

# Delaware

## Water-Quality Assessment of the Delmarva Peninsula

The effect of human activity on water quality is an important and visible national environmental issue. In response to this concern, the U.S. Geological Survey (USGS) is conducting the National Water-Quality Assessment (NAWQA) Program, a comprehensive assessment of water quality in 59 large regions across the Nation. The Delmarva Peninsula, which contains most of Delaware, is one of the study areas included in the NAWQA Program. The USGS is working with Federal, State, and local agencies that conduct water-resources research, regulate water

quality, and manage water resources. The Delmarva Peninsula study has provided useful information on the relation of water quality to residential and agricultural land-use practices. In 1991, study results indicated that concentrations of fertilizer-derived nitrate in shallow ground water vary across the region with differences in geology, soil chemistry, and land use. High concentrations of nitrate in shallow ground water are more common in upland areas, where soils are well-drained and sandy, and land use is primarily agricultural. Nitrate currently in the Delmarva ground-water system will continue to discharge into streams through springs and seeps for many years. Pesticides

were detected in the 1991 samples at very low concentrations (less than 1 microgram per liter) in shallow ground water from many wells near agricultural fields. Pesticide concentrations were below detection limits in samples collected in 1991 from the lower part of the surficial aquifer in the Delmarva Peninsula and in the underlying confined aquifers (fig. 1). A new NAWQA study, scheduled to start in 1999, will build upon the earlier results, and attempt to define the relations between land-surface properties and water quality. Factors such as forest cover, types of agriculture, land-surface slopes, natural and artificial drainage patterns, and underlying geologic properties can

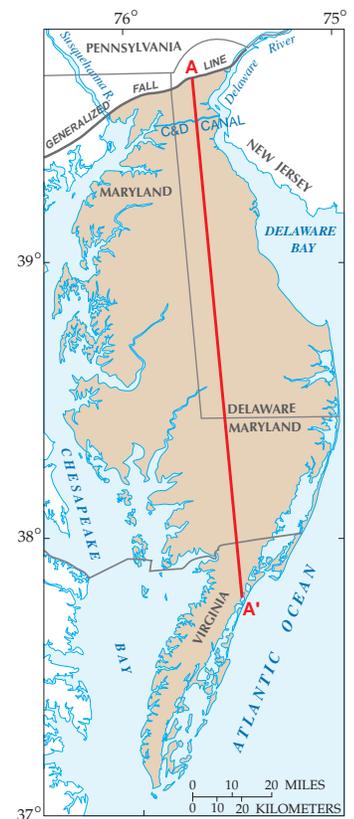
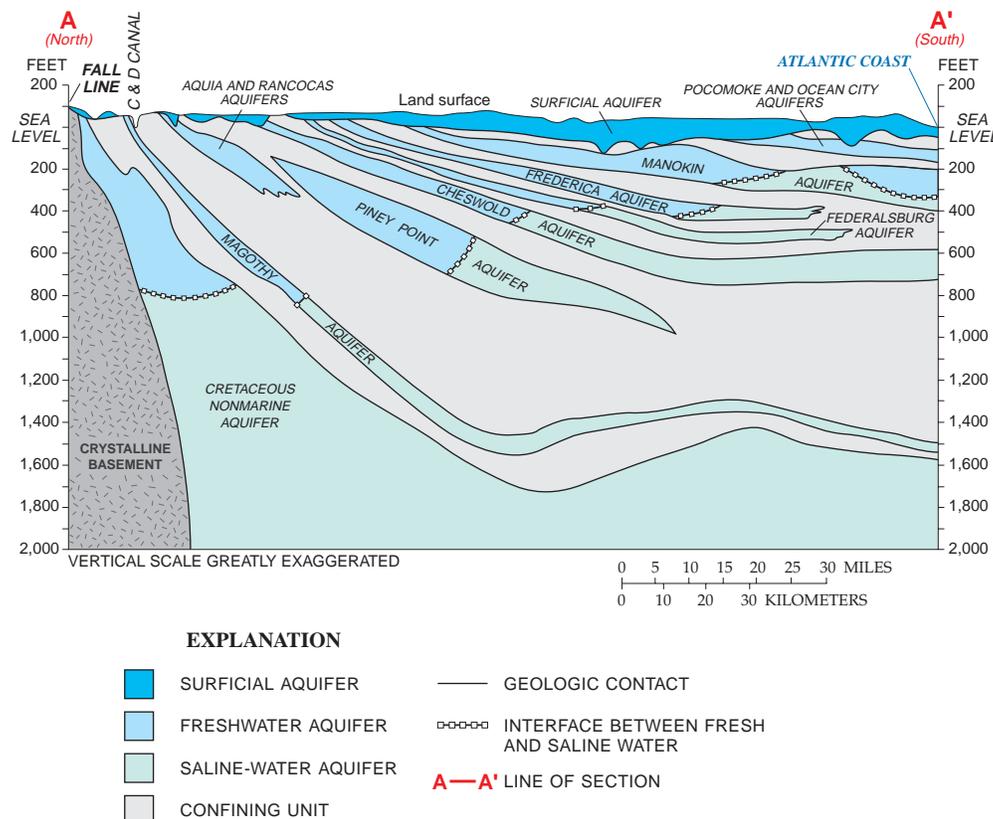


Figure 1. Generalized north-south geologic cross section of the Delmarva Peninsula, showing major aquifers.

have a significant effect on ground-water quality.

## Environmental Studies at Dover Air Force Base

Since World War II, Dover Air Force Base in Delaware has been a center for military air-cargo operations on the East Coast of the United States. The base has ground-water contamination resulting from past fuel spillage, disposal of degreasing solvents, and the burial of hazardous materials in landfills.

The USGS is providing multi-disciplinary technical assistance to the U.S. Air Force to monitor soil and ground-water contamination on the base, and to assess ground-water-flow rates and directions. The Air Force remediation procedures approach the problem in one of two ways: either by retrieving the material from the ground by pumping wells or excavating soil, or by allowing the contaminants to attenuate naturally as they are transported by ground water toward the boundaries of the base. Attenuation processes include the dilution and dispersion of contaminants in ground water to low levels, adhesion of pollutants onto mineral



Figure 2. USGS personnel install a water-level gage in a dredge pond near Dover Air Force Base.

grains in the soil and rocks, and microbial breakdown of hazardous compounds into harmless chemicals.

At Dover Air Force Base, the USGS is installing monitoring wells, sampling and analyzing ground water and soil, determining the natural capacity of geologic materials to attenuate contaminants, and developing computer models of ground-water flow and pollutant transport on the base. The results of these studies have shown that natural attenuation is a viable remediation process for decreasing contaminant concentrations to levels considered acceptable by the U.S. Environmental Protection Agency (EPA) before the contaminants are transported beyond the base boundaries.

## Streamflow, Ground-Water, and Water-Quality Information

Information about the amount and quality of ground water and surface water is vital to the citizens of Delaware. Most of the water supply in the urbanized northern part of the State comes from surface reservoirs, whereas drinking water in central and southern Delaware is supplied primarily by wells. Floods and droughts affect agriculture and the economy, and threaten public safety. State, county, and local planning officials use hydrologic data from the USGS for water management and for the design of roads and bridges.

The USGS operates a network of 15 long-term streamflow-gaging stations, 6 tidal gages, and numerous water-level recorders in wells to collect data needed for assessing and evaluating hydrologic conditions. Most of these gages are operated in cooperation with the Delaware Geological Survey (DGS), Delaware Department of Transportation (DelDOT), Delaware Department of Natural Resources and Environmental

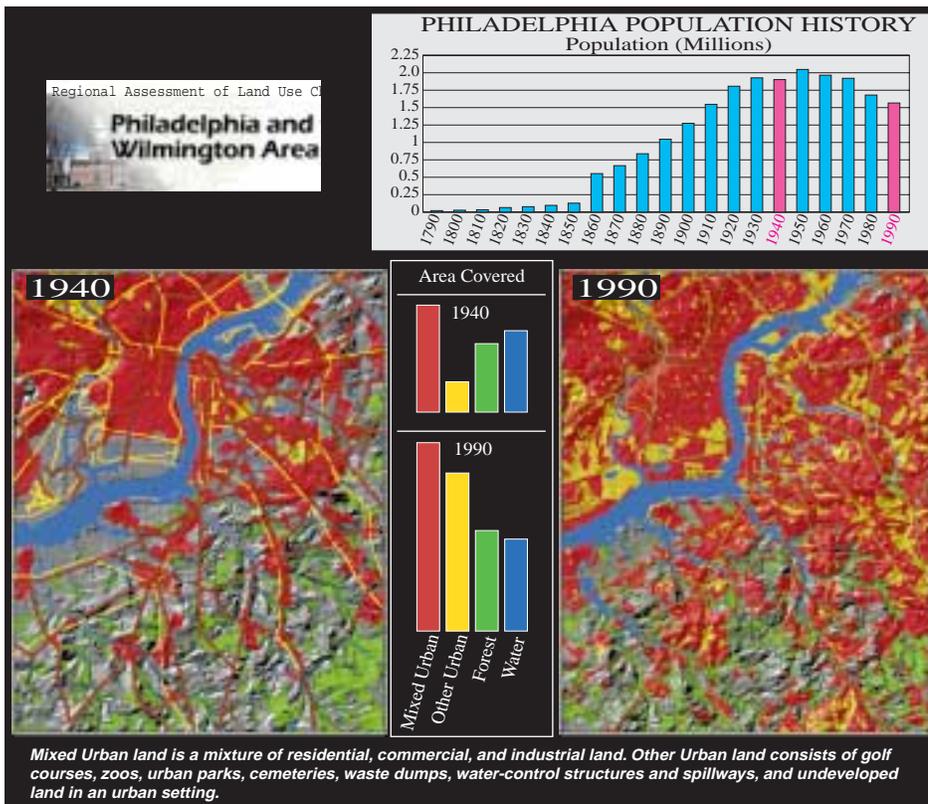
Control (DNREC), EPA, and the U.S. Army Corps of Engineers. Stream-flow data from many of these gages are available in real time on the World Wide Web.

Ground water in Delaware is produced from porous and permeable geologic formations known as aquifers that are separated by low-porosity, relatively impermeable confining layers. Alternating layers of confining units and aquifers dip gently to the southeast below an unconfined surface aquifer composed primarily of sands and gravels (fig. 1). The quality of water in a well can be affected by a number of factors, including ground-water-flow paths into the well and minerals within the aquifer. The USGS is participating in the Delaware Source-Water Assessment and Protection Program with State, Federal, and local agencies, and other interested parties to develop a plan to delineate source areas in Delaware and identify potential sources of contamination.

The USGS is cooperating with DGS and DNREC to address nutrient loading through direct measurements of surface water into Rehoboth, Indian River, and Little Assawoman Bays. USGS work with DelDOT provides the State agency with information on flood magnitude and frequency, which is used in designing and maintaining highway bridges. Water-level measurements in natural and created wetlands also are obtained for DelDOT to determine the effect of road construction on marshy areas and swamps.

## Regional Assessment of Land-Use Changes

The rapid increase of urbanization in the United States has affected the environment, leading to problems for both the local urban population and the global environment. Cities



Figures 3A and 3B. Areal changes around Philadelphia, Pa. from 1940 to 1990.

consume large quantities of energy and produce concentrated pollution. Decreased vegetation leads to climatic and atmospheric changes, which together with higher noise and physical stress levels affect human health and animal habitat. Impermeable ground cover allows less infiltration of water and puts people and property at risk from flooding.

To study the nature and effects of urban growth, the USGS implemented the Urban Dynamics Program, in which the unique problems of cities and their surrounding areas are investigated. One of these study sites is the Philadelphia-Wilmington-Trenton metropolitan area. This study builds on earlier research that mapped urban land-use change for the San Francisco Bay area and the Baltimore-Washington region. USGS researchers converted topographic maps of the area dating from 1940 to 1990 to digital form to create a data base of land-use change. The resulting data layers include those for

urban or built-up land, transportation, hydrography, slope, and woodland areas. The data base is used with digital visualization techniques to display urban growth over time and to show the growth of the metropolitan area. This provides a picture of the urban dynamics in the Philadelphia-Wilmington-Trenton corridor.

The data are being applied to an urban growth model that is calibrated by comparing the modeled projections of urban expansion at chosen years to the data base described above. This model, developed by the



Figure 4. Horseshoe crab on the beach.

USGS and the University of California at Santa Barbara, will be applied to other cities to predict potential urban growth patterns. This study is intended to assist those involved in understanding the effects of historical and future urban growth on regions surrounding major metropolitan areas.

An understanding of where and when urban growth is likely to occur helps planners anticipate and plan for the mitigation of environmental impacts. The Urban Dynamics Program is intended to contribute information to help solve problems involving urban sprawl, ground water, patterns of shifting land surface, and hydrologic and climatic temperature models.

### Horseshoe Crab Population Monitoring in Delaware Bay

The horseshoe crab supports a fishery of growing value in the Mid-Atlantic region. In the Delaware Bay area, horseshoe crab eggs constitute a critical resource for migrating shorebirds, which stop every spring to replenish energy reserves before continuing on to breeding grounds in northern Canada.

Horseshoe crabs also have commercial value stemming from their use as bait and their use in medical research. Increased harvesting of horseshoe crabs during the past decade has prompted concern for the sustainability of this valuable ecological and commercial resource. In 1996, USGS scientists began a study to determine how and when horseshoe crabs used beaches for spawning. The goal was to develop a consistent sampling procedure that would provide a measurement for use in population monitoring. The researchers found considerable variation in spawning activities associated with water depth, tidal cycle, and moon phase. Preliminary analysis suggests that surveys

should be concentrated in the shallowest waters, and be carried out on the higher of the two daily high tides, immediately following a new or full moon when tides are at their highest.

### **Effects of Snow Geese on Food Resources for Migratory Shorebirds**

Populations of North American snow geese are increasing, leading to high winter concentrations of the birds at several National Wildlife Refuges along the Atlantic Flyway. Wintering snow geese feed extensively on the emergent shoots of marsh plants. This feeding habit can dramatically alter the plant communities of tidal marshes and freshwater impoundments, and even convert large vegetated areas to mud flats. Thus, the geese may help to create the kinds of habitats favored by migratory shorebirds. It is still uncertain, though, how removal of vegetation and disturbance of the soil surface by snow geese affect the numbers and availability of subsurface invertebrates upon which shorebirds feed. At Prime Hook National Wildlife Refuge in Delaware, USGS scientists have been studying how the foraging of geese affects habitat quality for shorebirds. Preliminary results suggest that invertebrate populations may decrease in areas where geese have foraged extensively. Invertebrate densities may remain low for long periods of time due to reduced rates of emergence and reproduction of plants. These results are important for wildlife managers trying to maintain habitat for both geese and shorebird populations.

### **Structural Geology in Delaware**

USGS geologists are developing a cooperative program with DGS geologists to provide detailed information on the age, structure, and distribution of deformed and metamorphosed sedimentary and igneous crystalline rock types that make up the Delaware Piedmont. Information obtained from detailed structural analyses, dating the time sequence of events in the Earth's history, and determining the intensity of crustal deformation will be integrated into the 1:24,000-scale quadrangles being mapped by DGS geologists. Integration of map and analytical data is intended to provide a complete picture of the complex crust that underlies the State. This information is important for understanding ground-water movement, water chemistry, source-water protection, and potential geologic hazards.

### **Cooperative Programs**

The DGS is the official point of contact for cooperative programs between the USGS and the State of Delaware. The USGS is an active participant on the Delaware State Mapping Advisory Committee to help DGS assess the cartographic and data

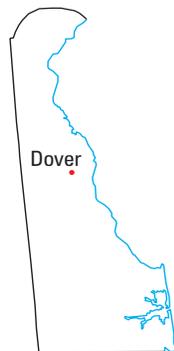
needs of the State. In cooperation with the USGS, Delaware recently became one of the first States to offer full mapping coverage using digital line graphs, which allow overlays of different features such as land use, roads, vegetation, and manmade structures on a topographic base. USGS activities in Delaware conducted in cooperation with other agencies include water-resource data collection and water-quality assessments. Past studies have included water availability, ground-water-flow modeling, investigation of potential saltwater intrusion into aquifers, relation of wetlands to surface- and ground-water quality, and documentation of floods.

For information on geologic and hydrologic reports published by the State of Delaware, and to obtain USGS map products (including topographic maps, images, and digital data) contact the Delaware Geological Survey, DGS Building, University of Delaware, Newark, DE 19716, (302) 831-2833, e-mail at [dgs@mvs.udel.edu](mailto:dgs@mvs.udel.edu), or visit their web site at <http://www.udel.edu/dgs/dgs.html>. Additional information about USGS programs and activities in Delaware can be found on the web at: <http://md.usgs.gov>.

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### **USGS office locations**

The USGS has 19 employees in Delaware



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### **USGS State Representative**

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### **USGS Home Page**

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