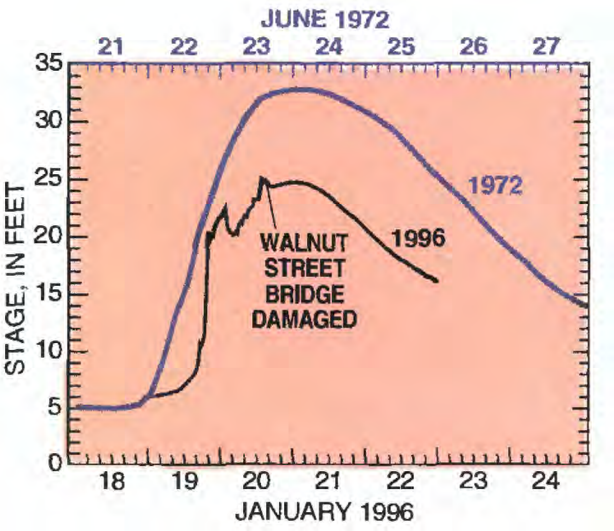


Figure 7. Comparison of river stages at U.S. Geological Survey streamflow-gaging station on Susquehanna River at Harrisburg, Pa., June 21-27, 1972, and January 19-23, 1996. Rapid rises on January 19 and 20, 1996, were caused by ice jams.

Table 1. Peak stages and discharges during 1996 floods and previously known floods for key U.S. Geological Survey streamflow-gaging stations in Pennsylvania

Site number on map	USGS station number and name	Drainage area (square miles)	Beginning year of record	Maximum during 1996			Maximum flood previously known		
				Date	Stage (feet)	Discharge (cubic feet per second)	Date	Stage (feet)	Discharge (cubic feet per second)
1	03079000 Casselman R. at Markleton	382	1920	1/19/96	13.26	44,700	10/15/54	14.06	50,000
2	03034500 L. Mahoning Cr. at McCormick	87.4	1939	1/19/96	13.68	6,790	6/23/72	13.20	6,200
3	03032500 Redbank Creek at St. Charles	528	1918	7/19/96	23.90	66,300	3/18/36	18.60	50,000
4	01567000 Juniata R. at Newport	3,354	1899	1/20/96	24.69	103,000	3/19/36	34.24	190,000
5	01570500 Susquehanna R. at Harrisburg	24,100	1890	1/21/96	25.08	569,000	6/24/72	32.57	1,020,000
6	01551500 W. Br. Susquehanna R. at Williamsport	5,662	1895	1/20/96	26.71	180,000	6/23/72	34.75	279,000
7	[1]01532000 Towanda Creek near Monroeton	215	1914	1/19/96	20.86	62,300	6/22/72	16.90	74,000
8	01447720 Tobyhanna Creek near Blakeslee	118	1961	1/19/96	11.61	8,420	9/27/85	12.33	9,190
9	01453000 Lehigh R. at Bethlehem	1,279	1941	1/20/96	16.88	43,300	5/23/42	25.90	92,000
10	01474500 Schuylkill R. at Philadelphia	1,893	1931	1/19/96	13.36	76,800	6/23/72	14.65	103,000
11	01463500 Delaware River at Trenton, N.J.	6,780	1913	1/20/96	22.20	179,000	6/20/55	28.60	329,000

[1] In 1972, station was one mile downstream from present location.

STREAM-CHANNEL ASSESSMENTS

Assessment of stream-channel instability and scour in the vicinity of bridges is essential to ensure public safety and reduce damage to bridges.

In 1996, the Pennsylvania Department of Transportation (PennDOT) reported that approximately 100 bridges across the Commonwealth were closed because of damage resulting from scour (erosion of sediment from streambeds and streambanks) or lateral stream movement. Floods and associated scour are the most common causes of bridge failures (U.S. Department of Transportation, 1995). Naturally occurring lateral migration of a stream channel also can affect the stability of bridges and nearby roadways. If too much sediment supporting bridge piers and abutments is scoured by the stream, the bridge can fail or become unsafe for use.

In 1987, the Federal Highway Administration mandated that all states assess their bridges for scour and identify sites where scour might eventually adversely affect the bridges. The USGS, in cooperation with PennDOT, began an 8-year project in 1993 to assess 15,800 bridges statewide that are greater than 20 feet in length and over water. The primary objective of this project is to rate the scour and site stability by observing geomorphic and hydraulic factors, structural features identified by PennDOT, and physical characteristics of bed and bank materials. Identification of scour-affected and -susceptible bridges assists PennDOT in monitoring and correcting problems before bridges become unsafe. PennDOT uses this and other information to prioritize remediation of bridges.

The USGS begins field assessment of a bridge site in the PennDOT district office responsible for maintaining the bridge. Bridge plans, historical inspections, and maintenance records are reviewed. A field team then visits the site and collects the following information (fig. 8):

Geomorphic Data - Site information, including location and appearance of streambanks and meanders, amount of woody vegetation stabilizing streambanks, and evidence of scour, is gathered and recorded in an electronic database using field computers. A sketch is drawn to further describe and document site conditions upstream of, downstream of, and at each bridge.

Survey Data - Bridge geometry and channel features upstream and downstream are surveyed with computerized survey equipment. A cross-sectional plot at the bridge, created from the processed survey data, shows the bridge structures in relation to channel conditions, including areas of deposition, scour, and debris accumulation.

Location Data - The bridge location is determined precisely by collecting latitude and longitude data using a Global Positioning System (GPS).

Video Data - Video images and accompanying audio tracks also are recorded to document conditions at the sites. Selected video images for each bridge are stored in the database as digital image files.

GIS Data - In addition to the field data, data sets of land use, soils, and bedrock units derived from a geographic information system (GIS) are used to compute percentage of urbanized area, mean basin slope, and selected flood discharges. Information from a site-indexed database compiled using all field data, GIS-derived data, and selected data from PennDOT files is used to compute bridge-site scour ratings, enhance PennDOT's existing bridge-management database, and contribute to a national bridge scour data-management system.

Reference

U.S. Department of Transportation, 1995, Evaluating Scour at Bridges: Washington, D.C., Hydraulic Engineering Circular No. 18, variously paginated.

Figure 8. Collection and storage of data for 15,800 bridges in Pennsylvania assessed for channel instability and scour.

ENVIRONMENTAL ASSESSMENTS

Human impacts on the environment—particularly on water resources—are a major concern to the citizens of Pennsylvania and the Nation.

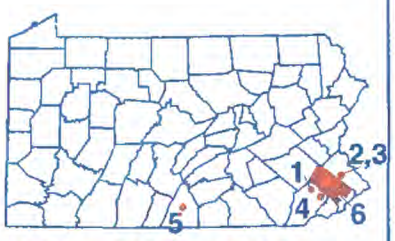
The USGS brings specialized data-collection and analysis expertise to environmental assessment. The USGS uses a variety of resources to conduct these assessments, including borehole-geophysical logging (figs. 9 and 10), borehole television surveys (fig. 11), aquifer (pumping) tests, aquifer-isolation (packer) tests (fig. 12), and laboratory analysis of water samples. The results of these assessments also enhance USGS local and regional studies of ground-water quality and the environmental effects of land use.

GROUND-WATER CONTAMINATION IN EASTERN CHESTER COUNTY

In cooperation with the U.S. Environmental Protection Agency (USEPA), the USGS is conducting a hydrogeologic study of the Malvern TCE (trichloroethylene) Superfund site in eastern Chester County. The drinking water in an adjacent residential development has been contaminated by volatile organic chemicals. USGS activities at the site helped delineate the extent of ground-water contamination, determine hydraulic characteristics of affected aquifers, and evaluate the feasibility and effects of extracting contaminated ground water through use of recovery wells (fig. 13).

SOURCE OF GROUND-WATER CONTAMINATION AT CASEY VILLAGE, BUCKS COUNTY

The source of volatile organic chemicals contaminating ground water at Casey Village is unknown. The USGS, in cooperation with the USEPA, is undertaking a study to identify the source of contamination. Measurements of water levels in wells are being used to determine the direction of ground-water flow. Water samples collected from wells are being used to determine the distribution of contamination in the aquifer.



1 Malvern TCE Superfund Site
2 Casey Village
3 Naval Air Warfare Center
4 Valley Forge National Historical Park
5 Letterkenny Army Depot
6 Montgomery County

U.S. NAVAL AIR WARFARE CENTER, WARMINSTER, BUCKS COUNTY

Since 1993, the USGS has provided technical support to the U.S. Navy to help identify and remediate ground-water contamination at the Naval Air Warfare Center. The USGS is helping to determine where additional monitor wells should be drilled and is using borehole-geophysical techniques to identify well characteristics, fracture distribution, water-producing and water-receiving zones, and zones of flow within the borehole.

CONTAMINATION AT VALLEY FORGE NATIONAL HISTORICAL PARK

Valley Forge National Historical Park is used heavily for tourism and recreation. The National Park Service is concerned that surrounding sources may have contributed contamination to the park's wells and recreational areas. Comprehensive ground-water sampling by the USGS is being used to delineate the extent and severity of contaminated ground-water supplies. Analyses of stream-sediment samples collected from the park's heavily used recreational areas are being evaluated to determine contamination levels associated with the solid phase.

MONITORING AT LETTERKENNY ARMY DEPOT, CHAMBERSBURG, FRANKLIN COUNTY

The USGS has an ongoing program to collect ground-water samples from six monitor wells at Letterkenny Army Depot. Evaluation of historical and recent water-quality data shows that remedial actions have reduced concentrations of volatile organic chemicals in the ground water.

HYDROGEOLOGIC ASSESSMENT OF SUPERFUND SITES IN THE LANSDALE AREA, MONTGOMERY COUNTY

Public and private drinking-water supplies are located near several Superfund sites in Montgomery County. The USGS is assisting USEPA at these sites by evaluating hydrogeology and aquifer characteristics. A USGS computer model is being used to simulate movement of contaminants through the aquifer. This information will be used to help determine the direction of contaminant movement and to aid in the design of remedial measures.

Figure 9. Borehole geophysical logging being conducted in an abandoned production well at a Superfund site.

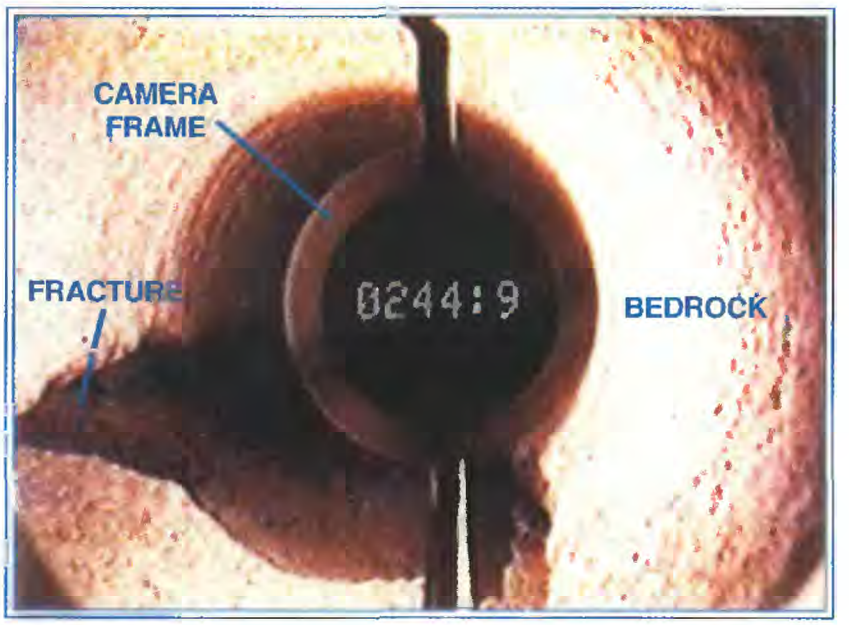


Figure 11. Photograph from a borehole television survey showing a large, vertical fracture at 244.9 feet below the land surface.

Figure 13. Capture zone formed by pumping recovery wells at the Malvern TCE Superfund site in eastern Chester County.

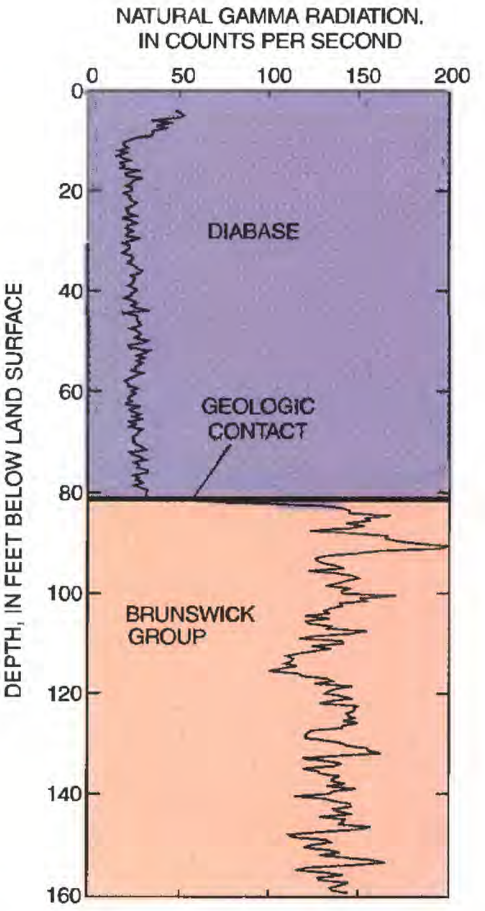


Figure 10. Natural-gamma log of well showing geologic contact between two rock formations.

Figure 12. Straddle packer assembly being prepared for use in hydraulic testing of fractures in a borehole.

WATER USE AND AVAILABILITY

Not only do the ground and surface waters of Pennsylvania supply the needs of the Commonwealth's 12 million residents—the Delaware River along Pennsylvania's eastern border also supplies drinking water for 10 million people in New York City and northern New Jersey.

Pennsylvania's ground-water and surface-water resources are critical for municipal, industrial, and agricultural water supply; maintenance of water quality; and maintenance of in-stream uses, as well as many other uses. Many USGS activities are directed at the hydrologic and geologic issues associated with water availability, including those related to human effects on the hydrologic cycle (fig. 14). Examples include quantification of water use, water quality, and aquifer properties, as well as evaluation of the response of hydrologic systems to stress.

WATER USE IN PENNSYLVANIA

The USGS collects, stores, and summarizes water-use and related data. The PaDEP, the primary cooperator with the USGS on statewide water-use activities, periodically surveys water use by category. The USGS combines this survey information with data from Federal agencies and other entities, including the Pennsylvania Bureau of Fisheries, the Pennsylvania State University, and the Pennsylvania Department of Agriculture, to produce water-use summaries for Pennsylvania. The summaries are suitable for many different audiences and applications and serve as the basis for the Pennsylvania contribution to the USGS Circular "Estimated Use of Water in the United States," published every 5 years. Estimated water withdrawals in Pennsylvania for 1995 are shown on figure 15.

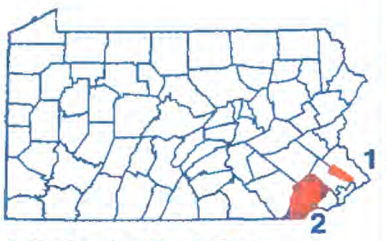
The USGS maintains two water-use databases for Pennsylvania—the Site Specific Water Use Data System (SSWUDS) and the Aggregated Water Use Data System (AWUDS). Details about sources of withdrawal and types of use are included in records for individual sites in SSWUDS, whereas records in AWUDS are exclusively totals, percentages, and statistical calculations of water use by category, counties, and basins.

WATER AVAILABILITY IN THE NESHAMINY CREEK BASIN

The Neshaminy Creek Basin is in a heavily populated part of southeastern Pennsylvania where the demand for water has increased greatly in recent years and is expected to continue increasing. The USGS developed a water-use analysis computer program for the basin to assist the Delaware River Basin Commission in allocating and managing water resources (Schreffler, 1996). This program allows the user to store and retrieve information on quantities and locations of withdrawals, discharges, and imports and exports of water in ways that can be used to effectively allocate and manage water resources. Methodologies developed for the Neshaminy Creek Basin have broader application and currently are being applied to other watersheds in southeastern Pennsylvania.

OTHER STUDIES

In Chester County, the USGS currently is analyzing statistics on low flows of streams, investigating trends in ground-water levels, and mapping the water table in selected areas. The results of comprehensive investigations of water resources in Chester County and northern Bucks County have been published recently by the USGS.



1 Neshaminy Creek Basin
2 Chester County

References

Schreffler, C.L., 1996, Water-use analysis program for the Neshaminy Creek Basin, Bucks and Montgomery Counties, Pennsylvania: U.S. Geological Survey Water-Resources Investigations Report 96-4127, 85 p.

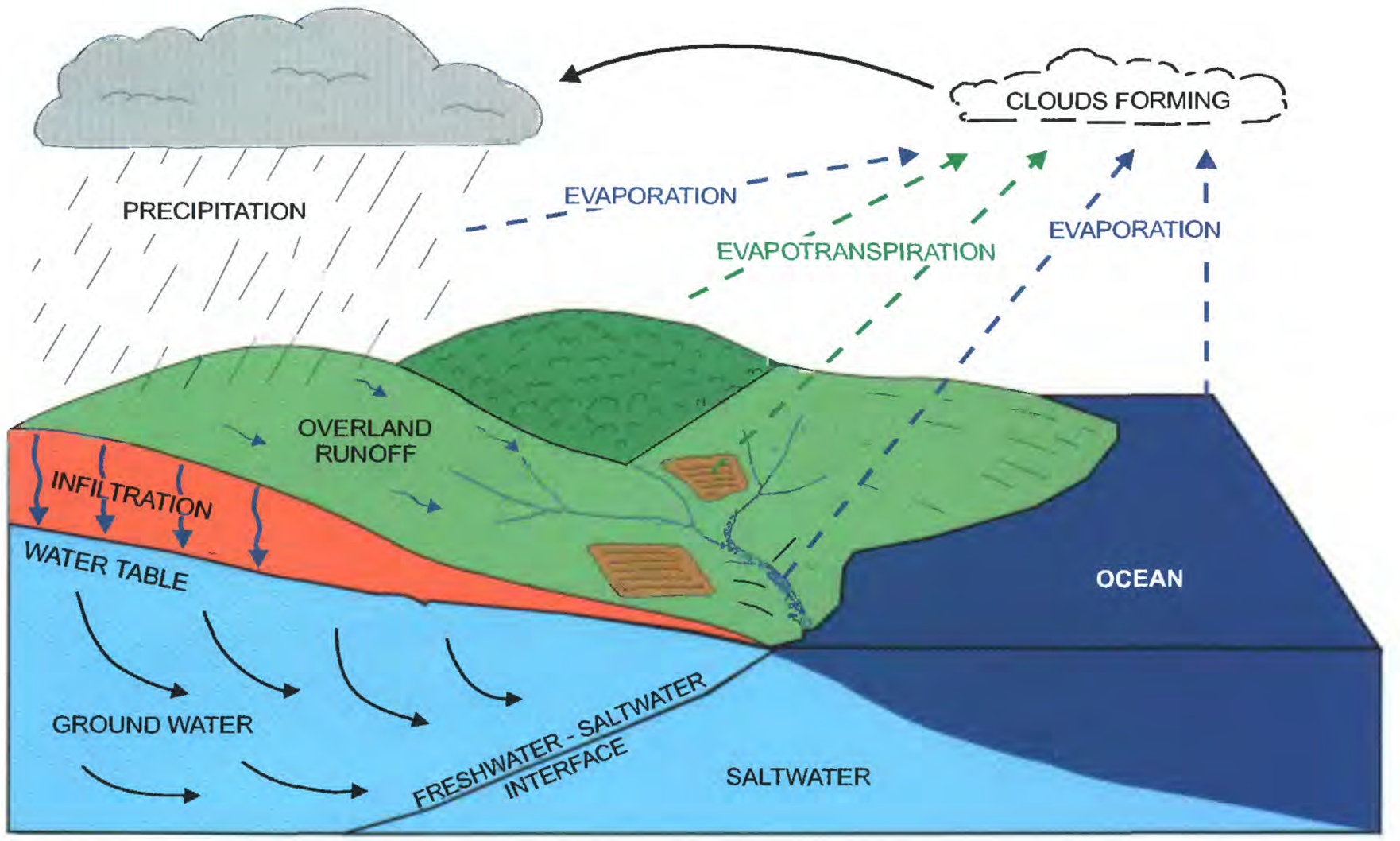


Figure 14. Hydrologic cycle.

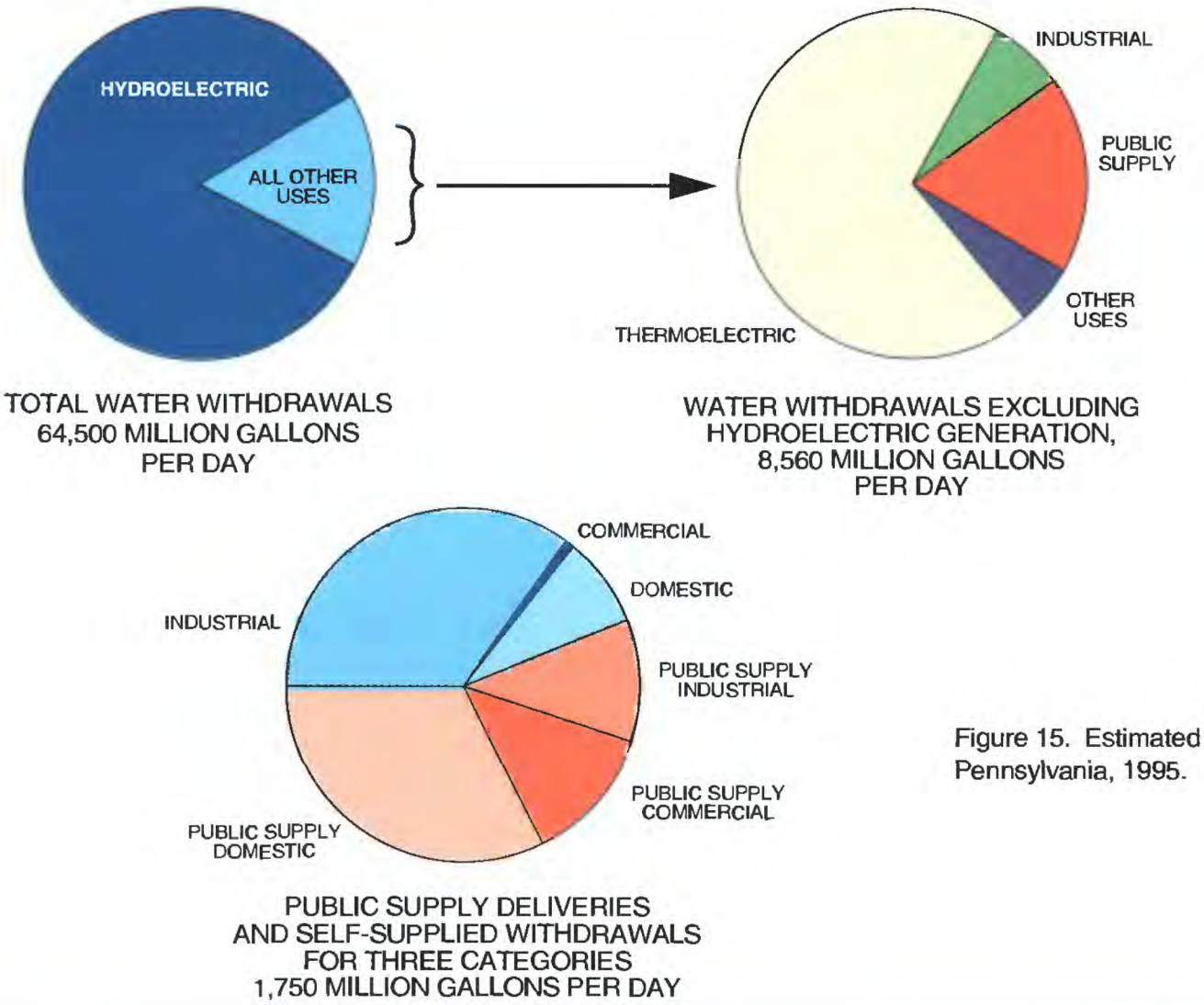


Figure 15. Estimated water withdrawals in Pennsylvania, 1995.

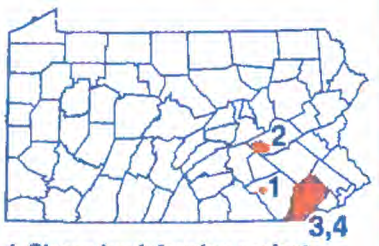
WATER QUALITY AND STREAM BIOLOGY

Pennsylvanians need good quality water for drinking, agriculture, industry, commerce, and recreation. Good quality water also is needed to sustain aquatic biological systems.

The USGS conducts local and area-wide studies to help Federal, State, and local agencies and other organizations evaluate water quality and stream biology. Standardized data-collection techniques, quality-assured laboratory results, and unbiased interpretations combine to produce scientific and technical information that is consistent, of high quality, and objective. A sampling of issues recently addressed by the USGS are highlighted below.

NUTRIENTS FROM AGRICULTURAL LANDS

The Susquehanna River is the largest tributary to the Chesapeake Bay. The most serious water-quality problems facing the Bay are caused by excessive nutrients (phosphorus and nitrogen) delivered in runoff from tributary streams. To address these problems, efforts have focused on reducing nutrient inputs from watersheds draining to the Bay. Progress has been made in reducing nutrient loads from point sources such as wastewater treatment plants. Loads from nonpoint sources such as agricultural runoff, however, are more difficult to control (fig. 16). The USGS has a long history in Pennsylvania of evaluating the effects on water quality of best-management practices for reducing nutrients draining from agricultural lands. Past studies have evaluated the effects of terraces, nutrient management, and phosphorus transport from farm fields on water quality. Currently, the USGS is evaluating nutrient reductions achieved by streambank fencing at a Lancaster County research site (fig. 17) and is calculating nutrient loadings to the Chesapeake Bay.



1 Streambank fencing project
2 Swatara Creek project
3 Cheater County
4 Christina River Basin

BIOLOGICAL WATER-QUALITY MONITORING AND ASSESSMENTS

More and more, resource managers are relying on biological assessments to evaluate water quality (fig. 18). Biological monitoring is a major component of each of the National Water Quality Assessment Program (NAWQA) studies being conducted by the USGS (see page 16). Biological assessments are being used to help determine the effectiveness of a streambank fencing project in Lancaster County (see description above) and a project to evaluate the effectiveness of limestone drains, limestone diversion wells (fig. 19), and limestone-lined channels in treating acidic mine drainage (fig. 20) in the Swatara Creek Basin. Since 1969, benthic invertebrates have been collected at nearly 50 sites on streams in Chester County through a cooperative project with the Chester County Water Resources Authority. From these data, determinations of stream biological status and trends are made (fig. 21).

RADON IN GROUND WATER IN CHESTER COUNTY

In cooperation with the Chester County Water Resources Authority, the USGS has collected water samples from more than 400 wells as part of a county-wide assessment of radon, a naturally occurring radioactive element, in ground water. The results will help local and county officials and citizens become aware of radon levels in ground-water supplies and the associated human health risks.

WATER QUALITY OF STREAMS IN THE CHRISTINA RIVER BASIN, PENNSYLVANIA AND DELAWARE

Streams in the Christina River Basin are used primarily for drinking-water supply and recreation. These uses, as well as the maintenance of biological habitat, are threatened, however, by contamination. The USGS, in cooperation with Federal, State, and county agencies, is preparing a computer model to simulate surface-water quantity and quality in the Basin. This model will allow officials to evaluate water-quality benefits from proposed management options and to develop scientifically and technically based land- and water-management plans for the Basin.

Figure 16. Runoff from agricultural land is a major source of nutrient loads to streams.

Figure 17. Fencing streambanks keeps grazing animals out of streams, helps stabilize streambanks, and allows native vegetation to remove nutrients from water before it reaches the streams.

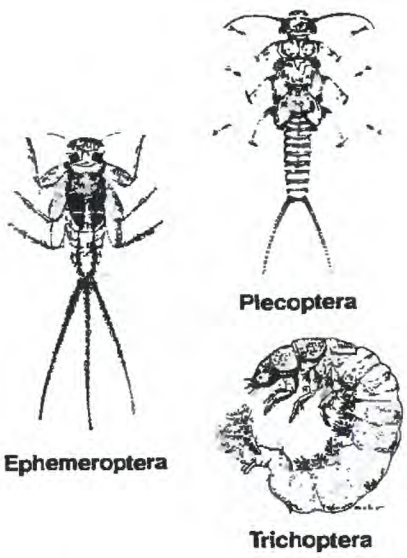


Figure 18. Biological organisms such as these typically are found in streams with good water quality.

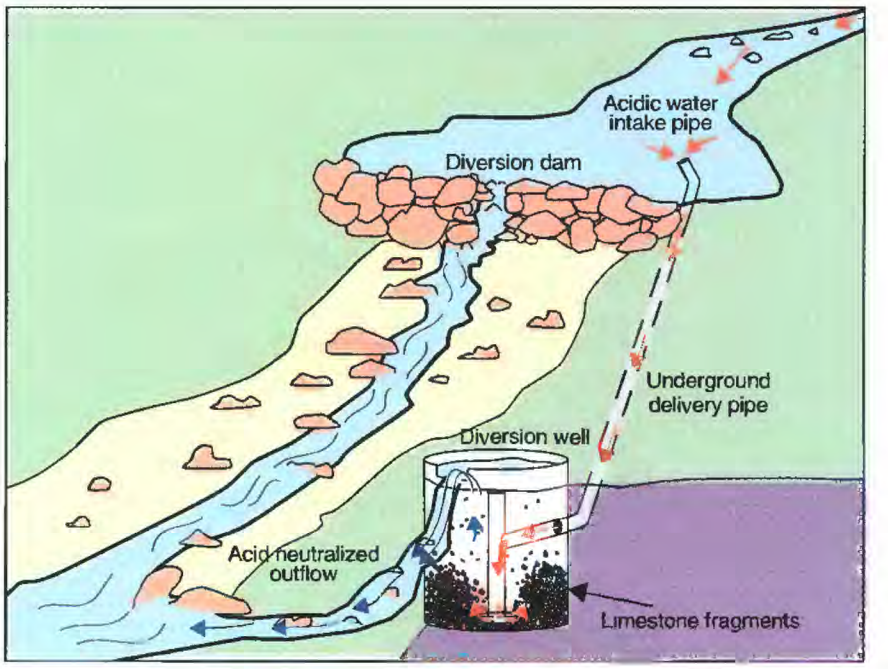


Figure 19. Schematic representation of a limestone diversion well. U.S. Geological Survey research is evaluating the effectiveness of diversion wells and other structures in remediating acid mine drainage.

Figure 20. Water draining from abandoned coal mines typically is acidic and contains large concentrations of toxic metals.

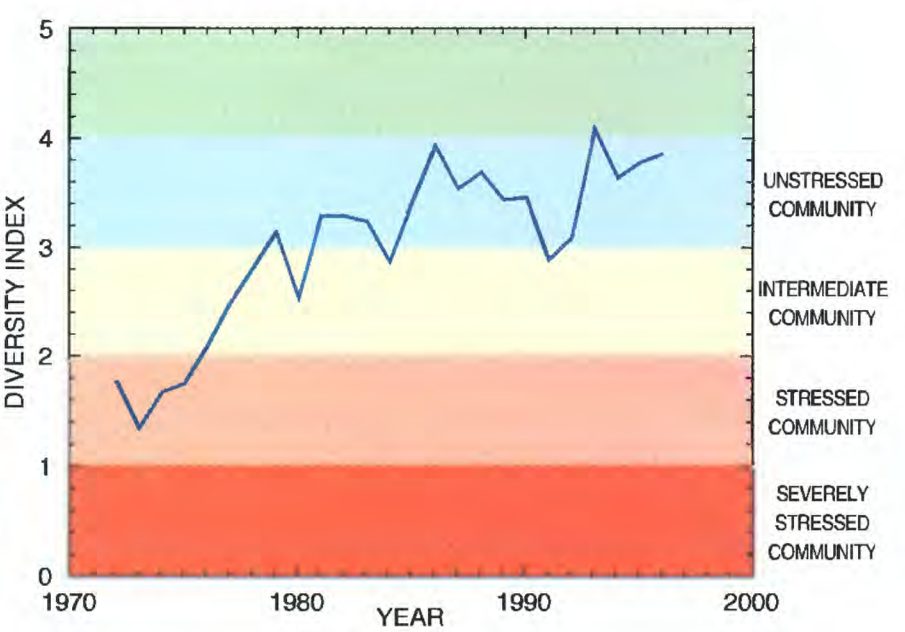


Figure 21. Diversity index for Brandywine Creek at Chadds Ford, Pa., indicates improving water quality.

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

The Nation needs to understand the factors that affect the quality of its water resources.

In 1991, the USGS began a National Water-Quality Assessment (NAWQA) Program. Its goals are to describe the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources and to identify the major factors that affect the quality of these resources. In addressing these goals, the NAWQA Program provides water-quality information that is useful to policy makers and managers at the Federal, State, and local levels.

Studies of 52 hydrologic systems that include parts of most major river basins and aquifer systems are the building blocks of the national assessment. The 52 study units range in size from less than 1,000 square miles to more than 60,000 square miles and represent from 60 to 70 percent of the Nation's water use and population served by public-water supplies. Twenty NAWQA investigations began in 1991, 15 began in 1994, and 17 began in 1997. Five of the current investigations are part of the NAWQA Program in Pennsylvania (fig. 22). The Lower Susquehanna River Basin and Potomac River Basin studies began in 1991, the Allegheny-Monongahela River Basin and Lake Erie-Lake St. Clair Basin studies began in 1994, and the Delaware River Basin study began in 1997.

In addition to their importance in the national assessment, these investigations are contributing to a consistent statewide water-quality database. Ground-water data currently available from three of the five study units in Pennsylvania show the importance of comparable, consistent, statewide results. Concentrations of nitrate and the herbicide atrazine in samples of ground water collected during 1993-96 from household water supplies are illustrated in figure 22. The results show where elevated concentrations of nitrate and atrazine are present in the areas sampled. Reconnaissance results for radon in ground water in the Lower Susquehanna and Potomac River Basins show that concentrations vary widely and general patterns of occurrence are related to bedrock geology (fig. 23) (Lindsey and Ator, 1996).

Surface-water-quality samples are collected for NAWQA investigations at long-term monitoring sites and at synoptic sites. The sites are carefully chosen for sampling of occurrence and distribution of contaminants in water, bed sediment, and tissue from whole fish in predetermined settings of interest. These settings are called subunits and are characterized by factors important to surface-water and ground-water studies, such as physiography, bedrock type, and land use. The Lower Susquehanna Basin and Potomac River Basin investigations focus on high-priority issues including nutrients and herbicides in the Chesapeake Bay watershed. The Allegheny-Monongahela River Basin investigation focuses on the effects of coal mining on water quality. The Lake Erie-Lake St. Clair Basin investigation is focusing on contaminants in fish and on the effects of contaminants in storm runoff on consumption, recreation, and aquatic life. Because of the large population centers in the basin, the Delaware River Basin investigation will focus, in part, on the effects of urban land use on water quality.

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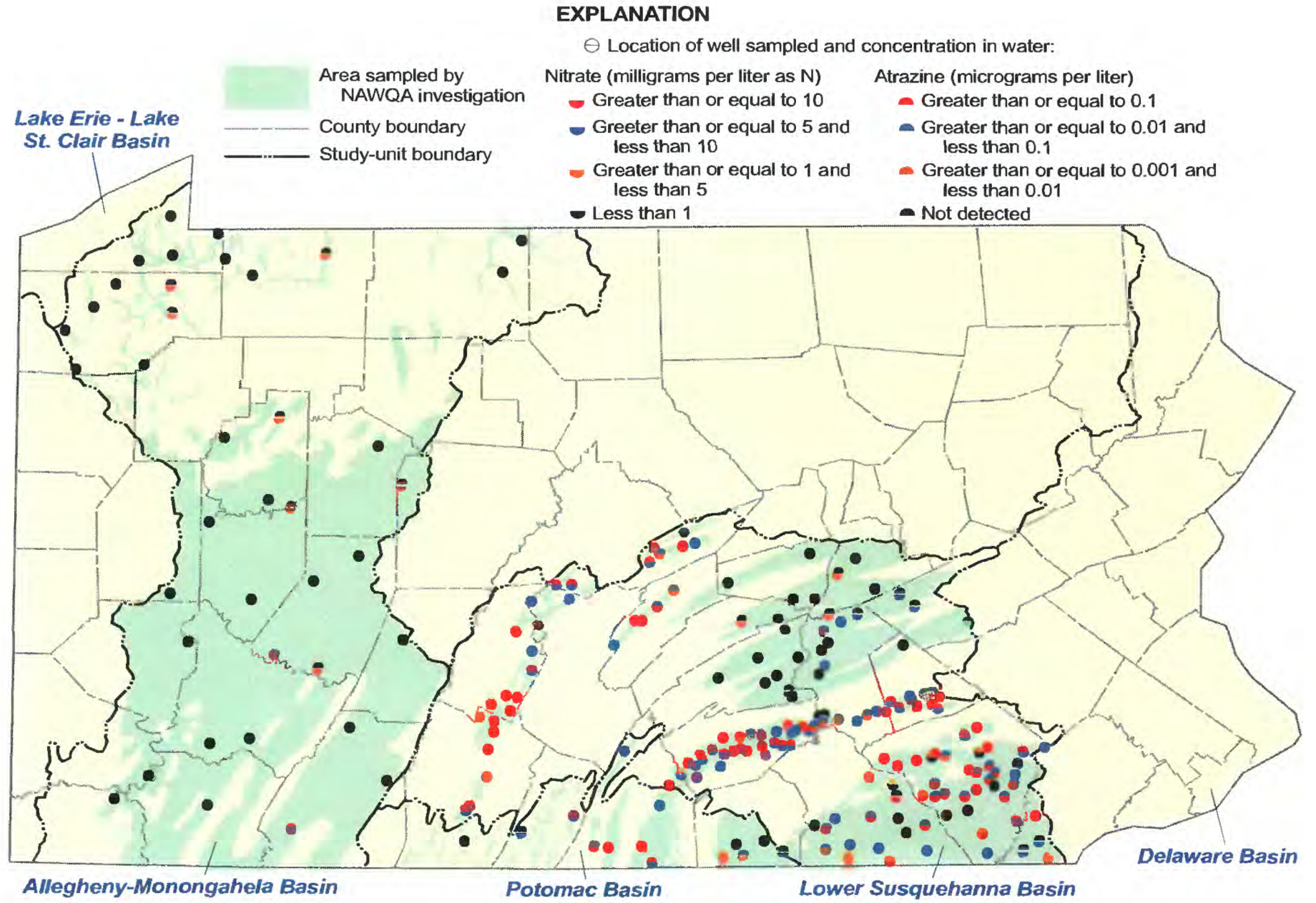


Figure 22. National Water-Quality Assessment Program study units in Pennsylvania and concentrations of nitrate and atrazine in ground water from domestic wells, 1993-96.

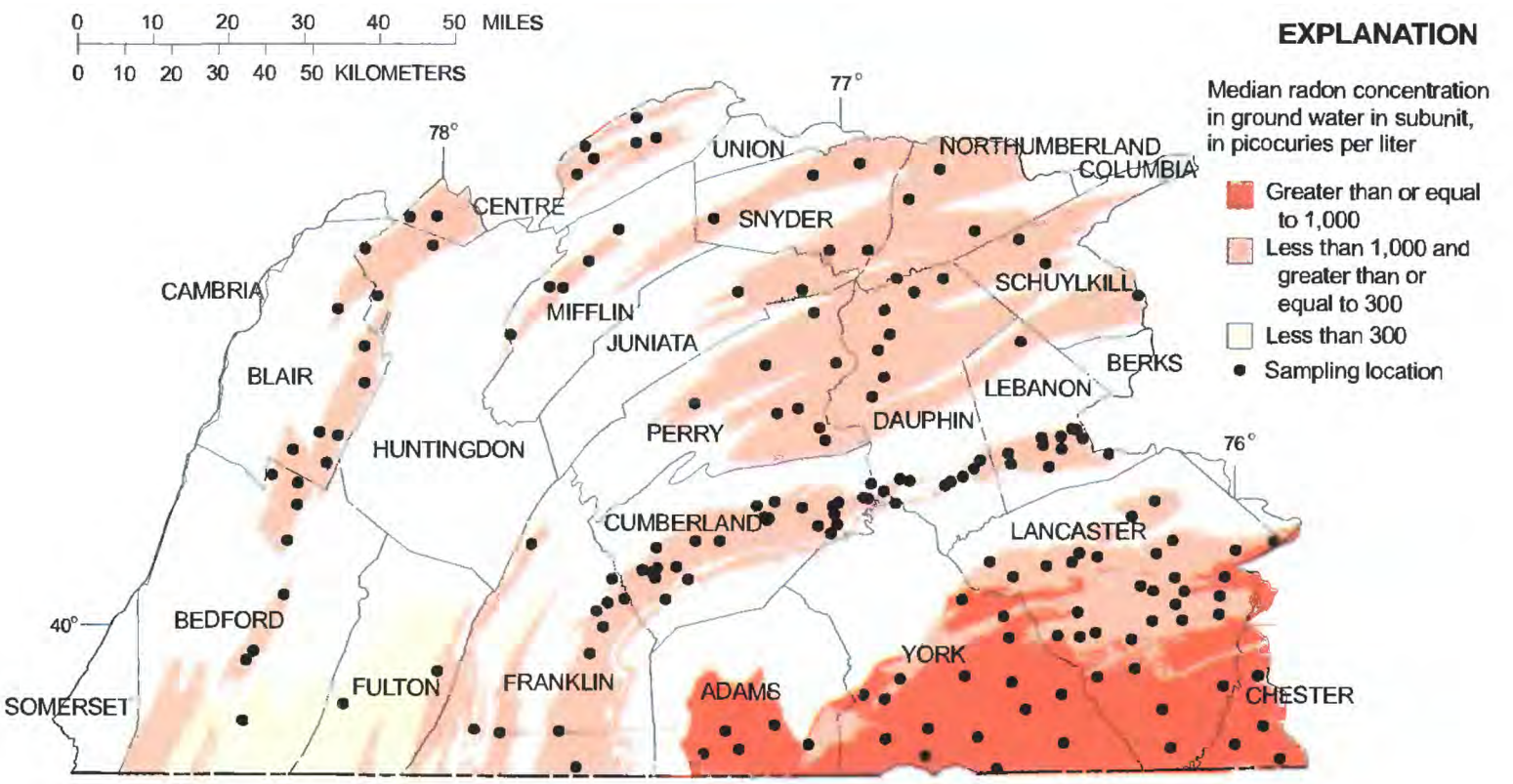


Figure 23. Sampling locations and subunits in the Lower Susquehanna and Potomac River Basins, Pa. Shading used to indicate median radon concentrations in ground water. [Modified from Lindsey and Ator, 1996.]

BIOLOGICAL RESEARCH

Working with others, the USGS develops high quality biological information for resource managers and the public, technologies to restore degraded habitats, and methods to ensure access to biological information.

Through local offices in Wellsboro and State College, the Biological Resources Division of the USGS gathers, analyzes, and disseminates the biological information needed for sound stewardship of natural resources and for understanding biological systems and their benefits to society.

HABITAT RESTORATION - NEW TREATMENT FOR ACIDIC MINE DRAINAGE

In Pennsylvania, acidic mine drainage has degraded approximately 2,400 miles of streams. The USGS has developed a new treatment process to assist in restoring streams affected by mine drainage. Pulsed bed reactors (fig. 24) that use low-cost limestone are integrated with carbon dioxide absorption and desorption to overcome problems that previously restricted the use of limestone—low dissolution rates and surface armoring of the limestone by metal compounds. With the new process, limestone dissolution rates are increased, providing high levels of alkalinity to buffer the acidity. The effects of the new process on acid-sensitive aquatic invertebrates and fish are being evaluated through laboratory studies.

SPECIES IN DECLINE

Freshwater mussel populations are declining throughout North America. More than two-thirds of the nearly 300 species of freshwater mussels are threatened by habitat alteration and loss, deteriorating water quality, and competitors including zebra mussels. USGS scientists are developing methods of surveying (fig. 25) and tracking mussels to study their biology, ecology, status, and population trends.

In the last two decades, defoliation caused by the hemlock wooly adelgid has caused eastern hemlock populations to decline substantially in the eastern United States. The entire hemlock forest ecosystem may be threatened by the spread of the adelgid. In cooperation with the National Park Service at the Delaware Water Gap National Recreation Area, the USGS is evaluating the biodiversity of aquatic species in streams draining hemlock ravines compared to that in streams draining hardwood ravines. This study will characterize landscape diversity, determine the contribution of hemlock-ravine habitats to aquatic biodiversity, and develop an empirical model of hemlock stand vulnerability.

Historically, the Delaware River supported the principal Atlantic sturgeon fishery in the United States. Commercial landings from the late 1800's to the present, however, indicate a severe decline in this fishery. Restoration efforts by the U.S. Fish and Wildlife Service have been hampered by lack of knowledge of the sturgeon genetic structure. USGS scientists have developed genetic markers, called microsatellites, for sturgeon that enable their identification at the individual and population levels (fig. 26). This research aids restoration efforts by providing information to maximize genetic diversity in stocked sturgeon populations.

FISH HEALTH

Historically, whirling disease of rainbow trout (fig. 27), caused by a parasite, has been a problem only in hatcheries, but it also could cause declining rainbow trout populations in natural systems. The USGS is evaluating water-quality effects on the host and the immune response of trout and whether whirling disease is affecting wild trout populations in Pennsylvania.

Coldwater disease, caused by bacteria, also has caused trout losses in Pennsylvania hatcheries. The USGS is studying the pathogenesis, examining antibiotic resistance of bacteria strains, determining predisposing factors that lead to increased susceptibility of fish, and identifying factors associated with increased virulence of the pathogen.

Infectious pancreatic necrosis is a viral disease affecting trout production. In Pennsylvania, the USGS is studying the fate of the virus after it is released into water bodies by infected fish.

1 Delaware Water Gap

Figure 24. Test equipment developed by the U.S. Geological Survey to neutralize acid in drainage from abandoned coal mines.

Figure 25. U.S. Geological Survey scientists surveying freshwater mussels in French Creek, Pa.

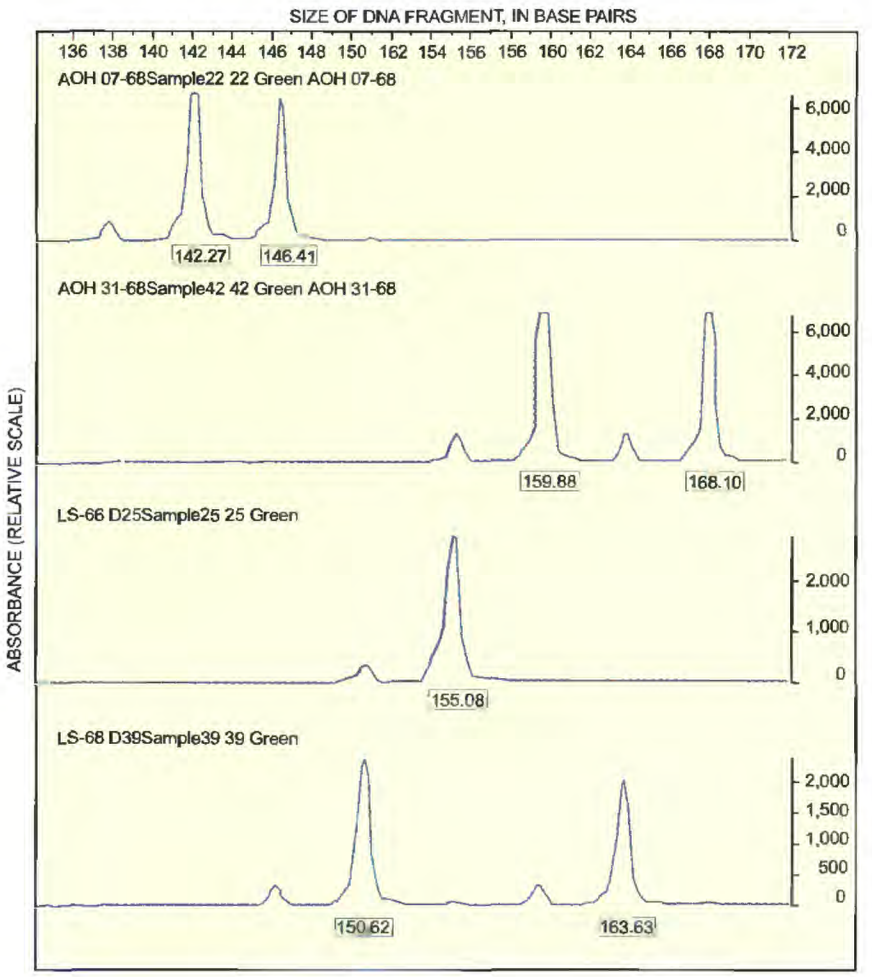


Figure 26. Electropherograms of microsatellite marker LS 68 present in individual sturgeon collected from the Hudson River (top 2 electropherograms) and from the Delaware River (bottom 2 electropherograms). Each peak represents a different form of the gene. Each individual has a different electropherogram, which indicates a high level of genetic diversity in these fish for genetic marker LS 68.

Figure 27. Young rainbow trout showing typical signs of whirling disease including black tail and bent back.

ENERGY AND MINERAL RESOURCE ASSESSMENTS

Energy and mineral resources are vital to Pennsylvania's economy and future. Understanding their location and extent, and the environmental effects of their extraction, is critical for wise resource development and management.

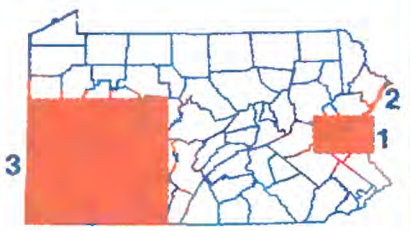
The Nation's ability to make informed decisions about energy- and mineral-resource needs and land use requires current, unbiased information on the occurrence, quantity, quality, and availability of nonrenewable resources. Through the collection of high-quality data and maintenance of standardized data systems, the USGS responds to requests for objective scientific information that management agencies rely on when making decisions about resources.

GEOLOGIC MAPPING

USGS bedrock and surficial geologic maps are used to study water contamination, resource availability, environmental effects of mineral extraction, hazard mitigation, and land-use management. The USGS, in cooperation with the Pennsylvania Topographic and Geologic Survey and Bloomsburg University of Pennsylvania, is preparing surficial and bedrock geologic maps of the Allentown 1:100,000 quadrangle and component 1:24,000 quadrangles. These maps and derivative products are being used by the Joint Planning Commission-Lehigh and Northampton Counties to develop wellhead-protection strategies. The USGS also is cooperating with the National Park Service at the Delaware Water Gap National Recreation Area (fig. 28) by supplying and interpreting geologic data for public outreach, training of park rangers, and park management.

MINERAL-RESOURCE INFORMATION

The USGS Mineral Resource Data System (MRDS) is a digital database of more than 110,000 mineral sites worldwide, providing information for Federal and state agencies, industry, and the public. The MRDS contains information on iron, limestone, sand, and gravel deposits for 800 Pennsylvania sites. A CD-ROM version of the database is available.



1 Allentown Quadrangle
2 Delaware Water Gap
3 Pittsburgh coal beds

NATIONAL COAL ASSESSMENT OF THE APPALACHIAN BASIN

The USGS is reassessing the largest-producing coal beds and coal zones in five critical areas of the Nation, including the Appalachian Basin. This project uses USGS data and expertise and state geological surveys to produce digital coal-resource assessments using geographic information system (GIS) software. The assessments emphasize the coal's quantity and quality, including ash yield, sulfur content, calorific value, and chemical concentrations.

The Northern and Central Appalachian Basin is the largest-producing coal region in the United States. About one-half of the region's coal comes from eight coal beds or zones, of which three are in Pennsylvania—the Pittsburgh and Upper Freeport coal beds and the Kittanning coal zone (figs. 29 and 30). Assessments of the Upper Freeport coal bed and the Kittanning coal zone are scheduled for completion by 1999. The Pittsburgh Coal bed assessment is expected to be completed in 1997. This bed ranks as the second-largest producing coal bed in the Nation.

All nonconfidential records in the stratigraphic and geochemical databases, original and remaining resource calculations, production statistics by state by county, and digital maps at a scale of 1:250,000 or 1:500,000, including mined areas, coal thickness, coal structure, and overburden thickness are scheduled to be released on the World Wide Web in early 1998. A GIS-derived map of the combined original extent and mined area for the Pittsburgh coal bed in Pennsylvania is shown in figure 31. This information will be combined with digital spatial data on coal isopachs and coal bed structure to calculate the remaining coal resources.

Figure 28. Delaware Water Gap. View looking upstream.

Figure 30. Coal beds and overburden.

Figure 29. Coal mining is a major industry in Pennsylvania.

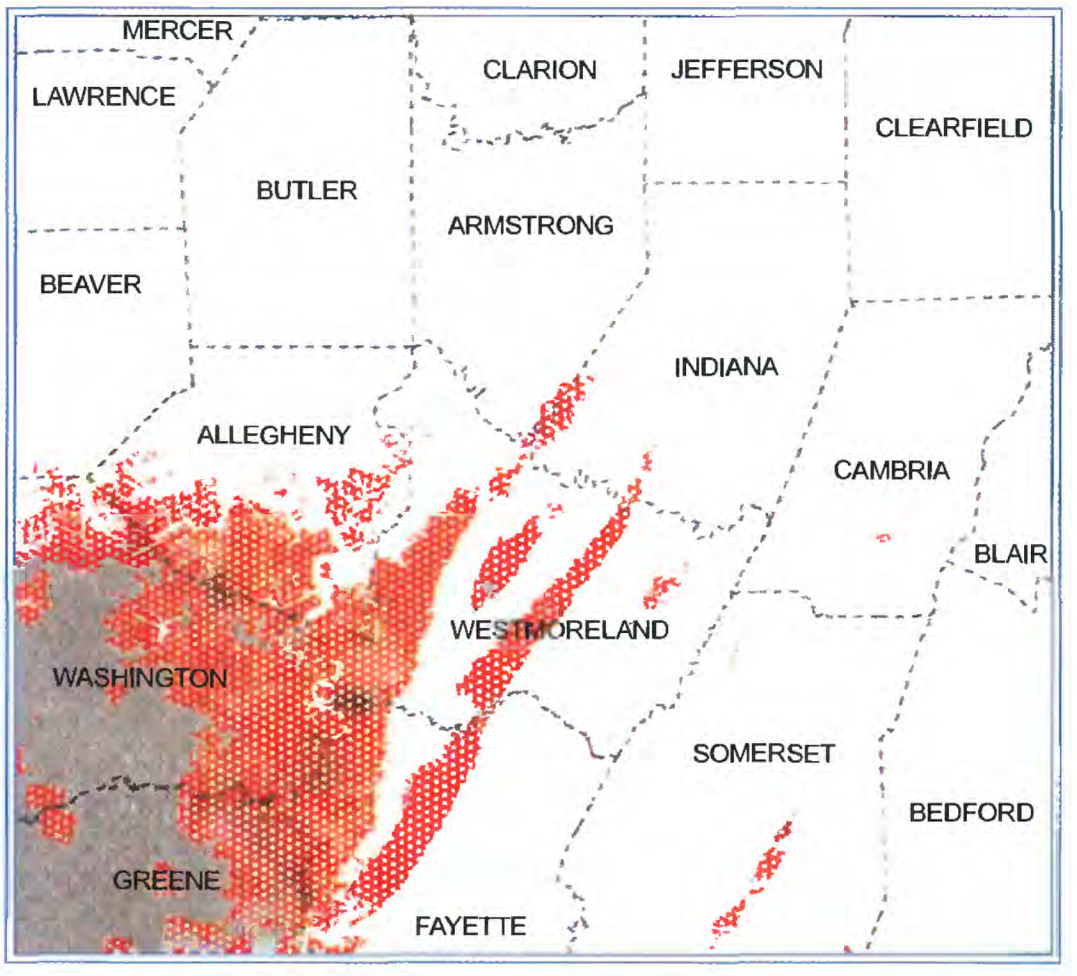


Figure 31. Unmined areas (grey) and mined areas (red) of the Pittsburgh Coal bed in Pennsylvania.

CARTOGRAPHIC PRODUCTS AND GEOGRAPHIC INFORMATION SYSTEMS

Accurate map data in graphic and digital forms, and geographic information systems, are essential tools for resource planning and management.

The USGS National Mapping Program strives to ensure the public availability of map data in graphic and digital forms through timely data collection and revision procedures. For many parts of Pennsylvania, USGS cartographic products are the only spatial-data framework available for resource management and disaster mitigation. These products include base maps documenting natural and constructed features, special purpose maps, digital data, and remotely sensed data. The USGS also is the principal Federal agency responsible for coordinating geographic information system (GIS) coverages and developing standards for cartographic and digital spatial data.

AVAILABILITY OF CARTOGRAPHIC DATA

Among the most popular USGS products are the 1:24,000-scale topographic maps, of which 876 cover Pennsylvania. These maps are available to resource managers, decision makers, and the general public for technical applications and general uses such as hiking and camping. Other topographic products, generally designed for more specialized purposes, include false-color composites produced from multispectral scanners, such as those on Landsat satellites, and land-use and land-cover maps.

Natural resource conservation activities, while fostering economic development, have become increasingly dependent on the use of digital spatial data. Digital data sets are being prepared to provide a comprehensive suite of spatial information to resource managers and scientists. The USGS and the Commonwealth have maintained long-standing agreements to collect and revise base cartographic data statewide. As a result, Pennsylvania is unique among the states in having available two USGS digital data sets with statewide coverage—digital raster graphics (DRG) and digital elevation models (DEM). A DRG is a scanned image of a topographic map that retains the map's positional accuracy. A DRG can be the basic reference layer for a GIS, allowing digital spatial data to be overlain or integrated with a high degree of accuracy. A DEM is an array of regularly spaced elevations. Among other uses, DEM's have been used to develop hydrologic models, help determine landslide probability, and assist in forest fire control.

From 1992 to 1994, the USGS, in cooperation with the (now) Pennsylvania Department of Conservation and Natural Resources, completed aerial photographic coverage of the Commonwealth. This coverage is being used to prepare digital orthophotoquads (DOQ). DOQ's combine the image characteristics of a photograph with the geometric qualities of a map (fig. 32). DOQ's have been completed for 25 counties in Pennsylvania (fig. 33); DOQ's for the remainder of Pennsylvania are scheduled for completion in late 1998. DOQ's commonly are used in GIS databases and for revising out-of-date maps.

APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS TECHNOLOGY

GIS technology has been applied to hydrologic data for Pennsylvania to plot discharge permit locations, assess the severity and distribution of corrosive ground water, delineate mine drainage locations, and determine ground-water availability. GIS technology also has been applied to regional water-quality studies, particularly those concerned with evaluating factors that affect water quality in Chesapeake Bay.

Figure 32. Example of a digital orthophotoquad.

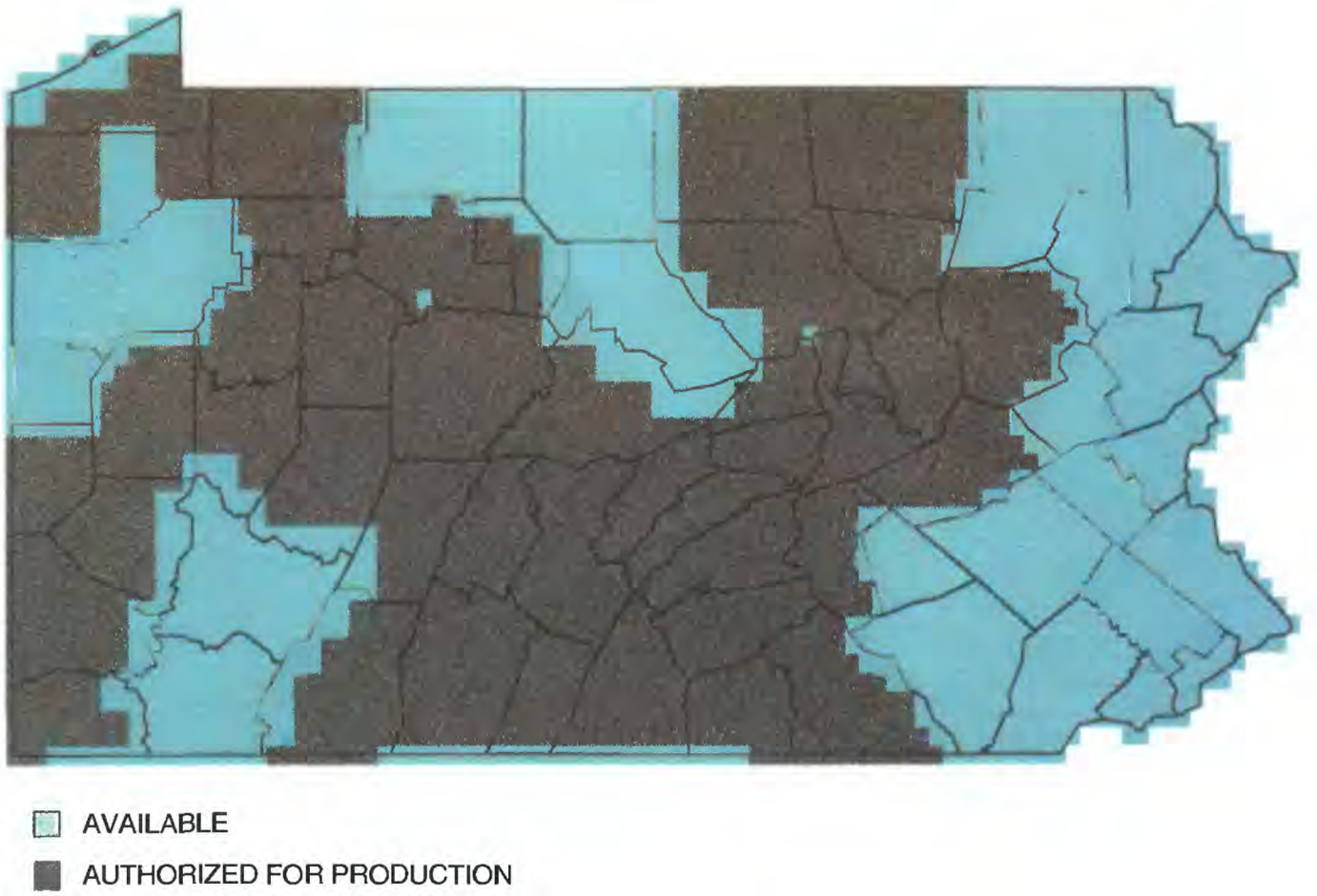


Figure 33. Status of digital orthophotoquad coverage for Pennsylvania at 1:12,000 scale, 1997.

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New Jersey Zinc Company mine at Friedensville, Pa., Lehigh County, 800 feet below land surface.

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Dr. Gordon P. Eaton
Director, U.S. Geological Survey
February 23, 1995

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- Stabilization & Conservation Service

U.S. Department of the Army
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  - Baltimore
  - Pittsburgh
  - Philadelphia
- Construction Engineer Research Lab
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Department of Commerce
- National Oceanic and Atmospheric Administration
  - National Weather Service

U.S. Department of the Interior
- Bureau of Reclamation
- National Park Service
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BASIN COMMISSIONS

Delaware River Basin Commission
Susquehanna River Basin Commission

STATE

Delaware Department of Natural Resources and
- Environmental Control
- Division of Soil and Water Conservation

Delaware Geological Survey
Maryland Department of Natural Resources
New York State Department of Environmental Conservation
Pennsylvania Department of Agriculture
Pennsylvania Department of Environmental Protection
- Bureau of Mining and Reclamation
- Bureau of Watershed Conservation
- Bureau of Water Quality Protection
- Bureau of Water Supply Management

Pennsylvania Department of Conservation and Natural Resources
- Bureau of Topographic and Geologic Survey

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LOCAL

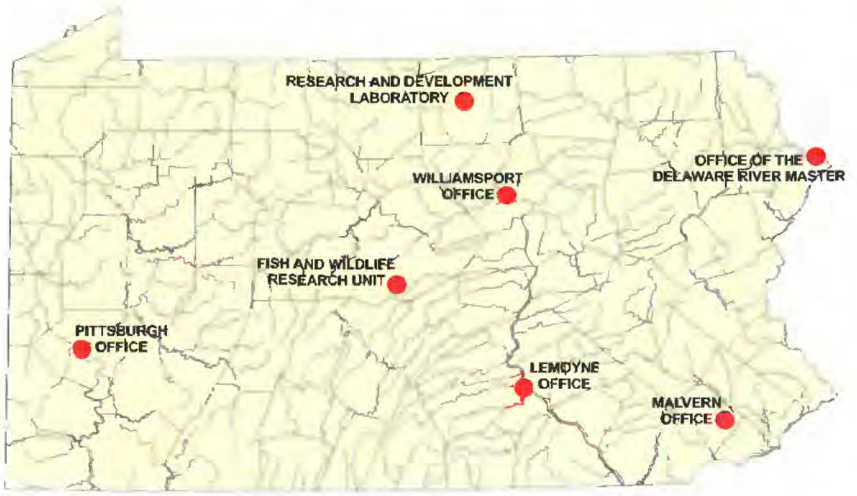
Academy of Natural Sciences of Philadelphia
Adams County Board of Commissioners
Alliance for the Chesapeake Bay
Berks County
Bucks County
Chester County Water Resources Authority
City of Allentown
City of Bethlehem
City of Cumberland, Maryland
City of Harrisburg
City of Philadelphia
City of Reading
City of Sunbury Municipal Authority
City of Williamsport
Delaware County Solid Waste Authority
Doylestown Township Municipal Authority
Erie County Department of Health
Fairfax County Water Authority, Virginia
Harmony Water Authority
Hazleton City Authority Water Department
Indiana County Commissioners
Indiana County Municipal Authority
Jefferson County
Joint Planing Commission-Lehigh and Northampton Counties
Lancaster County Planning Commission
Letort Regional Authority
Luzerne County Emergency Management Agency
Media Borough Water Department
Neshaminy Water Resources Authority
New Oxford Municipal Authority
North Penn Water Authority
North Wales Water Authority
Oley Township
Pike County Planning Commission
Roaring Spring Municipal Authority
Somerset Conservation District
Tinicum Township
Town of Bloomsburg
Township of West Bradford
Union County Commissioners
University Area Joint Authority
Warren County Commissioners
Warwick Township

Covered bridge over Cabin Run near Smith's Corner, Plumstead Township, Bucks County, Pa.

Headwaters of the Swatara Creek, Schuylkill County, Pa.

FOR MORE INFORMATION

Pennsylvania USGS office locations shown with river system



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http://www.usgs.gov/

Information on streamflow and USGS programs and activities in Pennsylvania can be found by accessing the Pennsylvania District Home page on the World Wide Web at:

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Map status by quarter quadrangle can be viewed at:

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Map status for digital orthophotoquads can be viewed at:

ftp://www.nmd.usgs.gov/pub/doi_high_priority/html/doq_stat.htm

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