A TEACHER'S GUIDE TO THE WATERSHEDS OF GLOUCESTER COUNTY

a guide for upper elementary and middle school teachers

Prepared by:

Delaware Valley
Regional Planning
Commission

Prepared for:

The Federation
of Gloucester County
Watersheds
and
Rowan University

A TEACHER'S GUIDE

Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty and intercity agency that provides continuing, comprehensive and coordinated planning to shape a vision for the future growth of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia, in Pennsylvania; and Burlington, Camden, Gloucester and Mercer counties in New Jersey. DVRPC provides technical assistance and services; conducts high priority studies that respond to the requests and demands of member state and local governments; fosters cooperation among various constituents to forge a consensus on diverse regional issues; determines and meets the needs of the private sector; and practices public outreach efforts to promote two-way communication and public awareness of regional issues and the Commission.

Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

This *Teacher's Guide* was funded by 1) Rowan University as part of the project *The Rowan University Community Partnership: Bridging Environmental Information to the Community*, funded by the United States Environmental Protection Agency; 2) the Federation of Gloucester County Watersheds as part of the project *Building Watershed Awareness in Gloucester County*, funded by the Stony Brook - Millstone Watershed Association's Watershed Institute Grant program; 3) the Tri-County Water Quality Management Program administered by the Delaware Valley Regional Planning Commission. The author is solely responsible for the Guide's findings and conclusions, which may not represent the official views or policies of the funding agencies.

ACKNOWLEDGEMENTS

The Delaware Valley Regional Planning Commission produced *A Teacher's Guide to the Watersheds of Gloucester County* for Rowan University and The Federation of Gloucester County Watersheds. Funding was provided by:

Rowan University as part of the project *The Rowan University Community Partnership: Bridging Environmental Information to the Community,* funded by the United States Environmental Protection Agency, grant number 98280603

The Federation of Gloucester County Watersheds as part of the project *Building Watershed Awareness in Gloucester County*, funded by the Stony Brook - Millstone Watershed Association's Watershed Institute Grant program

The Tri-County Water Quality Management Program administered by The Delaware Valley Regional Planning Commission

The model for this publication is the ***Teacher's Guide to the Great Swamp Watershed*** by Maureen Cremeans, Karen Parrish, and Karen Patterson, published by The Great Swamp Watershed Association, New Vernon, NJ, 2000. Sections of the information, many of the illustrations, and the layout from that Guide were used in this version. We extend special thanks to the authors and to the Great Swamp Watershed Association for permission to utilize and modify their excellent publication. Additional information has been obtained from reference works, from members of the Advisory Committee and other local individuals, and from web sites and print resources of environmental organizations and governmental agencies. Thanks also go to Alison Hastings, DVRPC, and Stephanie Potts, DVRPC intern, for their extensive work on the Guide, to Hollace Hoffman for her helpful review, and to Michael A. Hogan for his fine photographs.

Advisory Committee for the Project

Christine Nolan, The Federation of Gloucester County Watersheds
Robert Fonash, New Jersey-American Water Company, retired
Carolyn Grasso, Logan Township Elementary School
Dr. Jess Everett, P.E., Rowan University
Dr. John Hasse, Rowan University
Belinda Irizarry, Great Egg Harbor Watershed Association and the Federation of Gloucester County Watersheds
Dr. Kauser Jahan, P.E., Rowan University
Maggi Liebe, The Camden County Division of Environmental Affairs
Debbie Lord, The Pompeston Creek Watershed Association
Dr. DeMond Miller, Rowan University
Dave Orleans, Camden County Parks Department; County Naturalist
Dr. Joseph Orlins, P.E., Rowan University
Ted Pisciotta, Environmental Commission of Camden County
Jack Sworaski, Camden County Division of Environmental Affairs
Jill Taylor, Gloucester County Department of Parks and Recreation; County Naturalist
Joyce Trout, Union Valley Elementary School, Gloucester Township, Camden County
Rick Westergaard, Gloucester County Planning Division, Department of Public Works

Suzanne McCarthy, Delaware Valley Regional Planning Commission – Writer and editor

This Guide was developed for teachers of upper elementary and middle school classes, especially teachers of 4th through 8th grades. The printed Guide is free to Gloucester County teachers. The Guide is also available online and may be downloaded free of charge from the DVRPC website at www.dvrpc.org.

The Federation of Gloucester County Watersheds
P.O. Box 233
Glassboro, NJ 08028
856-478-2264
www.sjwatersheds.org

Rowan University
201 Mullica Hill Road
Glassboro, NJ 08028
www.rowan.edu

Delaware Valley Regional Planning Commission
The Bourse Building, 8th Floor
111 S. Independence Mall East
Philadelphia, PA 19106-2582
215-592-1800
www.dvrpc.org

Cover photo: Algonquin Lake on Oldmans Creek. Photo by Michael A. Hogan

A Teacher's Guide to the Watersheds of Gloucester County

Table of Contents

Chapter **Page**

1. INTRODUCTION

TO DO

For more information on Gloucester County history, resources, and events, see http://www.rootsweb.com/~njglouce/gchs/, which is the Gloucester County Historical Society and Genealogy web site.

The Tri-County Water Quality Management Board (Delaware Valley Regional Planning Commission), Rowan University, the Federation of Gloucester County Watersheds, and several other partners have prepared this teacher's resource guide so that area teachers can introduce their students to the natural and cultural resources of the watersheds of Gloucester County, helping to instill in them a sense of place and promoting stewardship of the environment. Learning about these resources will help students see the role we all play in our watershed, develop respect for their local environment, and learn about actions they can take to protect it.

This resource guide provides information on the following:

- Definitions of a watershed and the water cycle
- Location of the eight watersheds that are wholly or partly in Gloucester County, with maps and descriptions of each one
- The natural and human history of these watersheds
- A description of drinking water sources in Gloucester County
- Threats to the watersheds and to drinking water
- What you can do to protect Gloucester County water
- Teacher resources (local community groups, websites, activity guides, print resources, and watershed field trip destinations)
- A Glossary
- Appendices consisting of activities and lessons that teachers can utilize in the classroom
- A form for your evaluation of this Guide.

Many pages of the guide contain a sidebar with definitions of new terms, a "To Do" list of suggested activities that complement material on that page, and graphics that help illustrate the concepts being discussed.

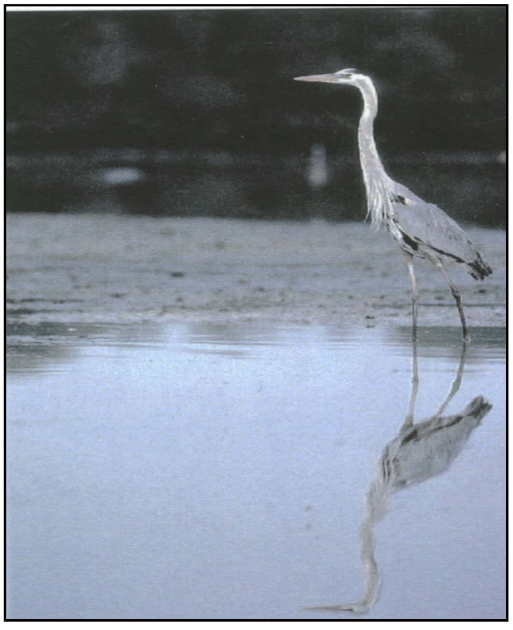
Various project partners of this guide provide education and outreach programs for area students and teachers. They are:

Contact the Scotland Run Nature Center, Scotland Run Park, Clayton, at 856/881-0845.

- The Gloucester County Department of Parks and Recreation offers watershed programs for all county schools. The Department operates the **Scotland Run Nature Center**, on Academy Street (County Route 610) in Clayton, which provides outdoor programs for students on water-related topics at its facility. The Nature Center offers various state-sponsored water-related workshops for teachers during the school year and upon request (including Project WET Watershed Education for Teachers). These programs and others are announced in the quarterly newsletter, the "Nature Network," which is available free of charge.
- **The Federation of Gloucester County Watersheds**, a countywide watershed association, provides information and assistance to teachers on watershed issues and on teaching about them. It can help in finding sites and conducting training for class water monitoring projects, and can also put teachers in touch with local individuals and resources. For contact information see Chapter 9. Teacher Resources – Local Organizations.

- **Rowan University** provides a variety of educational opportunities related to watershed science and engineering. Faculty and staff in Civil and Environmental Engineering, Geography, Sociology, and Biological Sciences conduct hands-on classroom activities, field trips, and presentations for audiences of all ages, from K-12 through adult education. Areas of faculty expertise include watersheds, water quality, dam safety, environmental science, sustainability, environmental justice, urban planning, and Smart Growth. Programs can be conducted in schools or on field trips upon teacher request. For contact information see Chapter 9. Teacher Resources – Local Organizations.
- **The Great Egg Harbor Watershed Association**, which is also part of the Federation of Gloucester County Watersheds, conducts educational programs for schools within the Great Egg Harbor River watershed. In Gloucester County, Monroe and Franklin Townships are partly within this watershed. For contact information see Chapter 9. Teacher Resources – Local Organizations.
- The Federation of Gloucester County Watersheds, with the Gloucester County Department of Parks and Recreation through Scotland Run Nature Center, administers a countywide **storm drain labeling program** that can be utilized by classroom students. See Appendix G. Storm Drain Labeling.
- The Gloucester County Parks Department in conjunction with the Federation of Gloucester County Watersheds and other partners sponsors **WaterFest**, an annual festival of water-related activities, exhibitors, environmental crafters, and live animal presentations, held on the first Sunday in June in Scotland Run Park in Clayton. It is free of charge to all. Call Scotland Run Nature Center for information.

A Great Blue Heron



Source: Teacher's Guide to the Great Swamp Watershed

2. THE WATER CYCLE

DEFINITIONS

Water cycle: Also known as the hydrologic cycle, this refers to the paths that water takes in its various states – vapor, liquid, and solid – as it moves throughout Earth's systems (oceans, atmosphere, groundwater, streams, etc.)

Aquifer: An underground bed of saturated sediment or rock that yields significant quantities of water.

Groundwater: Water found in spaces between sediment particles underground (located in the zone of saturation).

Evapotranspiration: The return of moisture to the atmosphere by the evaporation of water from the surface and by transpiration from vegetation.

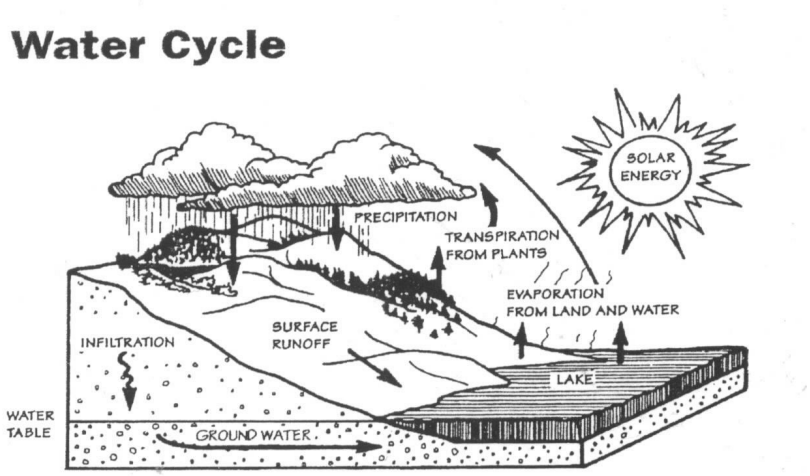
Transpiration: The process by which water that is absorbed through plant roots is returned to the atmosphere from the leaves.

TO DO

Have students participate in the *An Incredible Journey* activity (**Appendix A**) to learn how water moves through their local watershed.

The Earth's supply of fresh water is a precious, and very limited, resource. Although 75 percent of the Earth's surface is covered by water, less than 3 percent of that water is fresh, and only one half of 1 percent (0.5) is readily accessible for human use.

Water continuously moves from the atmosphere to the land to the oceans and back to the atmosphere in what is known as the hydrologic or water cycle. After precipitation falls (in the form of rain, snow or ice), it may immediately begin to evaporate from the ground surface, plants and trees, or water bodies, back into the air. A small percentage will run off into streams and rivers, eventually making its way to the oceans. Most of the water soaks into the ground, where it either replenishes shallow aquifers that sustain streams and springs, or seeps into deeper aquifers that serve as large underground reservoirs of freshwater. Water may remain in deep aquifers for centuries or millennia, gradually moving toward and into the Delaware River and the sea, where it evaporates again into the atmosphere.



Source: Project WET: Curriculum and Activity Guide, p. *119*

Despite the fact that water is constantly moving through the hydrologic cycle and being recycled, it is not necessarily being returned to its prior pristine state. Humans interfere with the basic processes of the water cycle in a number of ways. These interferences include depleting groundwater supplies, paving over the land surface, and releasing pollutants onto the land where they can seep into groundwater and run off into local streams. Once polluted or degraded, it is very difficult to restore water to the standards that must be met for use by humans and wildlife. Thus pollution prevention is the most efficient and effective way to protect our water quality.

Source: DVRPC

3. WHAT IS A WATERSHED?

DEFINITIONS

Drainage basin: A large watershed encompassing the watersheds of many smaller rivers and streams and draining to a major river, estuary, or lake.

Watershed: The land area from which surface runoff drains into a particular stream channel, lake, river, or other body of water.

Sub-watershed: The land area draining to the point where two smaller streams combine together to form a larger, single stream.

Catchment: The smallest watershed area, usually defined as the area that drains an individual site, such as a school or small neighborhood, to its first intersection with a stream.

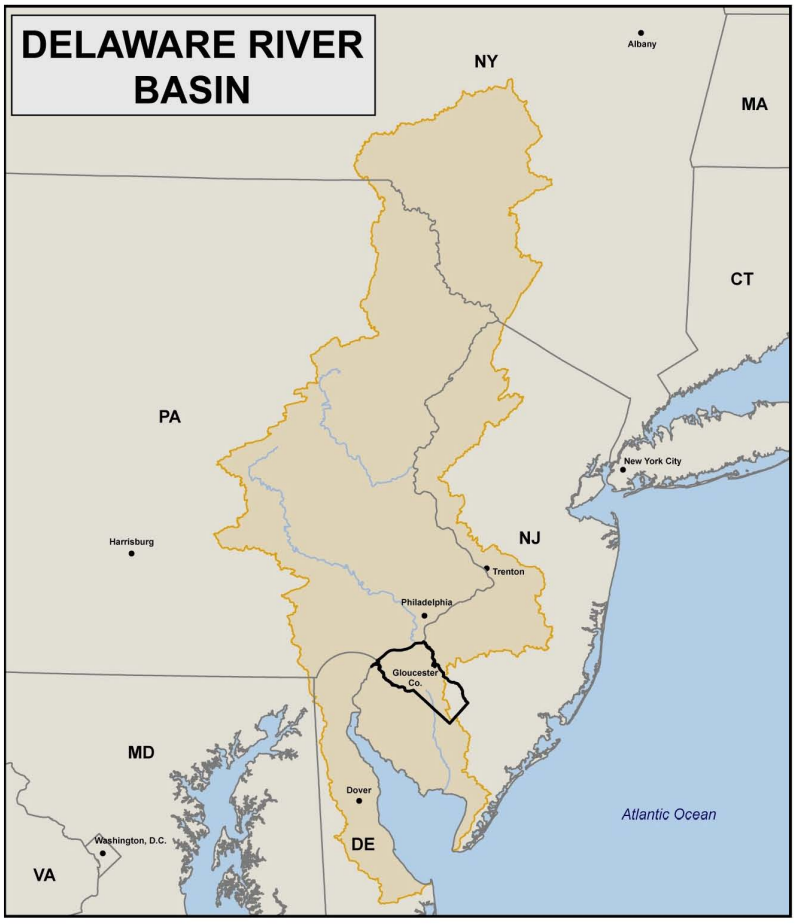
TO DO

Have students create their own watershed (**Appendix 2**), and/or invite the Scotland Run Park naturalist (Gloucester County Department of Parks and Recreation) to your classroom to demonstrate watershed concepts and pollution with its 2'x 4' watershed model. For contact information, see **Teacher Resources** –Local Organizations.

A watershed is any area of land that drains into a common water body such as a stream, river, lake, or wetland. Each watershed is separated from other watersheds by high points in the terrain, such as hills and ridges. A watershed includes not only the water body or waterway itself, but also the entire land area that drains into it. A watershed may be very small, like the drainage formed by your own driveway, or very large, like the drainage basin of the Delaware or Mississippi Rivers. Depending on the size of a watershed, it may be referred to as a drainage basin, watershed, sub-watershed, or catchment.

New Jersey's rivers and streams flow either to the Atlantic Ocean or to the Delaware River and Bay. They are thus in either the Atlantic drainage or the Delaware River watershed. In Gloucester County, all except one of the streams and rivers flow to the Delaware.

The Delaware River watershed is 13,000 square miles in size and covers parts of four states – New York, New Jersey, Pennsylvania, and Delaware. Although the watershed occupies only 1 percent of the land of the United States, it supplies water to 10 percent of the U.S. population. Many small municipalities and large metropolitan centers get all or part of their drinking water from the river, including Philadelphia, Trenton, and New York City, which obtains its water from reservoirs located in the headwaters of the Delaware.



Source: DVRPC

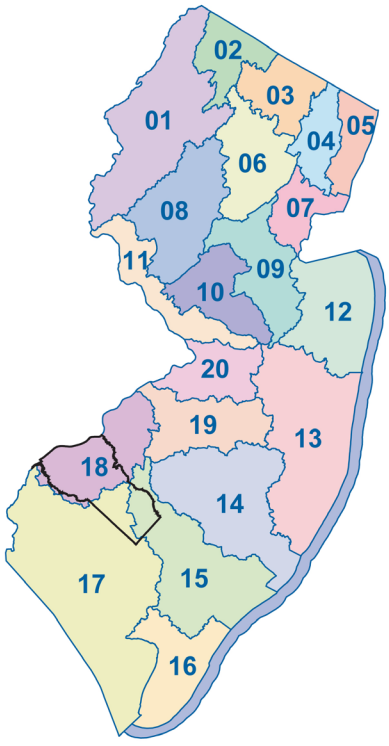
What is a Watershed?

All land—including our neighborhoods, commercial and industrial areas, forests, and parklands—is in one watershed or another. Each watershed is a dynamic and unique place, where our natural resources, such as soil, water, air,

plants, and animals, interact in a complex web. Yet, everyday activities can impact these resources, ultimately affecting our own health, well-being, and economic livelihood.

In New Jersey, the Department of Environmental Protection monitors and manages our natural resources on a watershed basis. The state has been divided into 20 Watershed Management Areas (WMAs). The watersheds in Gloucester County are part of three Watershed Management Areas:

- WMA 15 – Great Egg Harbor, Tuckahoe
- WMA 17 – Maurice, Salem, and Cohansey
- WMA 18 – Lower Delaware Tributaries



NEW JERSEY
Watershed Management Areas

01 - Upper Delaware
02 - Wallkill
03 - Pompton, Wanaque, Ramapo
04 - Lower Passaic and Saddle
05 - Hackensack and Pascack
06 - Upper Passaic, Whippany, and Rockaway
07 - Arthur Kill
08 - North and South Branch Raritan
09 - Lower Raritan, South River, and Lawrence
10 - Millstone
11 - Central Delaware
12 - Monmouth
13 - Barnegat Bay
14 - Mullica
15 - Great Egg Harbor
16 - Cape May
17 - Maurice, Salem, and Cohansey
18 - Lower Delaware
19 - Rancocas
20 - Assiscunk, Crosswicks, and Doctors

Source:NJDEP

4. THE WATERSHEDS OF GLOUCESTER COUNTY

TO DO

Make photocopies of the black and white version of the map of the Watersheds of Gloucester County and of the individual watershed maps appropriate for your town/township (in this **Chapter**) and ask students to locate their "watershed address."

TO DO

Have students carry out the activity *What's Your Watershed Address?* (**Appendix C**) to become familiar with their local waterways and their community.

There are eight watersheds that are wholly or partially within Gloucester County. Two of these consist of the headwater streams of two large river systems. These watersheds occupy 39.2 percent or 131.6 square miles of Gloucester territory. They are:

- The Great Egg Harbor River watershed
- The Maurice River watershed

The Great Egg Harbor River flows southeast and empties into the Atlantic Ocean. The Maurice River flows south to the Delaware Bay.

The U.S. National Park Service has designated both of these rivers as national Scenic and Recreational Rivers, because of their importance to the nation's cultural and natural heritage. Such rivers are generally free flowing and relatively undeveloped and have features that are "outstandingly remarkable" for their scenic or recreational value.

The other six watersheds in Gloucester County have streams that flow northwestward to the Delaware River. These six smaller watersheds make up 60.8 percent or 204.3 square miles of Gloucester County. They are, from north to south:

- The Big Timber Creek watershed, two-thirds of which is located in Camden County
- The Woodbury Creek watershed
- The Mantua Creek watershed
- The Repaupo Creek watershed
- The Raccoon Creek watershed
- The Oldmans Creek watershed, half of which is within Salem County.

Gloucester County Towns and Their Watersheds

Municipality	**Watersheds**	**% of acreage in watershed**
Clayton Borough	Maurice River	100
Deptford Township	Big Timber Creek Mantua Creek Woodbury Creek	49 32 19
East Greenwich Township	Mantua Creek Repaupo Creek	27 73
Elk Township	Maurice River Oldmans Creek Raccoon Creek	65 5 30
Franklin Township	Great Egg Harbor River Maurice River	36 64
Glassboro Borough	Mantua Creek Maurice River Raccoon Creek	43 47 10

Gloucester County Towns and Their Watersheds

Greenwich Township	Mantua Creek Repaupo Creek	2 98
Harrison Township	Mantua Creek Raccoon Creek Repaupo Creek	13 82 5
Logan Township	Oldmans Creek Raccoon Creek Repaupo Creek	21 34 45
Mantua Township	Mantua Creek Repaupo Creek	95 5
Monroe Township	Great Egg Harbor River Mantua Creek Maurice River	79 1 20
National Park Borough	Woodbury Creek	100
Newfield Borough	Maurice River	100
Paulsboro Township	Mantua Creek Repaupo Creek	60 40
Pitman Borough	Mantua Creek	100
South Harrison Township	Oldmans Creek Raccoon Creek	52 48
Swedesboro Borough	Raccoon Creek	100
Washington Township	Big Timber Creek Mantua Creek Maurice River	44 46 10
Wenonah Borough	Mantua Creek	100
West Deptford Township	Big Timber Creek Mantua Creek Woodbury Creek	3 22 75
Westville Borough	Big Timber Creek Woodbury Creek	86 14
Woodbury City	Big Timber Creek Woodbury Creek	1 99
Woodbury Heights Borough	Mantua Creek Woodbury Creek	10 90
Woolwich Township	Oldmans Creek Raccoon Creek Repaupo Creek	40 45 15

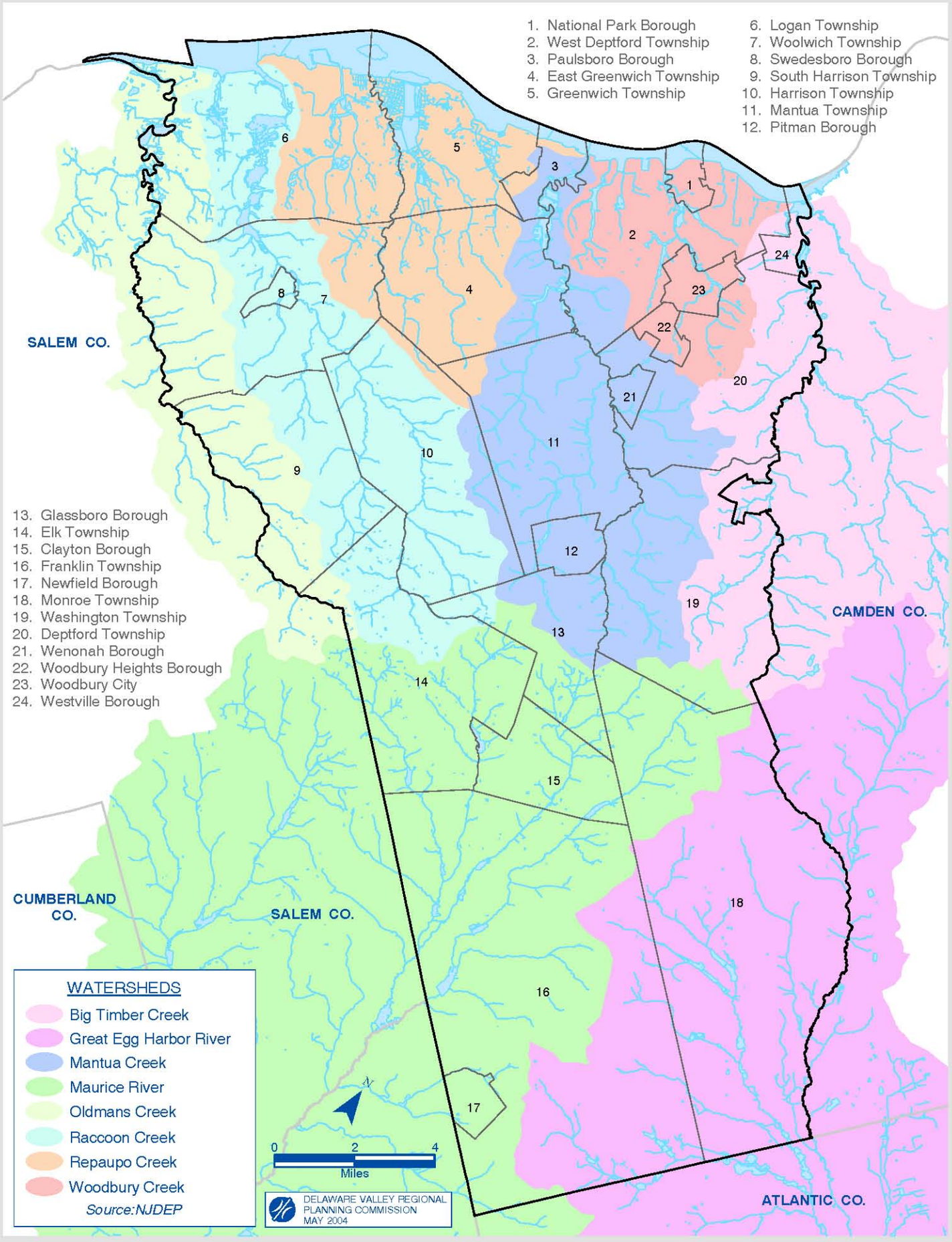
Source: DVRPC

The next section of this chapter is a **map of Gloucester County watersheds** in two forms:

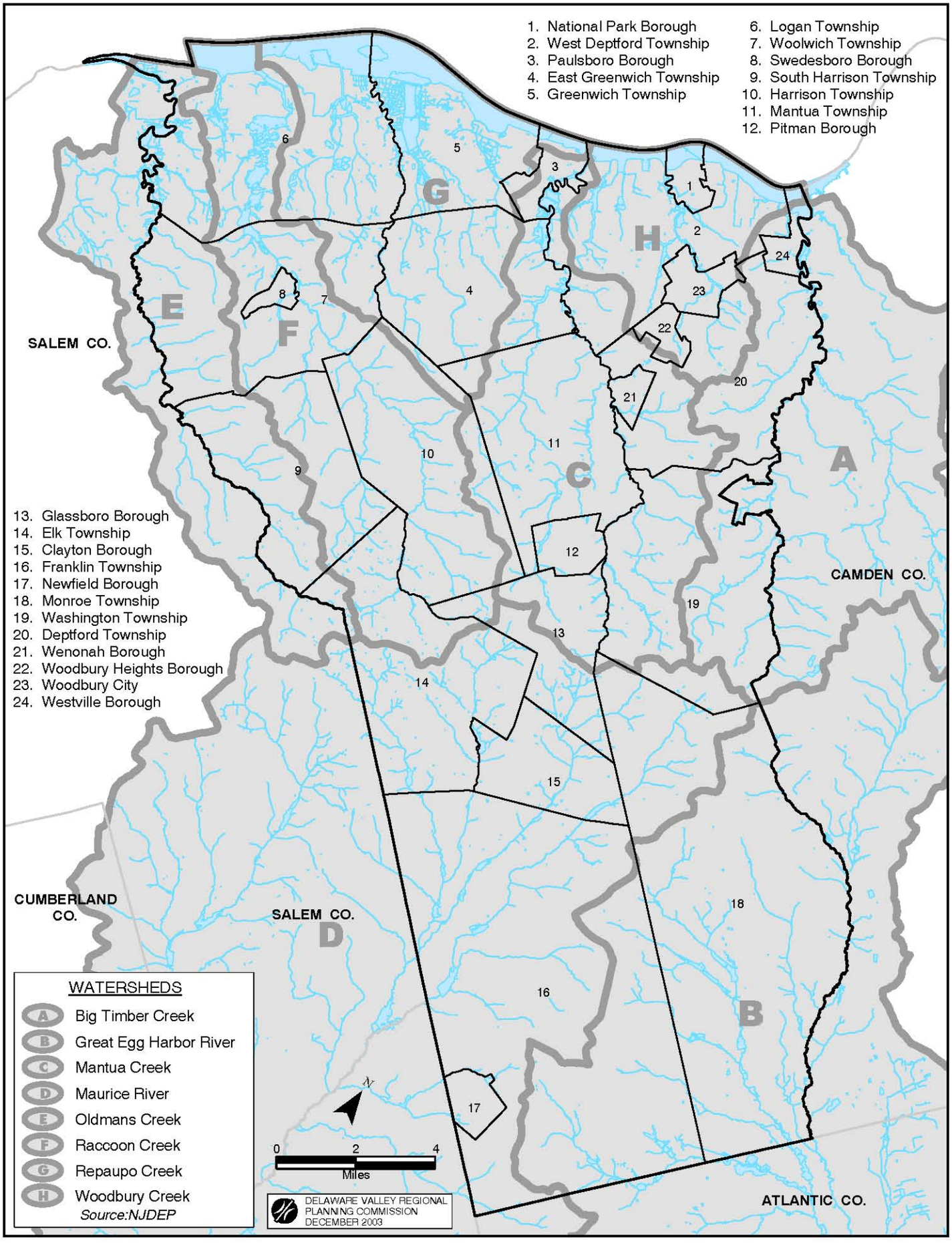
- A color version
- A version that was designed for making black and white photocopies for students (which is best copied using the "photo" setting, if possible).

Following the map is a section consisting of written **descriptions** of each watershed in Gloucester County, behind which are **eight individual maps** of the watersheds. These are in both color and black and white.

GLOUCESTER COUNTY : Watersheds



GLOUCESTER COUNTY : Watersheds



THE WATERSHEDS

Big Timber Creek Watershed (Maps – pp. 17 & 18)

DEFINITIONS

Branch: A smaller stream that flows into ("branches" off from) a larger one.

Run: A smaller stream that flows into ("runs" to) a larger stream or river.

Tributary: A stream or river that flows into a larger stream or river.

Headwaters: The small streams from which a larger creek or river "rises" or begins.

The Big Timber Creek Watershed drains an area of 63 square miles in Gloucester and Camden Counties. There are two branches of the Big Timber Creek: the **North Branch** and the **South Branch.** The North Branch begins in Berlin Borough in Camden County and flows northwest into Gloucester Township. The South Branch begins in Washington Township in Gloucester County and in lower Gloucester Township in Camden County and flows northward toward the Delaware River.

The North and South Branches of the Big Timber Creek are 10 and 11 miles long respectively and join together just below Clements Bridge Road in Deptford Township. From there, the main channel travels less than four miles before it empties into the Delaware River between Brooklawn Borough, Camden County, on the north and Westville Borough, Gloucester County, on the south. The South Branch and the main channel of the Big Timber Creek form about half of the border between Camden and Gloucester Counties. The creek is tidal up to Blackwood Lake, which is located between Washington Township in Gloucester County and Gloucester Township in Camden County.

Major tributaries of the Big Timber Creek on the Gloucester County side include **Little Lebanon Branch**, **Bells Lake Creek,** and the unnamed tributary that flows through the Lakeland complex, all flowing to the South Branch, along with **Almonesson Creek** and **Ladd's Branch** flowing to the main channel. In Camden County, major tributaries are **Otter Brook/Gravelly Run**, **Mason Run,** and **Trout Run** flowing to the North Branch, and **Pines Run, Holly Run,** and several smaller "Branches" flowing to the South Branch. There are numerous lakes within the watershed. Major ones are **Almonesson Lake, Blackwood Lake, Grenloch Lake, Nash's Lake,** and **Bells Lake** on the South Branch, and **Laurel Lake, Clementon Lake, Bottom Lake, Pillings Lake, Silver Lake** (in Clementon) and **Lake Worth** along the North Branch.

Big Timber Creek

Source: DVRPC

Originally named ***Timmer Kil*** by the Dutch ("Timmer" meaning "timber" and "kil" meaning "river"), the stream name later became "Great Timber Creek" and eventually "Big Timber Creek" to distinguish it from "Little Timber Creek." The **Little Timber Creek** is a separate stream within the Big Timber Creek watershed that starts in Tavistock in Camden County and joins the Big Timber Creek between Gloucester City and Brooklawn, just before the Big Timber empties into the Delaware River.

Four municipalities in Gloucester County and seventeen in Camden County are included within the Big Timber (and Little Timber) watershed boundaries (see *Towns and their Watersheds* for a listing of Gloucester County towns). Most of Westville Borough is within the watershed. Of the others in Gloucester County, Washington and Deptford Townships have large percentages and West Deptford Township and Woodbury City have small percentages of land within watershed boundaries.

Great Egg Harbor River Watershed (Maps – pp. 19 & 20)

The Great Egg Harbor River drains an area of 205 square miles in Camden, Atlantic, and Gloucester Counties, of which 58 square miles are within Gloucester County. The Great Egg Harbor River is one of the longest rivers in New Jersey (59 miles in length.) It originates in southeastern Camden County and is joined by tributaries from Gloucester County before flowing southeast through the Pinelands region to the Great Egg Harbor Bay and into the Atlantic Ocean. The river is tidal downstream of the dam at Mays Landing in Atlantic County.

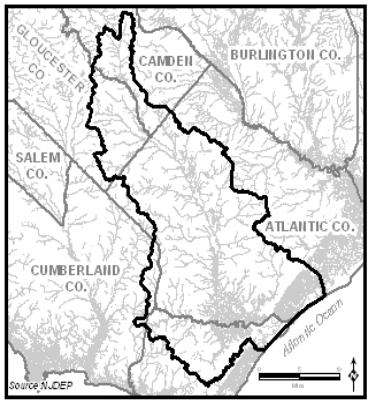
Great Egg Harbor River

Photo: Michael A. Hogan

The Great Egg Harbor River's main channel actually begins behind the Berlin Plaza Shopping Center in Camden County, which is the site of a former wetlands area that was filled to create the shopping center and its parking lot. Because of the natural springs on the site, water had to be routed around the shopping center and diverted to underground pipes, where it travels until it emerges from a pipe at Camden County's Berlin Park in Berlin Borough to continue its long journey to Great Egg Harbor Bay.

One tributary of the Great Egg Harbor River, **Four Mile Branch**, starts in Monroe Township, Gloucester County, and forms a portion of the boundary between Camden and Gloucester Counties. It joins the main channel east of Malaga Road in Monroe Township, at the start of the Winslow Wildlife Management Area. Other large tributaries originating in Gloucester are **Squankum Branch**, **Boggy Meadow Branch**, and **Hospitality Branch.** Hospitality Branch has numerous large tributaries running to it. These include **Whitehall Branch**, **White Oak Branch, Faraway Branch** and **Marsh Lake/Main Lake Branch** in Monroe and Franklin Townships. Hospitality Branch eventually joins the main channel at Penny Pot in Atlantic County.

The Great Egg Harbor River Watershed



Source: DVRPC

The Great Egg Harbor River watershed also includes several lakes within Monroe and Franklin Townships. These are **Crystal Springs Lake** along the Four Mile Branch; **Timber Lake**, **Sunset Lake**, **Victory Lake**, **Cranes Lake**, **Diamond Lake**, and **Hospitality Lake** along the Hospitality and Whitehall Branches; and **McCarthy's Lakes, Marsh Lake,** and **Collings Lake** (in Atlantic County) along the Main Lake Branch. Other impoundments in the watershed are the remnants of cranberry bogs that were once abundant in the area.

The name "Egg Harbor" comes from the Dutch "Eyer Haven." This name was applied by early navigators to the Great Egg Harbor Bay because of the immense colonies of nesting birds and their eggs that were found along the seashore. The "Great" in the name of the river was a means of distinguishing it from the Little Egg Harbor River, which is now called the Mullica River. The Little Egg Harbor was smaller in size and extent than the Great Egg.

The Great Egg Harbor River watershed encompasses a large part of Monroe Township and over a third of Franklin Township.

Mantua Creek Watershed

Source: Federation of Gloucester County Watersheds

Mantua Creek Watershed (Maps – pp. 21 & 22)

Mantua Creek drains an area of 50.9 square miles in Gloucester County. The main branch rises (starts) in Glassboro and flows 18.6 miles to the Delaware River just north of Paulsboro Borough. Two major tributaries are the **Chestnut Branch** and **Edwards Run**. The Chestnut Branch is seven miles long and flows from Glassboro through Pitman to Mantua where it joins the main branch at the border of Mantua Township and Wenonah Borough. It drains an area of approximately 9.5 square miles. Edwards Run, which is 6.9 miles long, flows from Mantua Township through East Greenwich to join the Mantua Creek at Mount Royal. Its drainage area is 10.6 square miles. The Mantua Creek is tidal on its main channel up to a point in Wenonah. Edwards Run is tidal up to the NJ Turnpike in East Greenwich, and Chestnut Branch is tidal for a very short distance to Mantua Boulevard in Mantua Township.

There are several additional tributaries to the main branch. Major ones are **Duffield Run, Porch Branch**, **Bethel Run**, **Bees Branch**, **Monongahela Brook**, and **Breakneck Run**. Other tributaries to the Chestnut Branch and Edwards Run include **Tylers Run**, **Richwood Branch** and **Myers Run**. There are several large and small lakes in the watershed. Major ones are **Kandle Lake**, **Kressey (Wadsworth) Lake**, **Alcyon Lake**, **Lake Oberst** and **Bethel Lake**. Nearer to the mouth of the Mantua are wide tidal marshes. At the mouth itself some of these areas were filled in past years with "spoils" from dredging the Delaware River.

The name Mantua comes from "Manta," meaning "frog," the name for the Native American group that lived in the area at the time of European arrival. The Mantaes were a sub-tribe of the Lenape Indians and had a large village near Mount Royal, in East Greenwich Township. Another village was located at Hurffville in Washington Township.

The Mantua Creek watershed encompasses all or parts of 13 municipalities in Gloucester County. These include Mantua, Washington, Deptford, East Greenwich, and West Deptford Townships, and Glassboro, Pitman, Wenonah and Paulsboro Boroughs. Smaller portions of Harrison Township and Woodbury Heights Borough, and tiny areas of Greenwich and Monroe Townships are also within the watershed.

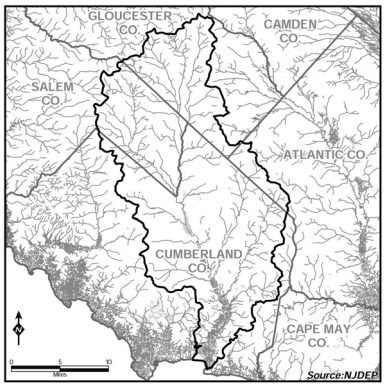
Maurice River Watershed Franklinville Lake

Photo by Michael A. Hogan

Maurice River Watershed (Maps – pp. 23 & 24)

The Maurice River originates in Gloucester and Salem counties and flows into the Delaware Bay at the southern end of Cumberland County. The Maurice River forms part of the border between Salem and Cumberland Counties. The drainage basin of the Maurice River is 385 square miles altogether, making it one of the largest watersheds in New Jersey. The length of the Maurice River from its northernmost headwaters to its mouth is 58 miles. The river is tidal below Union Lake in Millville, Cumberland County. Within Gloucester County the watershed (referred to as the Upper Maurice River watershed) encompasses 74 square miles. This area includes all of Newfield Township and Clayton Borough and parts of the Borough of Glassboro and the Townships of Elk, Franklin, and Monroe.

The Maurice River Watershed



Source: DVRPC

The three main branches of the river located within Gloucester County are **Still Run**, **Little Ease Run**, and **Scotland Run**. The three stream systems come together in Willow Grove Lake, located just below the Gloucester border in Pittsgrove Township, Salem County. Most of the headwaters of Little Ease Run are within the Glassboro Wildlife Management Area in Glassboro, although **Beaverdam Branch** begins in Monroe Township. **West Clayton Branch**, **Reed Branch,** and **Elwell Branch** are tributaries to Still Run, and **Kinard Branch**, **Hell Branch**, **Jericho Branch**, **Indian** and **Hays Branches,** and **Malaga Branch** are tributaries to Scotland Run. Both **Burnt Mill Branch**, which drains from Newfield Borough, and **Blackwater Branch** flowing from the southwestern corner of Franklin Township, travel across Vineland in Cumberland County to join the Maurice River main channel below Willow Grove Lake. Major lakes within Gloucester County include **Silver Lake**, **Wilson Lake**, **Garrison Lake**, **Franklinville Lake**, **Iona Lake**, and **Malaga Lake**.

The river was called "Wauhatquenack" by the Lenape Indians. The current name is thought to have come from the name of a Dutch ship, the Prince Maurice, which burned and sank in 1657 below present day Mauricetown, Cumberland County. The name of the river is pronounced like "Morris," with the accent on the first syllable.

The Maurice River watershed is home to more than half of the species of plants and animals listed on the New Jersey Threatened and Endangered Species List.

Oldmans Creek Watershed **(Maps – pp. 25 & 26)**

Oldmans Creek Watershed

Photo by Michael A. Hogan

Oldmans Creek drains an area of 44 square miles and is 20 miles long. The creek forms half of the boundary between Gloucester and Salem Counties. The creek is tidal up to a point near the boundary between Woolwich and South Harrison Townships. A large tidal marsh, **Pedricktown Marsh**, located between Logan Township in Gloucester County and Oldmans Township in Salem County, is known as a particularly important stopover site for migratory waterfowl.

The original inhabitants within the Oldmans Creek were a sub-tribe of the Lenape Indians known as the Kagkakaini Sakins. Their name for the creek was the "Mosackas," the meaning of which is unknown. "Oldmans Creek" is a variation on the name "Aldermans Creek," given to the waterway by the Dutch.

Oldmans Creek has one main channel without significant branching but with many tributaries. Major ones are **Tide Branch**, Beaver Creek, **Indian Branch (Gloucester County), Ebenezers Branch, Rainey Run, Porches Creek, Indian Run (Salem County), Marl Run**, and **Lincoln Stream**. Two major lakes, **Algonquin Lake** and **Harrisonville Lake**, are located in the watershed in South Harrison Township.

The creek flows through seven municipalities. Those on the Gloucester County side from southeast to northwest are Elk, South Harrison, Woolwich, and Logan Townships. In Salem County the creek flows from Upper Pittsgrove Township through Pilesgrove Township to empty into the Delaware River on the north side of Oldmans Township.

Raccoon Creek Watershed (Maps – pp. 27 & 28)

Raccoon Creek Watershed

Source: DVRPC

The Raccoon Creek watershed contains approximately 40 square miles of land and drains central Gloucester County. The creek itself is 19 miles long and has two main branches. The **North Branch,** or main channel, flows from Glassboro and Elk Township across Harrison Township. The **South Branch** starts in Elk and South Harrison Townships and joins the North Branch on the western side of Harrison Township. The channel then flows across Woolwich Township and Swedesboro, and empties into the Delaware River in Logan Township. The Raccoon Creek Watershed also includes the smaller **Birch Creek,** which flows directly into the Delaware River and is entirely within Logan Township.

The Raccoon Creek was home to the Narraticons, a sub-tribe of Lenape Indians. They called the creek the "Narraticon-sippus," meaning "raccoon-river." Early European settlers did a thriving trade in furs with these indigenous people. Beavers may have been especially abundant in this watershed. The earliest settlement by Europeans in Gloucester County was at the mouth of the Raccoon Creek, near the town of Bridgeport. This settlement was called "New Stockholm" by its early Scandinavian settlers.

The creek is tidal up to a point to the east of Swedesboro. Closer to its mouth, the Raccoon Creek is wide, with broad tidal marshes along its channel. As with other creeks in Gloucester County that drain to the Delaware River, the marshes closest to the mouth were partly filled with deposits of materials dredged from the Delaware River in order to maintain its depth for shipping. Thus the outlet channel of these creeks, including that of the Raccoon, are narrower at their ends and have less tidal marsh than upstream, due to the dredge spoil sites.

Major tributaries to the North Branch of the creek are **Hill** and **Jefferson Branches**, **Miery Run, Little Clem's Run**, **Clems Run, Cartwheel Branch,** and **Gilman Branch**. **Poplar Branch** and **Shivers Run** are tributaries to the South Branch. Tributaries to the main channel are **Basgalore Creek**, **Narraticon Run,** and **Grand Sprute Run. Winarski Lake, Lake Gilman, Ewan Lake**, **Mullica Hill Pond**, **Narraticon Lake,** and **Lake Basgalore** are among the many lakes and ponds in this area.

Repaupo Creek Watershed

Photo by Michael A. Hogan

Repaupo Creek Watershed (Maps –pp. 29 & 30)

This watershed in Gloucester County drains an area of 41 square miles. The Repaupo Creek is the largest of several streams flowing directly to the Delaware River. Other smaller streams that also flow directly to the Delaware, but which are classed as part of this watershed, are **Clonmell Creek, Nehonsey Brook**, and **Little Timber Creek**. The Repaupo Creek's two main branches are **Still Run** on the north and **Pargey Creek** to the south (also spelled "Purgey"). On some maps, Still Run is labeled as "Repaupo Creek" for its full length. From the point where the two branches join together, in Greenwich Township, the main channel of the stream is called the Repaupo Creek. **Rattling Run** is a tributary to Pargey Creek and **London Branch** is a tributary to the Still Run/Repaupo channel. Lakes in the Repaupo Creek watershed include **Greenwich Lake**, **Warrington Mill Pond**, and **Cooper Lake**.

The name "Repaupo" comes from the Native American word "repapack," meaning "still water." This watershed has very extensive wetlands and slowly meandering, interconnected channels near the Delaware River. The region also includes several impoundments and cut channels that were created in previous centuries or in earlier decades of the twentieth century to control flooding and to drain the rich soils for agricultural use. Many of these managed wetlands are still controlled by sluice gates and other water control structures. An extensive levee or dike along the Delaware, running north for approximately 4.5 miles from the Repaupo, protects Gibbstown and its surroundings from flooding by the larger river. Tidegates at the mouths of all the creeks prevent Delaware River water from entering them. There is thus no tidal action on streams in this watershed.

Municipalities within the watershed are Greenwich, East Greenwich, Woolwich, and Logan Townships. There are also small parts of Harrison and Mantua Townships and Paulsboro Borough included in the watershed.

Woodbury Creek Watershed (Maps – pp. 31 & 32)

Woodbury Creek Watershed
Woodbury Lake

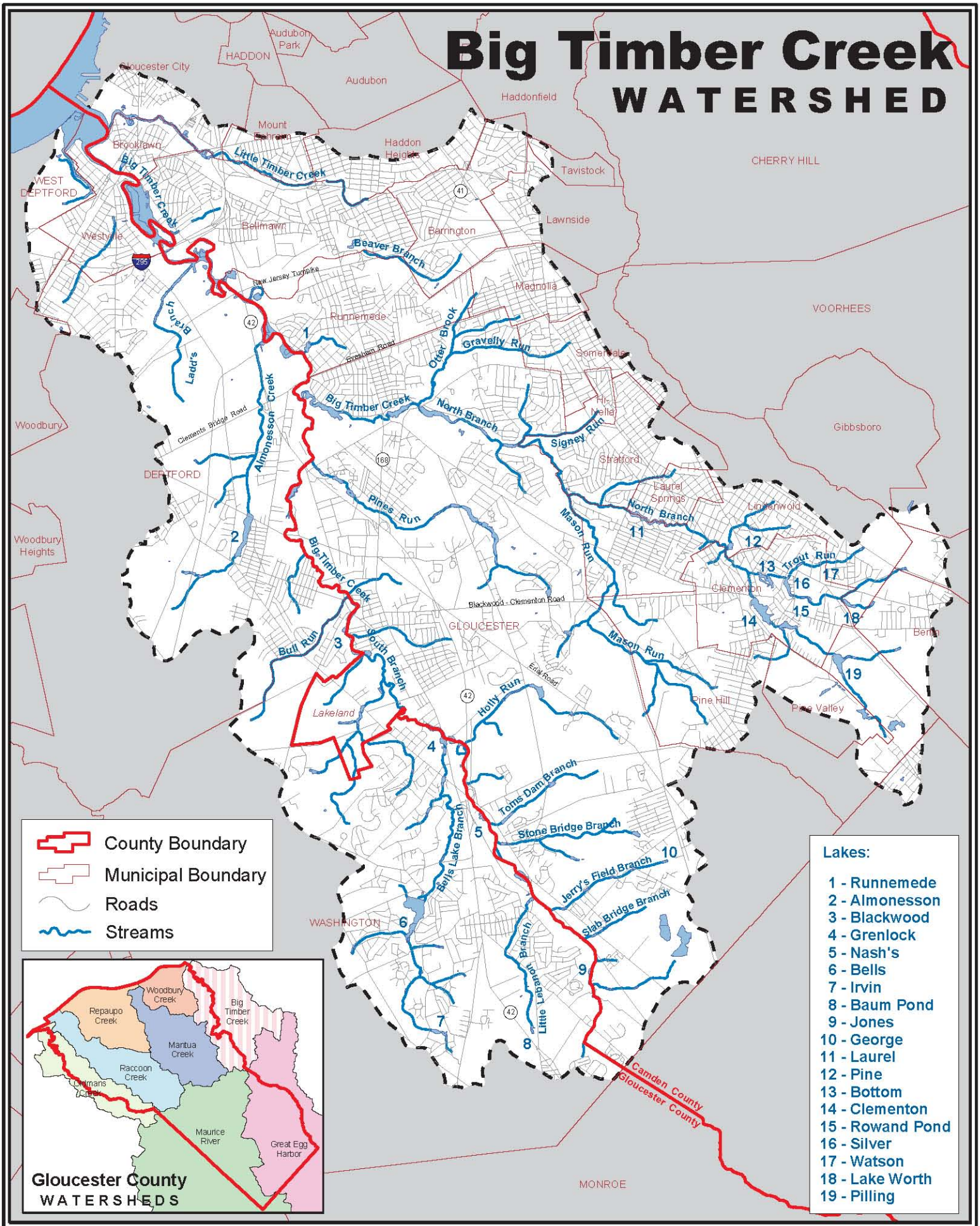
Source: DVRPC

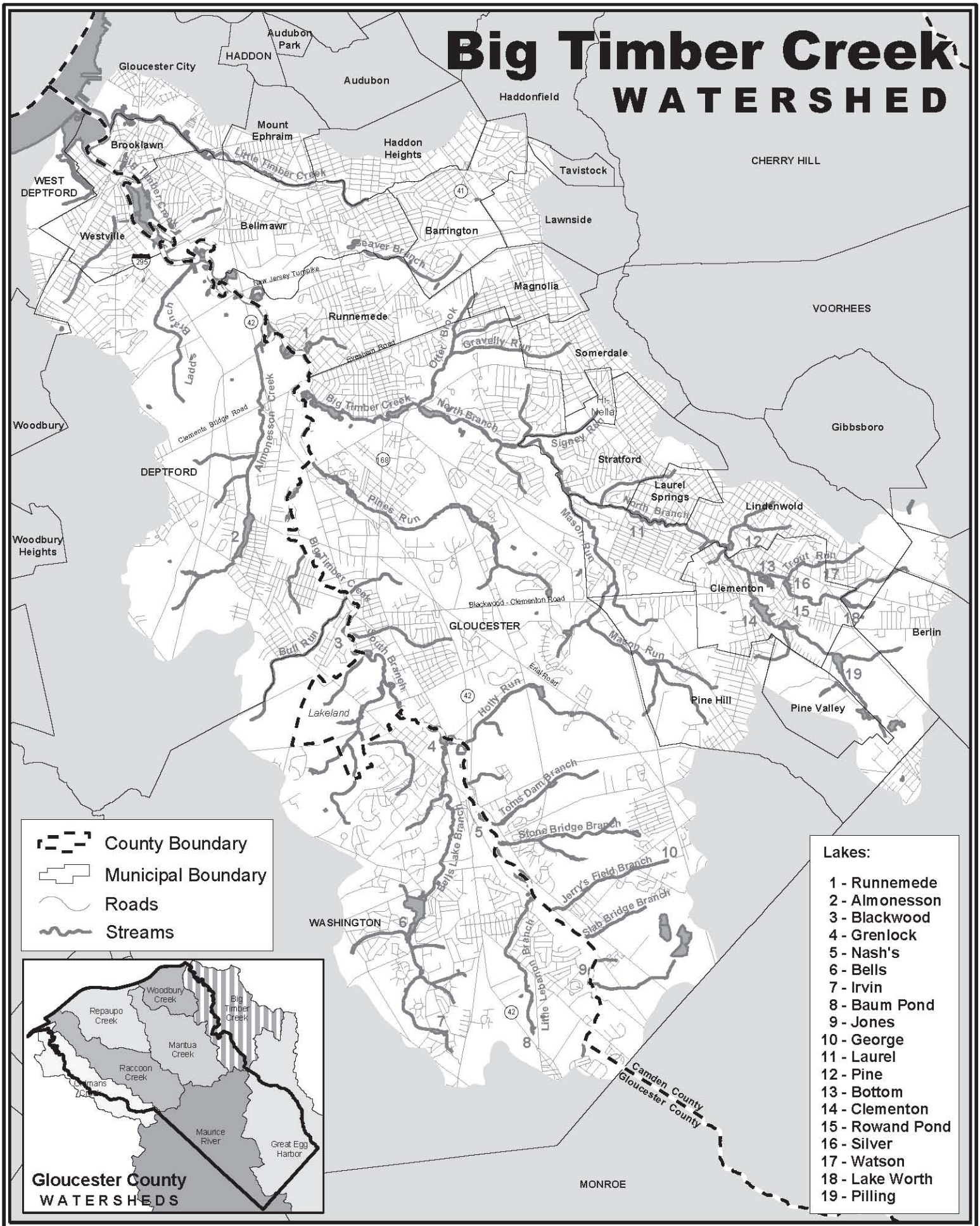
The Woodbury Creek watershed is the smallest in Gloucester County, occupying 21 square miles. Two major tributaries are **Hessian Run** and **Matthews Branch**. The main channel has two branches. One of these begins in the Gardenville section of Deptford and the other starts near **Glen Lake** in Woodbury Heights. The branches meet to form the two-pronged **Stewart Lake** in Woodbury. The main channel of the creek is five miles long and is tidal up to the dam at Route 45 in Woodbury. Matthews Branch and Hessian Run are also tidal for half or more of their lengths.

Native Americans called this creek the Pescozakasing, which meant "place of black burrs," possibly a reference to the burrs of the chestnut trees that abounded in the area. The creek and City of Woodbury derived their current name from the Wood family, English Quakers from the town of Bury who settled in the area in 1683 and who named their property with a combination of their family name and place of origin.

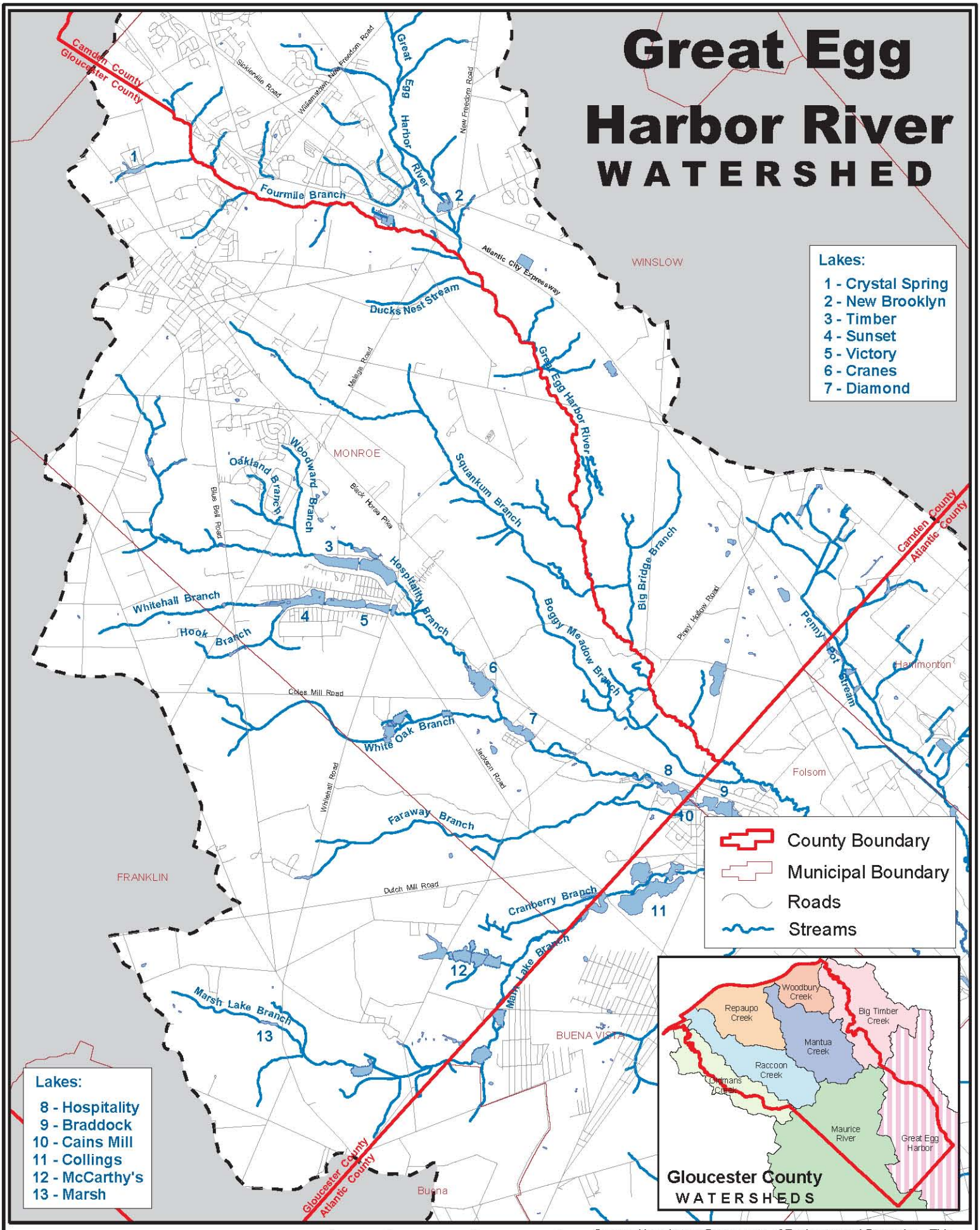
Five municipalities are within the Woodbury Creek watershed boundaries. They are Woodbury City, which is almost wholly within the watershed, and parts of Woodbury Heights, West Deptford Township, National Park Borough, and Deptford Township. West Deptford and National Park border the creek as it flows into the Delaware River.

Several small streams that run directly to the Delaware River are also classed by the US Geological Survey as being within the Woodbury Creek watershed, although they do not connect to the creek. These include the **Little Mantua Creek**, **Main Ditch**, and three other unnamed waterways, all of which are within West Deptford Township. Some of these streams have been channelized, or straightened, either because they served as passageways for the industry that sits beside them or to provide drainage from sites on which spoils from Delaware River dredging have been piled.


Big Timber Creek
WATERSHED
Gloucester City
HADDON
Audubon Park
Audubon
Haddonfield
Brooklawn
Mount Ephraim
Haddon Heights
Tavistock
CHERRY HILL
WEST DEPTFORD
Westville
Bellmawr
Barrington
Lawnside
Little Timber Creek
Big Timber Creek
Beaver Branch
New Jersey Turnpike
Magnolia
VOORHEES
Runnemede
Otter Brook
Gravelly Run
Somerdale
Hi-Nella
Gibbsboro
Woodbury
Clements Bridge Road
Almonesson Creek
Ladd's Branch
Big Timber Creek
North Branch
Signey Run
Stratford
DEPTFORD
Laurel Springs
Lindenwold
Pines Run
Mason Run
North Branch
Woodbury Heights
Big Timber Creek
Trout Run
Clementon
Blackwood - Clementon Road
GLOUCESTER
Bell
Buff Run
South Branch
Mason Run
Erial Road
Holly Run
Pine Hill
Pine Valley
Lakeland
Toms Dam Branch
Stone Bridge Branch
Bells Lake Branch
Jerry's Field Branch
Slab Bridge Branch
WASHINGTON
Little Level Branch
Camden County
Gloucester County
MONROE
County Boundary
Municipal Boundary
Roads
Streams
Lakes:
1 - Runnemede
2 - Almonesson
3 - Blackwood
4 - Grenlock
5 - Nash's
6 - Bells
7 - Irvin
8 - Baum Pond
9 - Jones
10 - George
11 - Laurel
12 - Pine
13 - Bottom
14 - Clementon
15 - Rowand Pond
16 - Silver
17 - Watson
18 - Lake Worth
19 - Pilling
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Maurice River
Great Egg Harbor
Gloucester County
WATERSHEDS
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0
1
2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.


Big Timber Creek
WATERSHED
Audubon Park
HADDON
Gloucester City
Audubon
Haddonfield
Mount Ephraim
Haddon Heights
Brooklawn
Little Timber Creek
Big Timber Creek
CHERRY HILL
Tavistock
WEST DEPTFORD
Lawnside
Bellmawr
Westville
Barrington
Beaver Branch
New Jersey Turnpike
Magnolia
VOORHEES
Runnemede
Ladds Branch
Otter Brook
Gravelly Run
Somerdale
Firestem Road
Big Timber Creek
North Branch
Hi-Nella
Clements Bridge Road
Almonesson Creek
Woodbury
Gibbsboro
Signey Run
Stratford
DEPTFORD
Laurel Springs
North Branch
Lindenwold
Pines Run
Mason Run
Woodbury Heights
Big Timber Creek
Trout Run
Clementon
Blackwood - Clementon Road
GLOUCESTER
Berlin
Bull Run
South Branch
Mason Run
Erial Road
Holly Run
Pine Hill
Pine Valley
Lakeland
Toms Dam Branch
Stone Bridge Branch
Bells Lake Branch
Jerry's Field Branch
Slab Bridge Branch
WASHINGTON
Big Branch
Little Legg Mundy
Camden County
Gloucester County
MONROE
County Boundary
Municipal Boundary
Roads
Streams
Lakes:
1 - Runnemede
2 - Almonesson
3 - Blackwood
4 - Grenlock
5 - Nash's
6 - Bells
7 - Irvin
8 - Baum Pond
9 - Jones
10 - George
11 - Laurel
12 - Pine
13 - Bottom
14 - Clementon
15 - Rowand Pond
16 - Silver
17 - Watson
18 - Lake Worth
19 - Pilling
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Maurice River
Great Egg Harbor
Gloucester County
WATERSHEDS
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0
1
2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

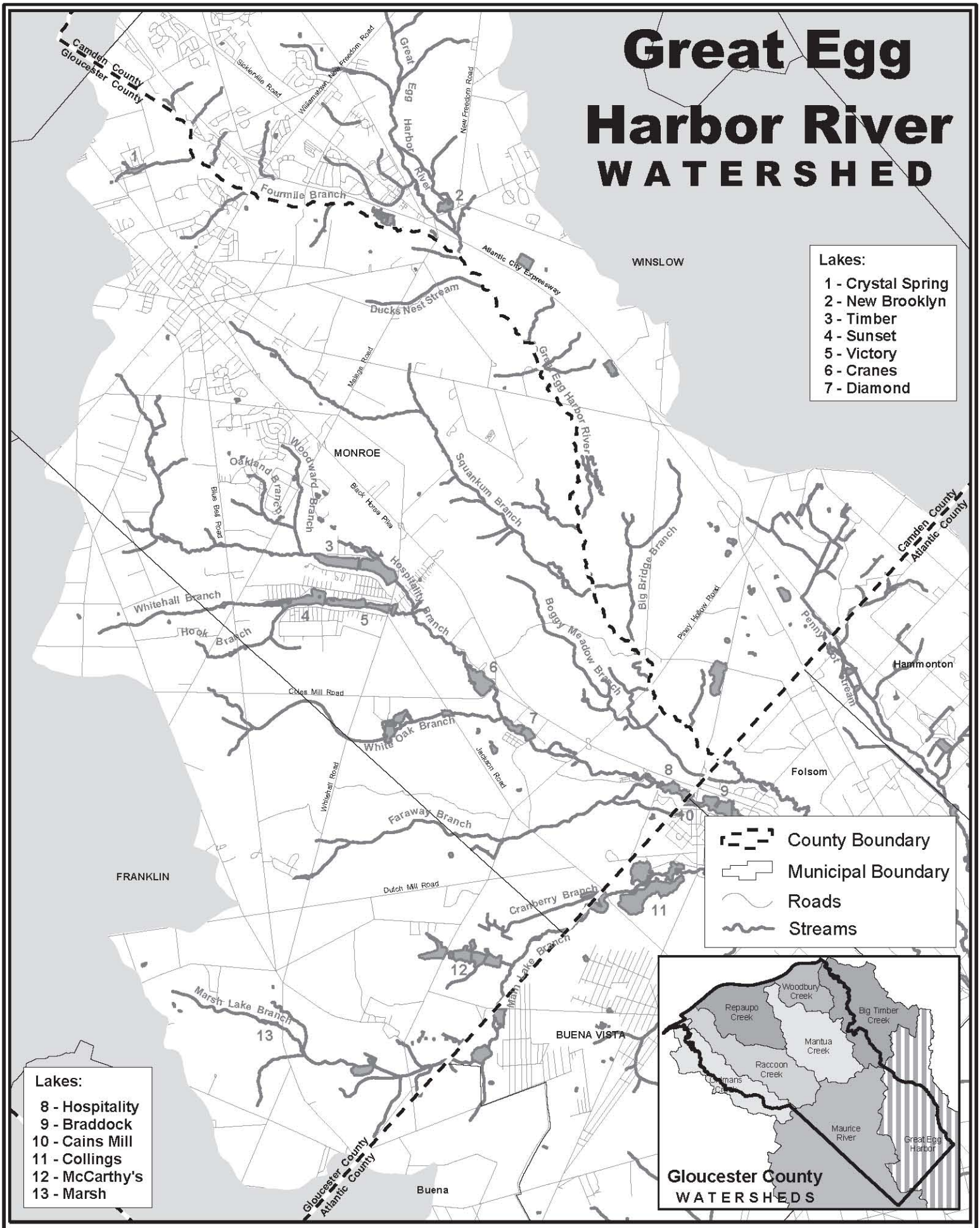
Great Egg Harbor River WATERSHED

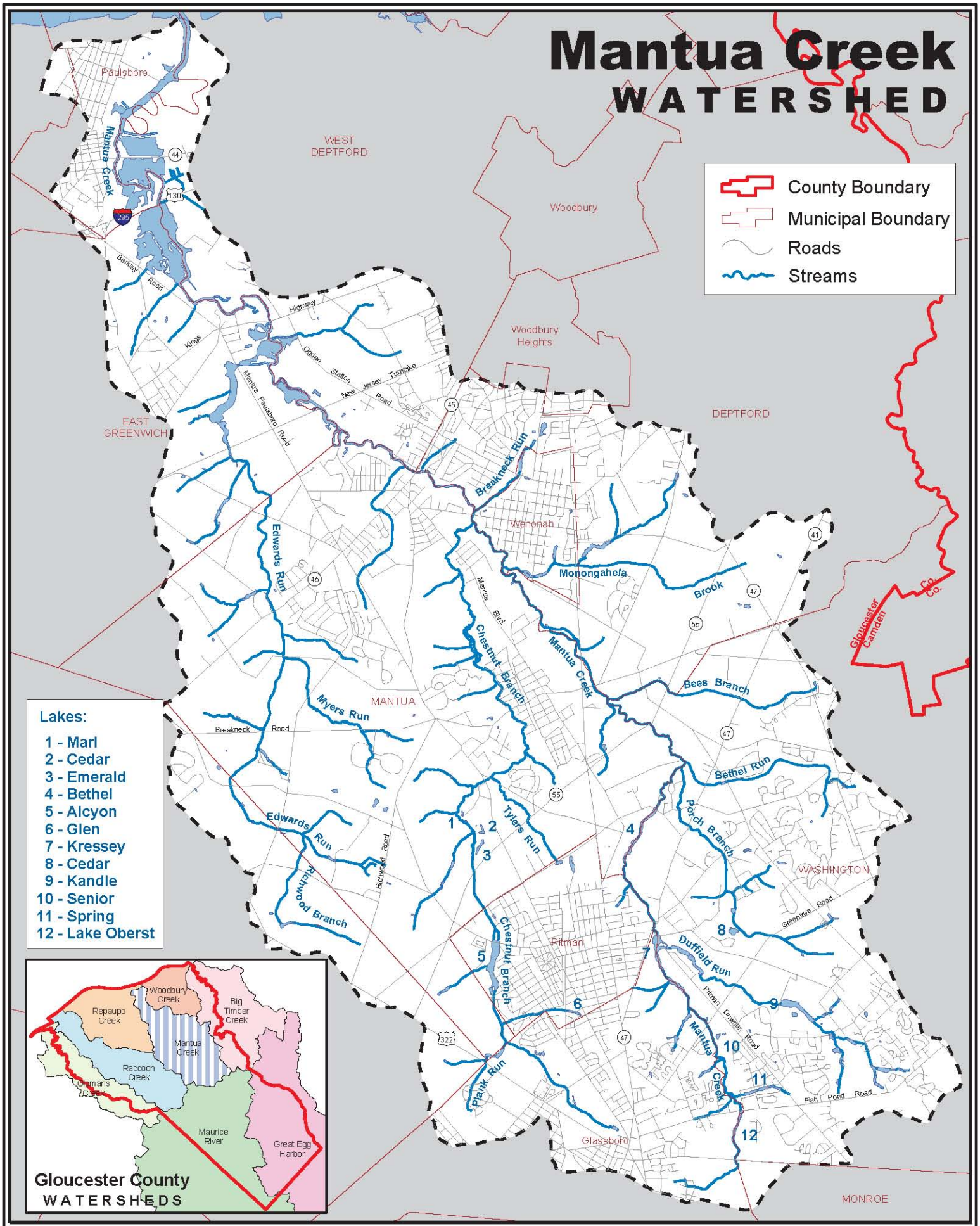


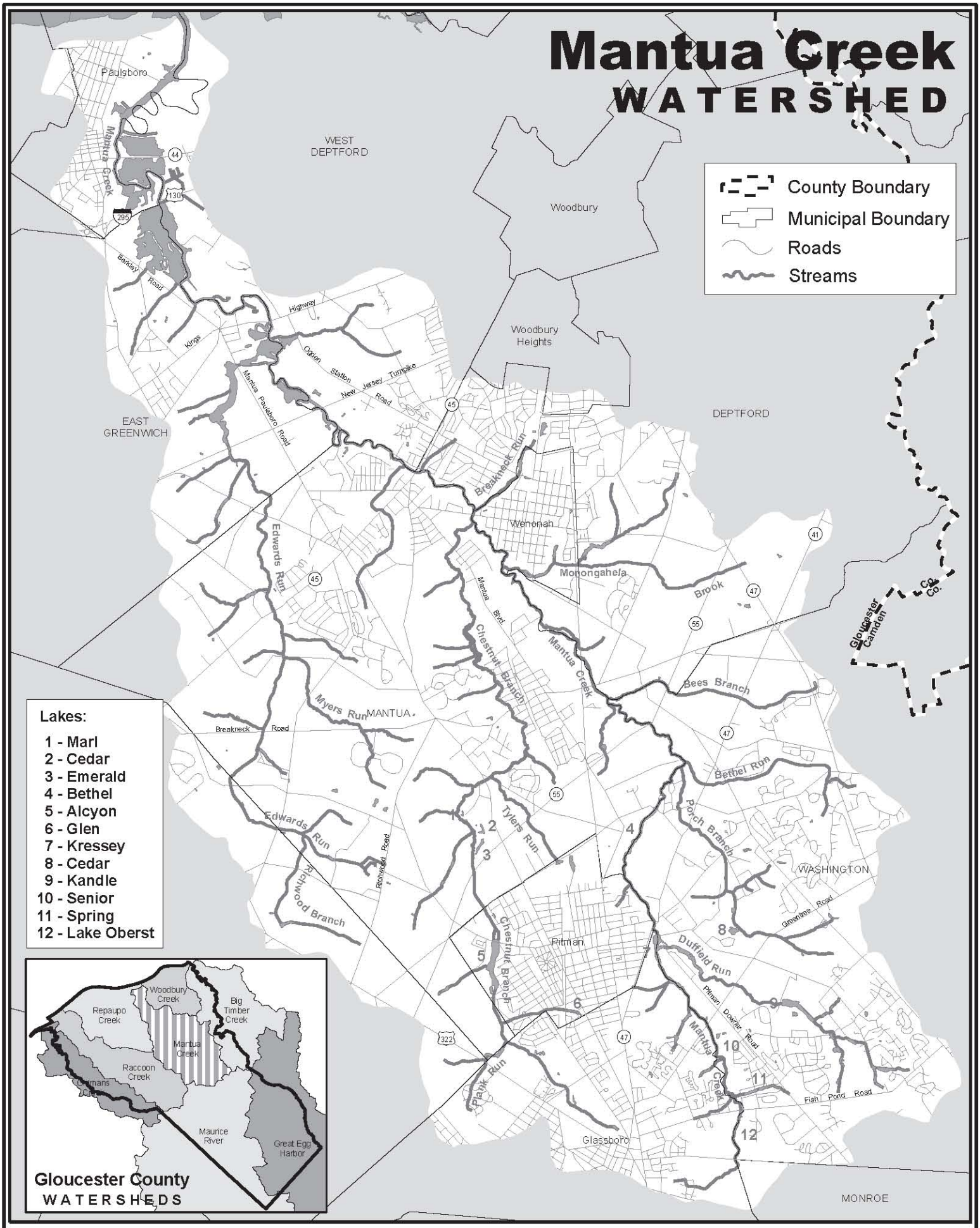
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION

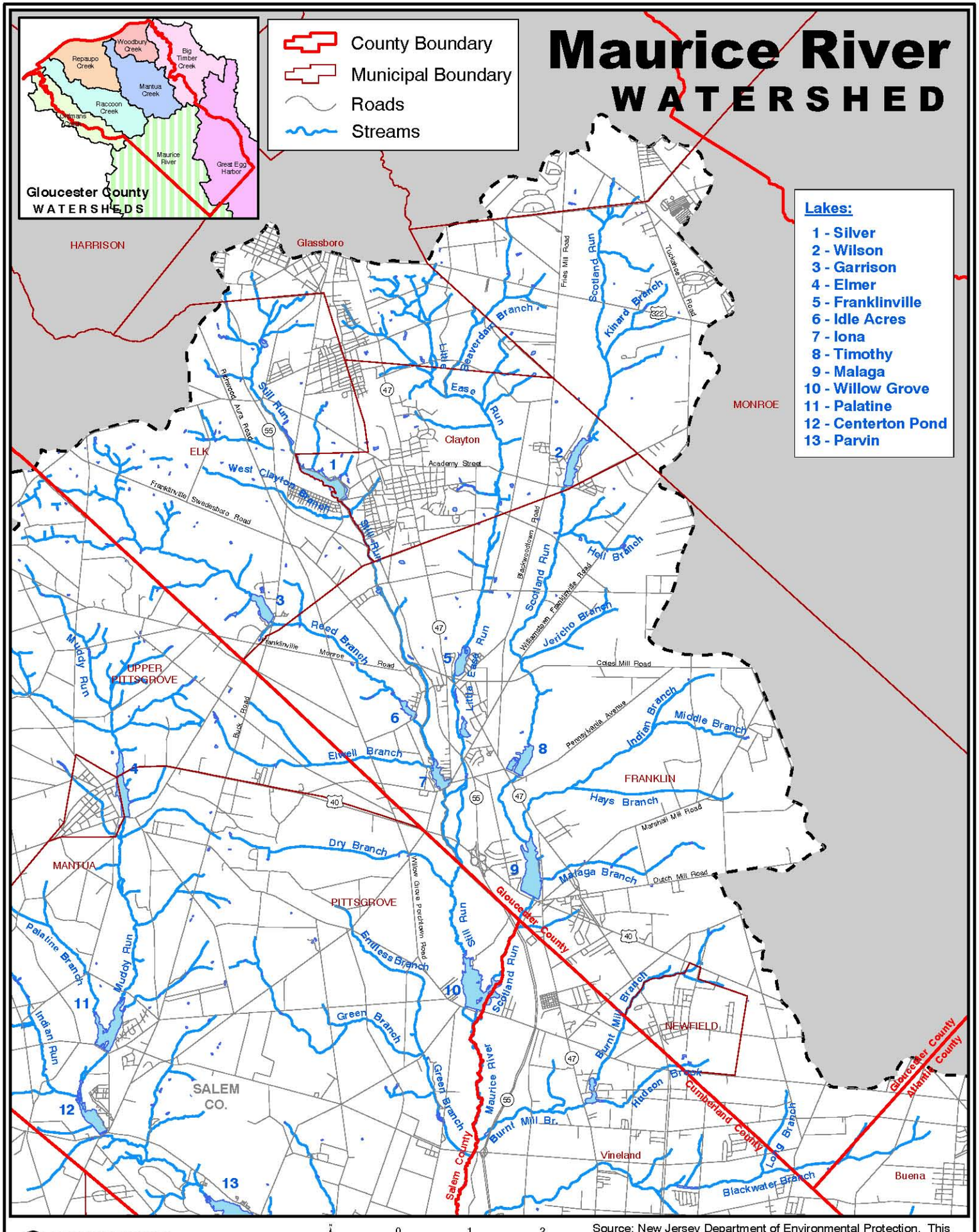
0 1 2
Miles

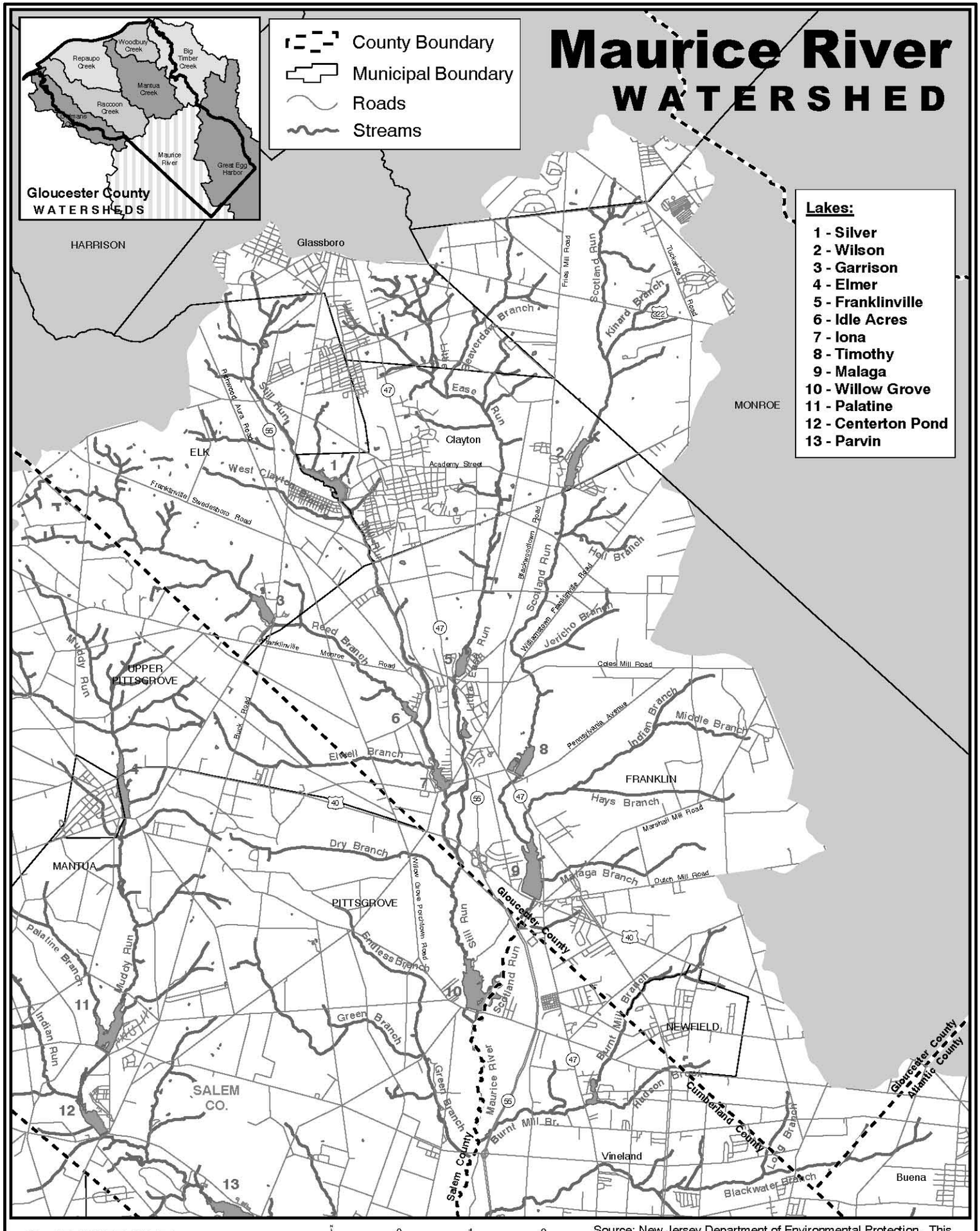
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.


Great Egg Harbor River
WATERSHED
Lakes:
1 - Crystal Spring
2 - New Brooklyn
3 - Timber
4 - Sunset
5 - Victory
6 - Cranes
7 - Diamond
Lakes:
8 - Hospitality
9 - Braddock
10 - Cains Mill
11 - Collings
12 - McCarthy's
13 - Marsh
County Boundary
Municipal Boundary
Roads
Streams
Gloucester County
WATERSHEDS
Repaupo Creek
Woodbury Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Maurice River
Great Egg Harbor
WINSLOW
MONROE
FRANKLIN
BUENA VISTA
Buena
Folsom
Hammonton
Camden County
Gloucester County
Atlantic County
Fourmile Branch
Great Egg Harbor River
Ducks Nest Stream
Squankum Branch
Big Bridge Branch
Boggy Meadow Branch
Hospitality Branch
Whitehall Branch
Hook Branch
Oakland Branch
Woodward Branch
White Oak Branch
Faraway Branch
Cranberry Branch
Marsh Lake Branch
Main Lake Branch
Penny Pot Stream
Atlantic City Expressway
New Freedom Road
Malaga Road
Blue Bell Road
Black Horse Pike
Cates Mill Road
Whitehall Road
Jackson Road
Dutch Mill Road
Piney Hollow Road
Miles
0
1
2
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

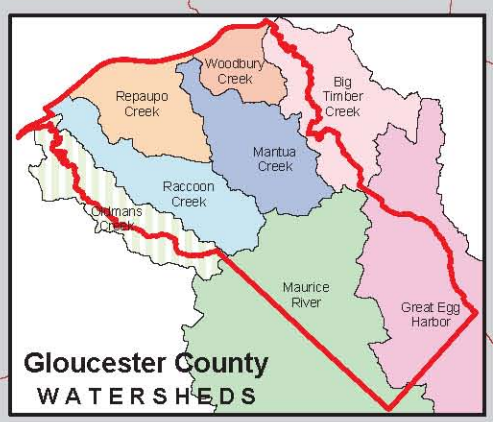

Mantua Creek
WATERSHED
County Boundary
Municipal Boundary
Roads
Streams
Paulsboro
WEST DEPTFORD
Woodbury
Woodbury Heights
DEPTFORD
EAST GREENWICH
MANTUA
Pitman
WASHINGTON
Glassboro
MONROE
Wenonah
Mantua Creek
Edwards Run
Myers Run
Breakneck Run
Chestnut Branch
Monongahela Brook
Bees Branch
Bethel Run
Porch Branch
Tylers Run
Duffield Run
Plank Run
Delaware Co.
Gloucester
Camden
Lakes:
1 - Marl
2 - Cedar
3 - Emerald
4 - Bethel
5 - Alcyon
6 - Glen
7 - Kressey
8 - Cedar
9 - Kandle
10 - Senior
11 - Spring
12 - Lake Oberst
Gloucester County
WATERSHEDS
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Maurice River
Great Egg Harbor
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0
1
2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.


Mantua Creek
WATERSHED
County Boundary
Municipal Boundary
Roads
Streams
Paulsboro
WEST DEPTFORD
Woodbury
Woodbury Heights
DEPTFORD
EAST GREENWICH
Wenonah
MANTUA
WASHINGTON
Pitman
Glassboro
MONROE
Mantua Creek
Edwards Run
Myers Run
Chestnut Branch
Tylers Run
Bees Branch
Bethel Run
Porch Branch
Duffield Run
Plank Run
Breakneck Run
Monongahela Brook
Mantua Blvd.
Mantua Paulsboro Road
New Jersey Turnpike
Ogden Station Road
Kings Highway
Barkley Road
Breakneck Road
Richwood Road
Greenfield Road
Pitman Downer Road
Fish Pond Road
Gloucester Co.
Camden Co.
Lakes:
1 - Marl
2 - Cedar
3 - Emerald
4 - Bethel
5 - Alcyon
6 - Glen
7 - Kressey
8 - Cedar
9 - Kandle
10 - Senior
11 - Spring
12 - Lake Oberst
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Maurice River
Great Egg Harbor
Gloucester County
WATERSHEDS
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0
1
2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.


Maurice River
WATERSHED
County Boundary
Municipal Boundary
Roads
Streams
Gloucester County
WATERSHEDS
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Maurice River
Great Egg Harbor
Lakes:
1 - Silver
2 - Wilson
3 - Garrison
4 - Elmer
5 - Franklinville
6 - Idle Acres
7 - Iona
8 - Timothy
9 - Malaga
10 - Willow Grove
11 - Palatine
12 - Centerton Pond
13 - Parvin
HARRISON
Glassboro
MONROE
ELK
Clayton
Academy Street
Franklinville Swedesboro Road
West Clayton Branch
Still Run
Richwood Aura Road
Ease Run
Little Beaverdam Branch
Scotland Run
Fries Mill Road
Kinard Branch
Tuckahoe Road
Blackwoodtown Road
Williamstown Franklinville Road
Hell Branch
Jericho Branch
Franklinville Monroe Road
Reed Branch
Muddy Run
UPPER PITTSGROVE
Buck Road
Elwell Branch
Coles Mill Road
Pennsylvania Avenue
Indian Branch
Middle Branch
FRANKLIN
Hays Branch
Marshall Mill Road
Dry Branch
MANTUA
PITTSGROVE
Willow Grove Pecktown Road
Malaga Branch
Dutch Mill Road
Gloucester County
Emilless Branch
Palatine Branch
Indian Run
Green Branch
Burnt Mill Branch
NEWFIELD
SALEM CO.
Maurice River
Burnt Mill Br.
Hudson Brook
Cumberland County
Atlantic County
Vineland
Buena
Blackwater Branch
Salem County
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0 1 2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.


Maurice River
WATERSHED
County Boundary
Municipal Boundary
Roads
Streams
Gloucester County
WATERSHEDS
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Hurffmans Creek
Maurice River
Great Egg Harbor
Lakes:
1 - Silver
2 - Wilson
3 - Garrison
4 - Elmer
5 - Franklinville
6 - Idle Acres
7 - Iona
8 - Timothy
9 - Malaga
10 - Willow Grove
11 - Palatine
12 - Centerton Pond
13 - Parvin
HARRISON
Glassboro
MONROE
ELK
Clayton
Academy Street
West Clayton
Franklinville Swedesboro Road
Still Run
Repaupo Alva Road
Ease Run
Little Beaverdam Branch
Beaverdam Branch
Scotland Run
Fries Mill Road
Kinard Branch
Tuckahoe Road
Blackwoodtown Road
Williamstown Franklinville Road
Hell Branch
Jericho Branch
Cokes Mill Road
Pennsylvania Avenue
Indian Branch
Middle Branch
Little Ease Run
Reed Branch
Franklinville Monroe Road
Muddy Run
UPPER PITTSGROVE
Buck Road
Elwell Branch
FRANKLIN
Hays Branch
Marshall Mill Road
Dry Branch
Malaga Branch
Dutch Mill Road
MANTUA
PITTSGROVE
Willow Grove Porchtown Road
Emilless Branch
Gloucester County
Palatine Branch
Indian Run
Green Branch
Burnt Mill Branch
NEWFIELD
SALEM CO.
Maurice River
Burnt Mill Br.
Hudson Brook
Cumberland County
Atlantic County
Salem County
Vineland
Long Branch
Blackwater Branch
Buena
1
2
3
4
5
6
7
8
9
10
11
12
13
47
55
40
322
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0
1
2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Oldmans Creek
WATERSHED



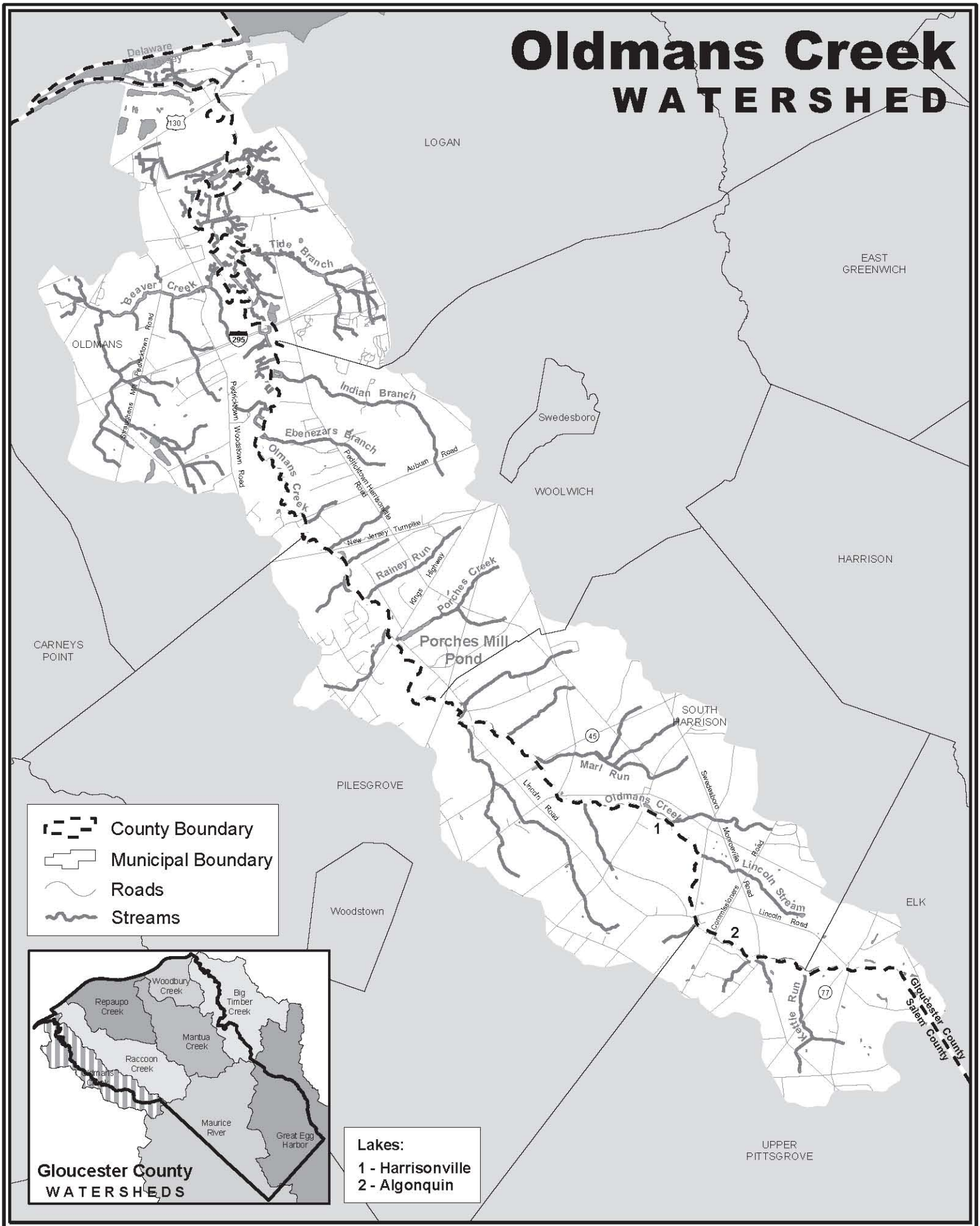
Lakes:
1 - Harrisonville
2 - Algonquin

DELAWARE VALLEY
REGIONAL PLANNING COMMISSION

0 1 2
Miles

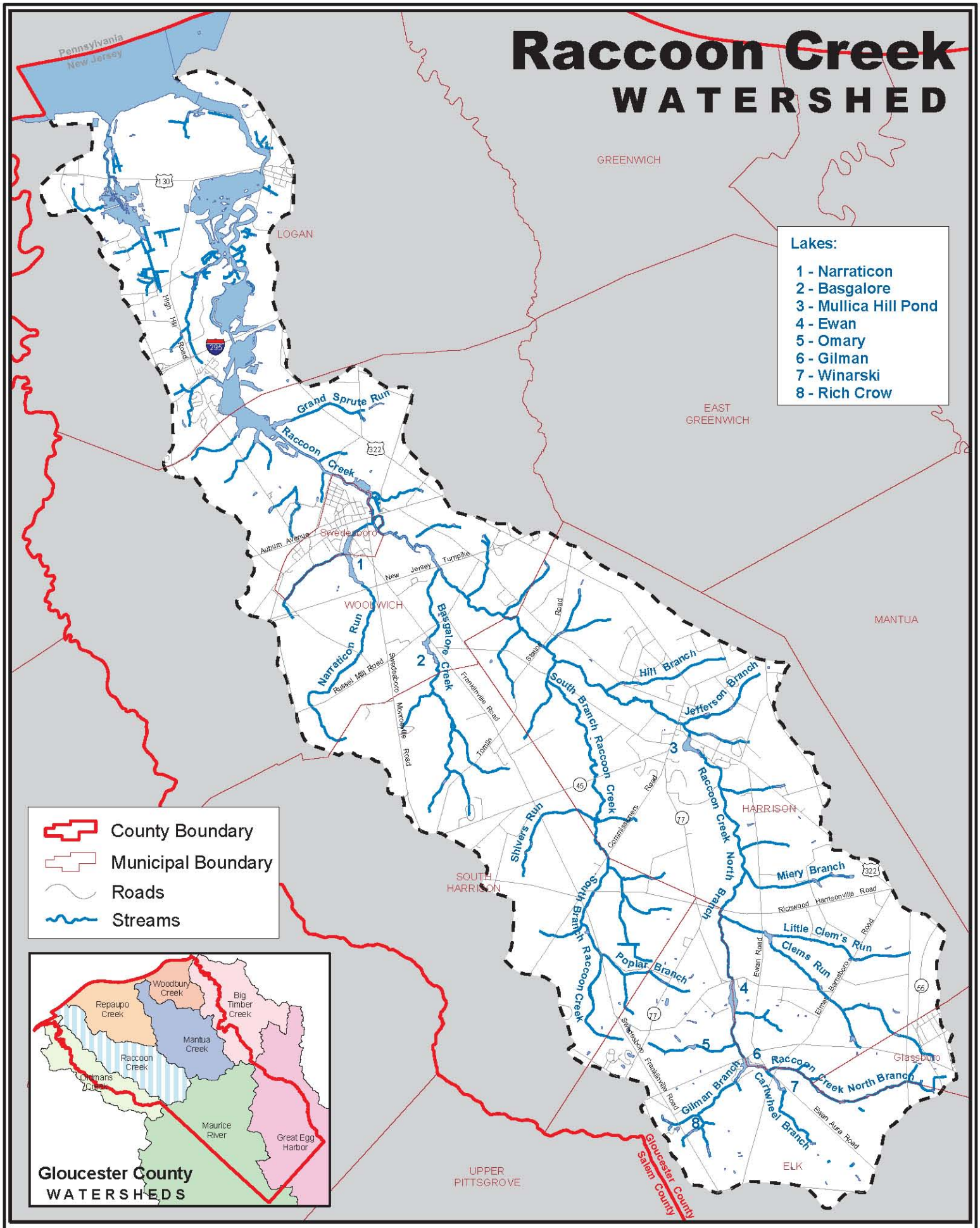
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

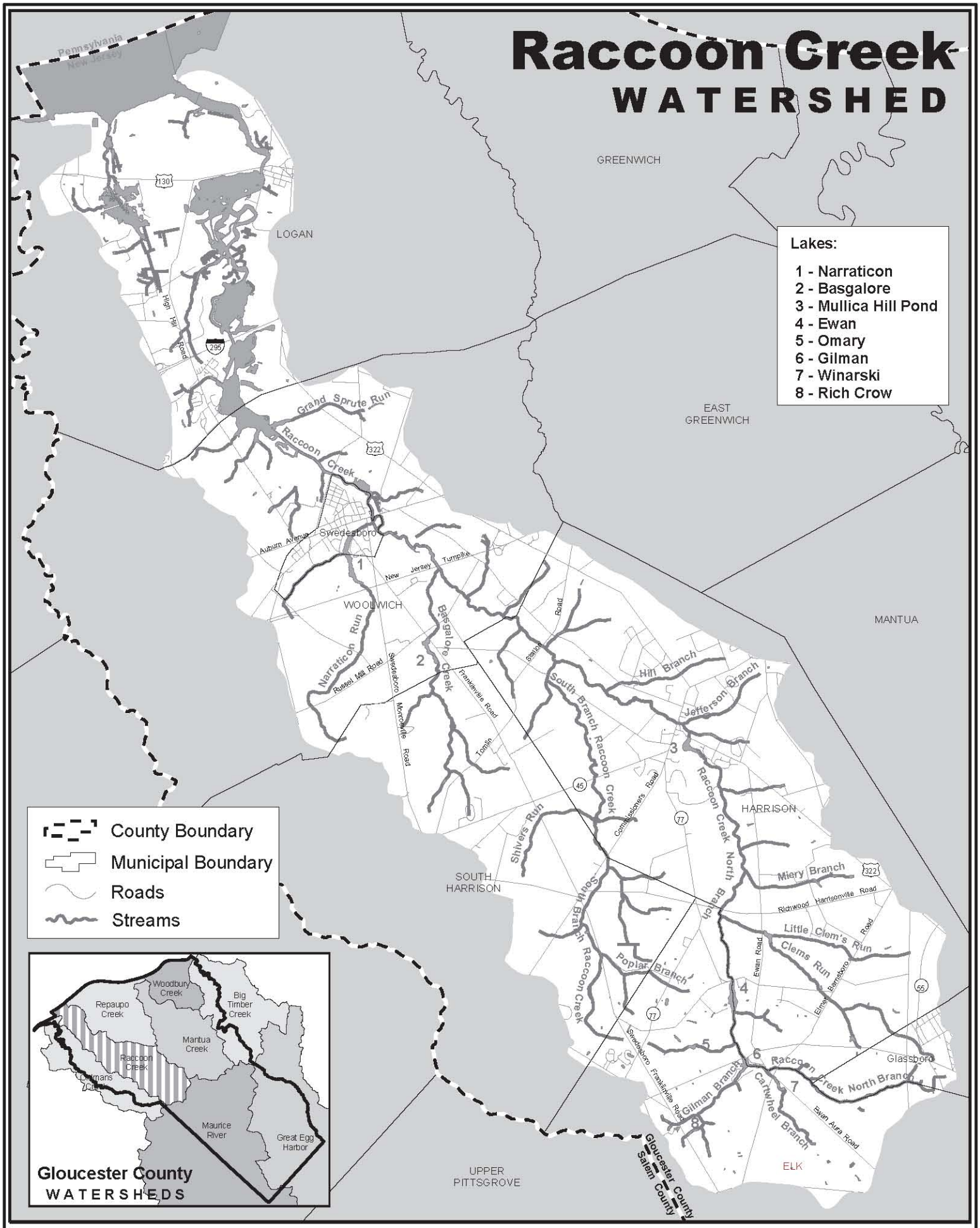
Oldmans Creek
WATERSHED



DELAWARE VALLEY
REGIONAL PLANNING COMMISSION

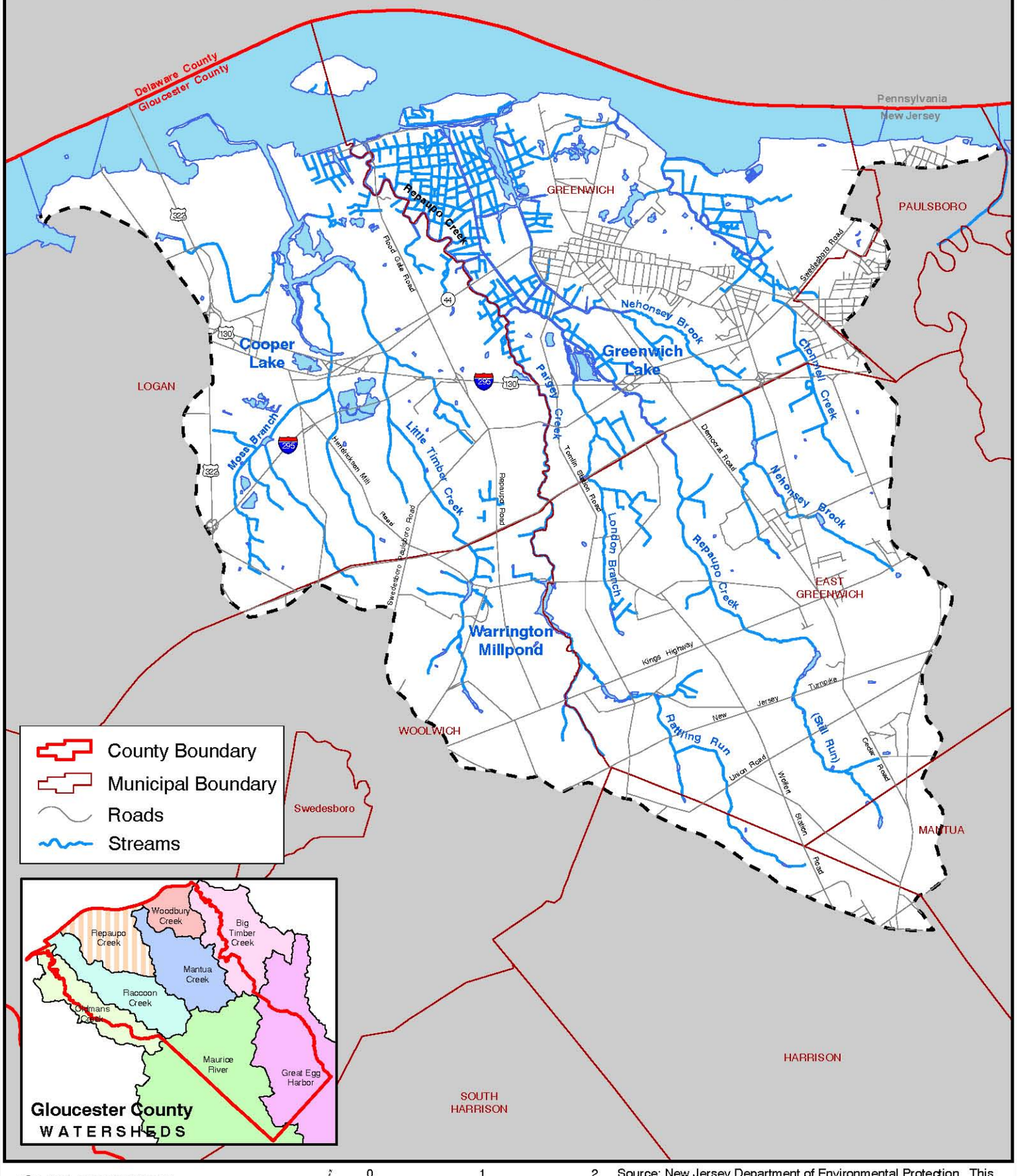
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.


Raccoon Creek
WATERSHED
Pennsylvania
New Jersey
GREENWICH
LOGAN
EAST GREENWICH
MANTUA
WOOLWICH
HARRISON
SOUTH HARRISON
UPPER PITTSGROVE
ELK
Glassboro
Swedesboro
Lakes:
1 - Narraticon
2 - Basgalore
3 - Mullica Hill Pond
4 - Ewan
5 - Omary
6 - Gilman
7 - Winarski
8 - Rich Crow
Grand Sprute Run
Raccoon Creek
Narraticon Run
Basgalore Creek
Hill Branch
Jefferson Branch
South Branch Raccoon Creek
Raccoon Creek North Branch
Shivers Run
Miery Branch
Little Clem's Run
Clems Run
Poplar Branch
Gilman Branch
Cartwheel Branch
Raccoon Creek North Branch
High Hill Road
Auburn Avenue
New Jersey Turnpike
Russel Mill Road
Swedesboro Road
Monroeville Road
Franklinville Road
Tomlin Station Road
Commissioners Road
Richwood Harrisonville Road
Ewan Road
Barnsboro Road
Ewan Aura Road
Gloucester County
Salem County
County Boundary
Municipal Boundary
Roads
Streams
Gloucester County
WATERSHEDS
Woodbury Creek
Repaupo Creek
Big Timber Creek
Mantua Creek
Raccoon Creek
Oldmans Creek
Maurice River
Great Egg Harbor
DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
0
1
2
Miles
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.



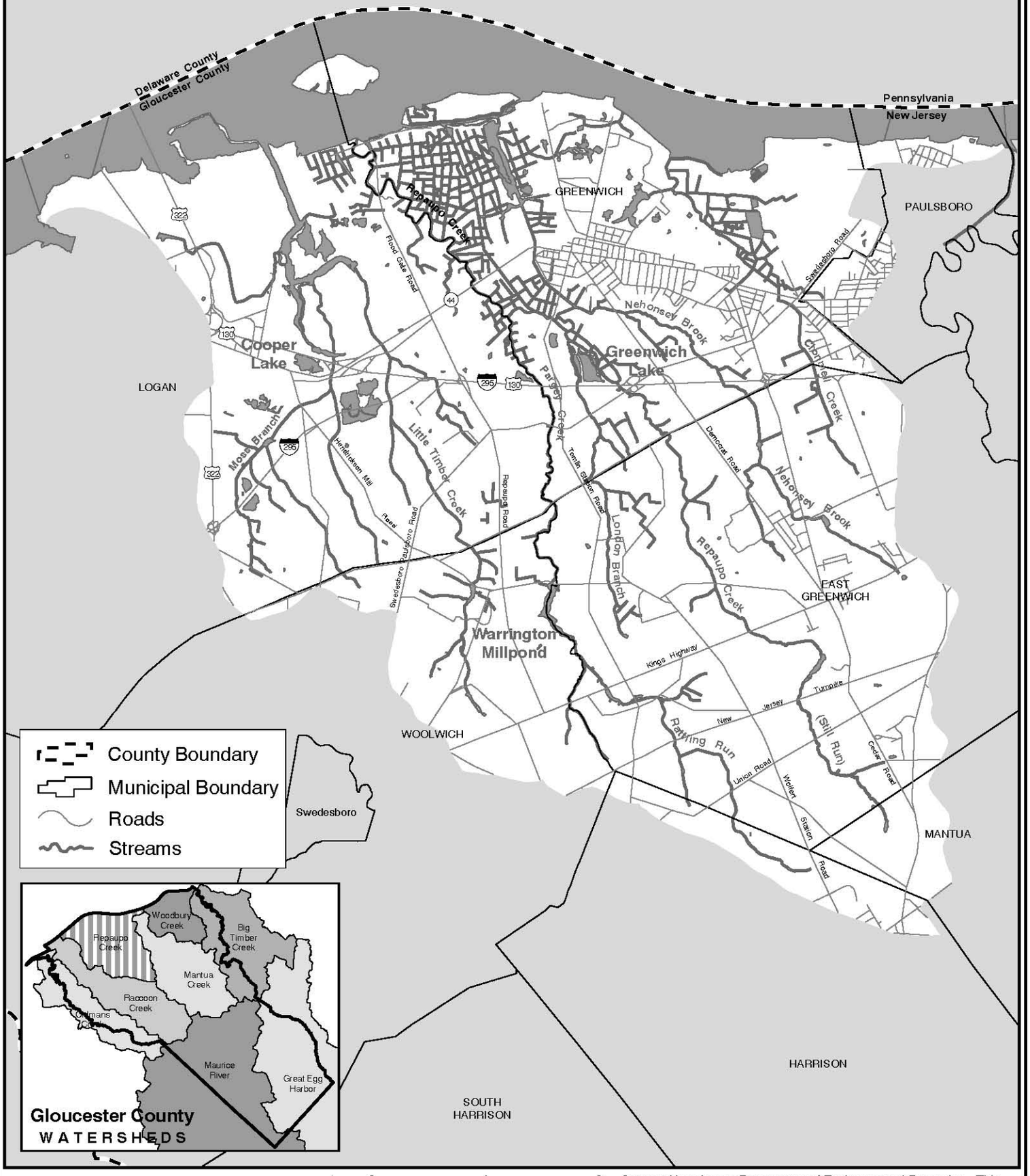
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Repaupo Creek
WATERSHED



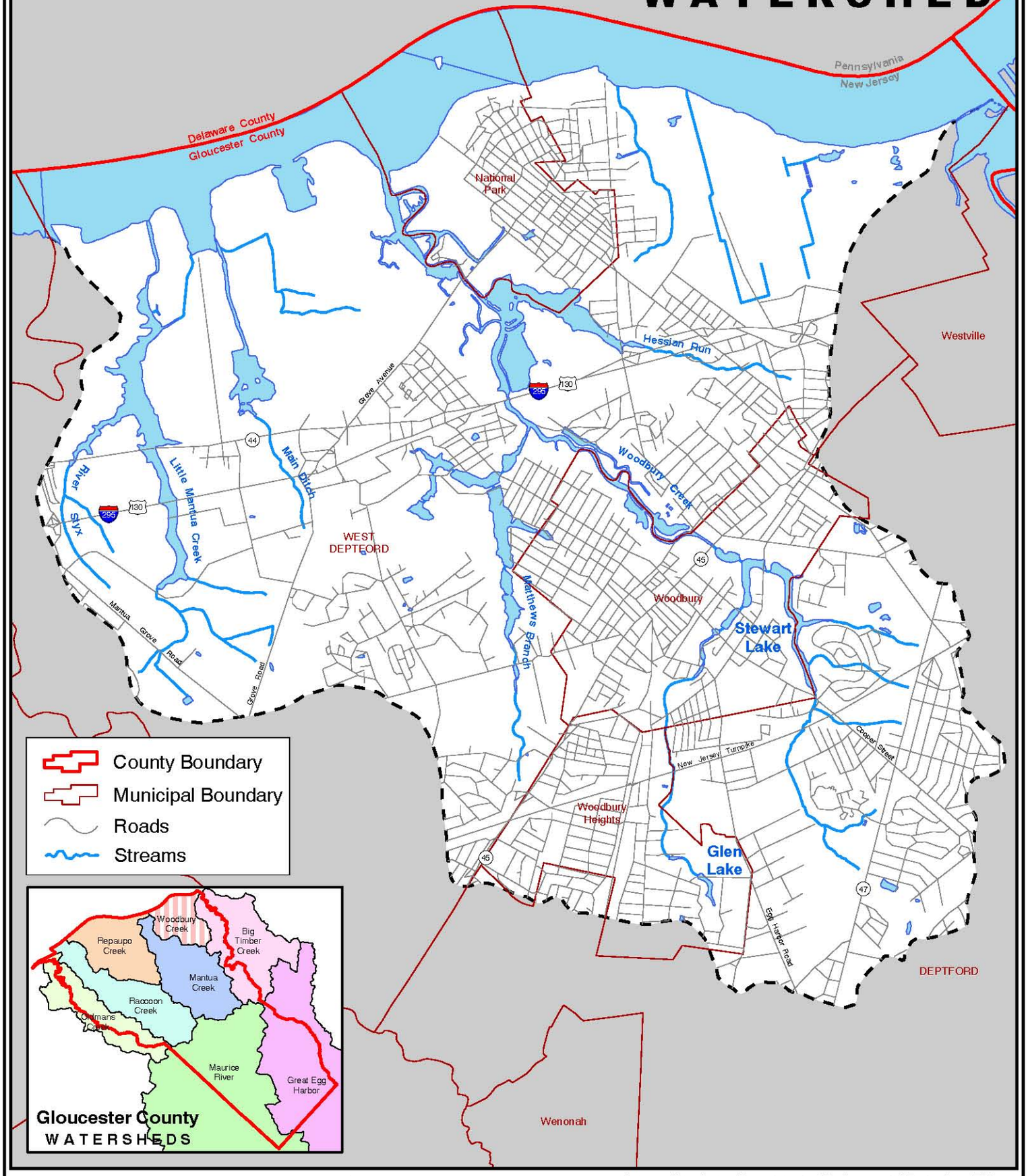
Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Repaupo Creek
WATERSHED



Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Woodbury Creek
WATERSHED

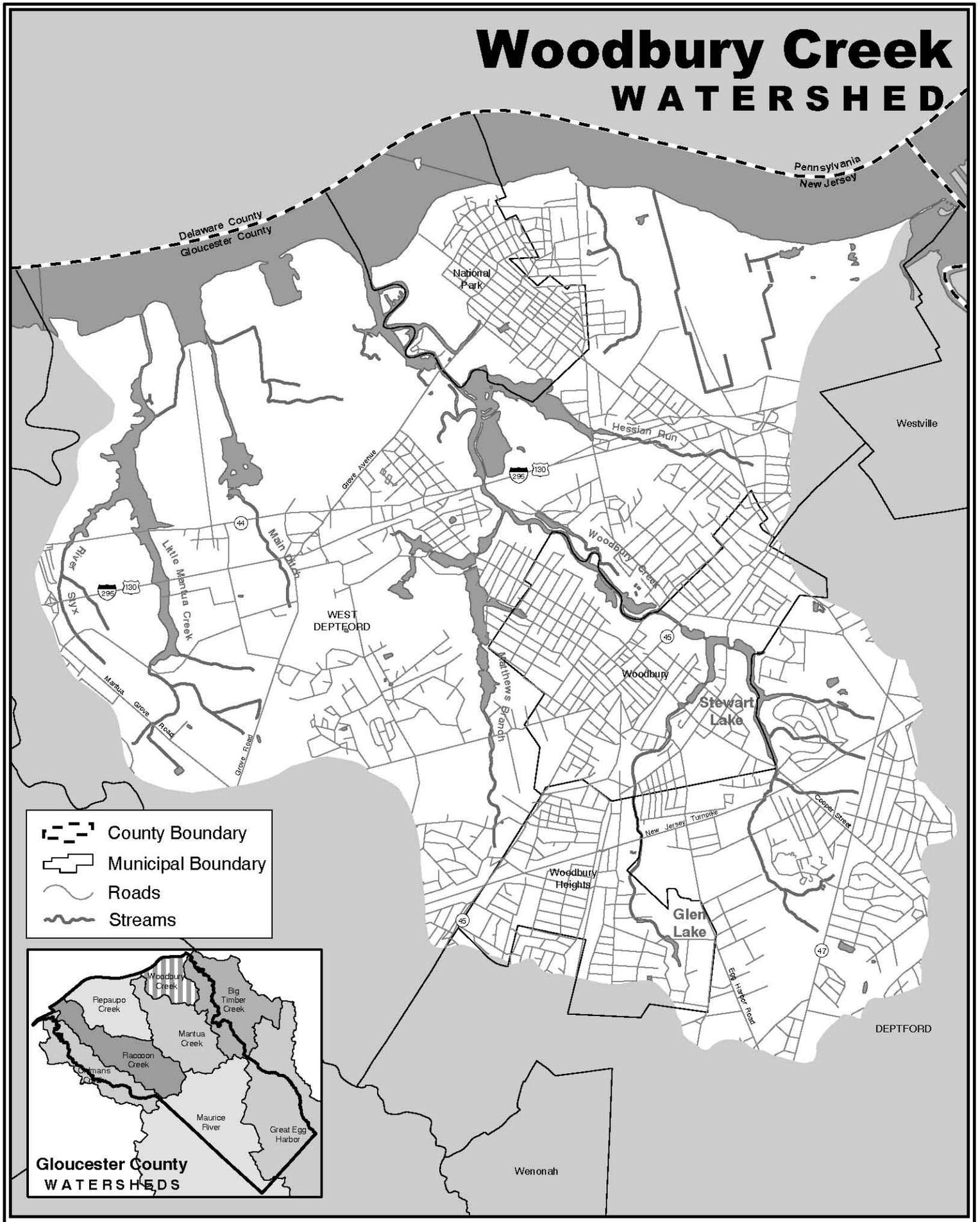


DELAWARE VALLEY
REGIONAL PLANNING COMMISSION

0 0.5 1
Miles

Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Woodbury Creek
WATERSHED



DELAWARE VALLEY
REGIONAL PLANNING COMMISSION

0 0.5 1
Miles

Source: New Jersey Department of Environmental Protection. This map was developed using NJDEP GIS Digital Data, but this secondary product has not been verified by NJDEP and is not state-authorized.

5. THE WATERSHEDS OF GLOUCESTER COUNTY: NATURAL AND HUMAN HISTORY

DEFINITIONS

Physiography: The study of a location in relation to its underlying geology.

Marl: A clay–sand soil with a high percentage of the mineral glauconite, which sometimes gives it a green color. Useful as a soil enricher when mixed into less fertile soils.

Floodplain: The land areas adjacent to a river or stream that are flooded during storm events.

TO DO

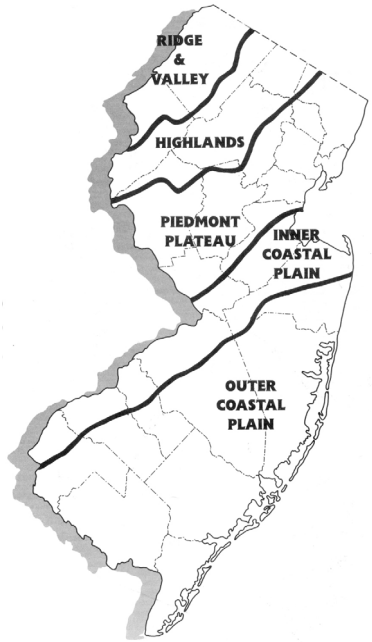
Use the *Who Am I?* game (**Appendix D**) to familiarize students with the wildlife of Gloucester County's watersheds.

NATURAL HISTORY

GEOGRAPHY

Gloucester County sits on the Atlantic Coastal Plain physiographic province of New Jersey. The state is divided into four such provinces, ranging from the rocky terrain of the Ridge and Valley Province at one extreme to the sands of the coast at the other. The Atlantic Coastal Plain is the most southerly of these four provinces in New Jersey.

The Atlantic Coastal Plain landscape is divided into Inner and Outer sections. The **Inner Coastal Plain** was formed during the Cretaceous Period (135 to 70 million years ago) by deposits of material that came from the breakdown and erosion of the Appalachian and Catskill mountains. This deposition was interrupted by layers laid down by the ocean, as the ocean shoreline advanced and receded over long stretches of time. The resulting geology is a stacking of layers of the eroded mountain rocks interspersed by marine deposits of sand and other materials. Inner Plain soils are quite fertile.



Source: NJ Audubon's Bridges to the Natural World

During the period of Inner Coastal Plain formation, dinosaurs still roamed the earth. In New Jersey the ocean shoreline came up as far as the Woodbury area. The region probably had good habitat for plant–eating, duck–billed dinosaurs such as *Hadrosaurus foulkii*, the first dinosaur discovered in North America, which was found in a marl pit in Haddonfield, Camden County. The skeleton of *Hadrosaurus foulkii* (named for its discoverer, William Foulke) is at the

Academy of Natural Sciences in Philadelphia and there is a model of the dinosaur in the State Museum in Trenton. *Hadrosaurs* undoubtedly roamed throughout the northwestern sections of Gloucester County.

The **Outer Coastal Plain**, which covers all of the rest of southern New Jersey, was formed more recently than the Inner Coastal Plain. It was laid down by the ocean and consists of unconsolidated deposits of quartz sand with some areas of gravel and clay, which developed during the mid to late part of the Cenozoic Era, 70 million years ago to the present. Outer Coastal Plain soils are less fertile than those of the Inner Coastal Plain and don't hold water as well. They become progressively less rich as one goes east, to the poor agricultural soils of the Pine Barrens, which are sandy, acidic, and "droughty" because rain water drains through them so rapidly.

See **Teacher Resources** for
- Additional information on natural history and
- A detailed list of potential field trip destinations with facilities that are in Gloucester County or close to its borders.

The dividing line between the two segments of the Coastal Plain is a belt of low hills, called a "cuesta," running northeast and southwest through southern New Jersey. These hills are the youngest of the Cretaceous formations and run from Monmouth County south to Gloucester County, becoming progressively lower in elevation from north to south. In Gloucester County they are low but identifiable in Harrison, Mantua, and Washington Townships. Many towns along the cuesta derive part of their name from these hills: Mount Holly, Mount Laurel, Pine Hill, and Mullica Hill are examples.

The **Inner Coastal Plain** lies to the west of these hills, with most surface waters starting in the hill area and draining toward the Delaware River. The **Outer Coastal Plain** slopes more gradually to the south and east, with drainage toward the Delaware Bay or the Atlantic Ocean, although some streams start in the Outer Coastal Plain and flow toward the Delaware River. The Raccoon and Oldmans Creeks are examples.

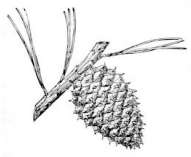
Big Timber Creek

Source: DVRPC

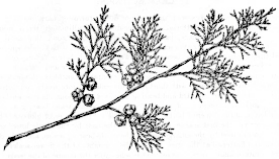
VEGETATION OF GLOUCESTER COUNTY

White Oak

Pitch Pine



Atlantic White Cedar



The differences in geology within Gloucester County generate different kinds of soils that support characteristic vegetation. On the Inner Coastal Plain, with its more fertile soils, Gloucester County was once covered with a forest of mixed deciduous trees. Pockets of this forest survive, especially on steep streamside slopes and in some forest preserves. Trees on many community streets and in parks often reflect this forest type, with its white, black and red oaks, beech trees and, in some areas, tulip poplar, sweet gum, red maple, hickories, and ash trees. However, many street and park trees today are imported varieties that have been planted because of their hardiness or attractiveness.

As one moves southeast across Gloucester County, the vegetation ranges gradually into Pineland varieties. The original forests were mixed oak–pine. Where fire was, or is, a key factor, they are pine-dominated. Oak species are mixes of black, red, and white. The principal pines are pitch, short-leaf and Virginia, but pitch pine dominates.

Wetland areas were once more abundant throughout all of the state. Draining and filling have reduced wetland habitats, which were found primarily in the floodplains of stream corridors and where the streams flowed into the Delaware River. Wetland habitats still exist in many of these locations, although some tidal wetlands along the Delaware shore were filled with sediments dredged to maintain the Delaware River channel depth. Pineland areas of Gloucester County still have extensive wetlands, especially within the Great Egg Harbor River watershed. There, red maples and black gum trees are most prevalent and stands of Atlantic white cedar trees are still found. Stream water tends to be more acidic, slow moving, and shallow. The water is tinted brown by the high iron content of the soil and the leaching of roots and leaves from cedar and oak trees and is referred to as "cedar water."

Gloucester County is a world stronghold of **Swamp Pink**, *Helonias bullata*, which is a wetland plant that produces a beautiful pink flowering cluster at the top of its 12-inch stalk. Swamp Pink can only live in certain wetland habitats and its populations are easily damaged or destroyed, especially by filling or smothering with sediment, and by drops in water levels within its wetland habitat resulting from increased pumping of groundwater. It is listed as an endangered plant on the New Jersey Endangered and Threatened Species list. Swamp Pink populations are found in the headwater wetland areas of the Big Timber River, the Mantua, Raccoon, and Oldmans Creeks, and in Pineland areas.

Swamp Pink

Photo: Michael A. Hogan

ANIMALS OF GLOUCESTER COUNTY

A surprising array of wildlife is found throughout Gloucester County and much of it is associated with water. Besides those species that live in water for all or part of their lives, 90 percent of all terrestrial (land) species visit a water body every day. **Bald eagles** are known to nest along the Raccoon and Oldmans Creeks. **Great blue herons** are abundant on county ponds, lakes, and marshes. **Migrating birds** fly north in spring along the Delaware River corridor. Flights of smaller woodland species that are heading to New England and Canada to nest are often sighted in Logan and Greenwich Townships and at sites in West Deptford and Westville. **Barred owls** are found in the wet forests of Franklin and Monroe Townships. **Frogs and salamanders** breed in small ponds and remaining wetland areas in the western half of the county, and in parts of the more agricultural and Pineland areas in the eastern townships. The county also boasts important sites for endangered and threatened species such as **bog turtles** and a variety of butterflies and moths.

In **Pineland areas** of Gloucester County (the same as the Great Egg Harbor River watershed area within the County), there are species of animal life that are rare outside this ecosystem. These include some small hair streak and elfin butterflies, species of another butterfly group called "skippers," various moth species, the black-banded sunfish, the Pine Barrens tree frog, the carpenter frog, and the Northern Pine snake.

Streams, lakes, and wetlands contain microscopic organisms that feed upon plant material or other smaller creatures, and are fed upon, in turn, by many **small aquatic animals**. These macroinvertebrates are food sources for fish and amphibians, which are, in turn, prey for great blue herons, raccoons, bald eagles, and ospreys. The diversity of the macroinvertebrate community – the number of species and the particular types – are also an important measure of water quality, because of their different tolerances to pollutants. They are sampled by the NJ Department of Environmental Protection, and local watershed association water monitoring programs, as a means of assessing the health of a stream or lake.

Freshwater **mussels,** relatives of clams, are still found in some Gloucester streams. These mollusks are filter-feeders and are sensitive to excess silting of stream waters, and to pollution. Several species of freshwater mussels have declined due to reduced water quality in freshwater streams. Mussels have an interesting life cycle that involves hitching a ride on a fish of a particular species during their young lives in order to complete their larval development.

Fish populations in Gloucester County have begun a slow recovery from the days when the Delaware River was extremely polluted. Shad numbers along the Delaware have increased over the past 10 years. A fish ladder on Woodbury Creek and one that is partly completed at Blackwood Lake on the Big Timber Creek will allow migrating varieties to return to their historic upstream spawning grounds. Although fish populations are at good levels throughout the county, there are still state Health Advisories against eating several of the fish species in Gloucester waters, due to the concentration of contaminants in some fish from river, stream, and lake sediments. These contaminants include such human health hazards as mercury, found in certain lake species, and polychlorinated biphenyls (PCBs), in some fish in tidal waters.

DEFINITION

Macroinvertebrates: Animals lacking backbones and internal skeletons (invertebrates) that are large enough to be seen by the naked eye (macro). Includes insects, crustaceans (such as crayfish), mollusks (clams, mussels and snails), and worms. Many of these animals spend all or part of their lives in water. Some insects, such as dragonflies, spend their juvenile lives in water and their adult lives on land.

Macroinvertebrates are relatively simple to collect from shallow stream bottoms. More species and groups are found in pristine waterways than in polluted ones.

Dragonflies

Nymph *Adult*

For information on Fish Advisories, obtain a copy of *New Jersey Fish & Wildlife Digest*, the publication of the Fish and Wildlife Division of NJDEP, or read it online at www.state.nj.us/dep/dsr/njmainfish.htm.

HUMAN HISTORY

For a list of Gloucester County historic sites see www.co.gloucester.nj.us/sites.htm

As early as 12,000 years ago, Native Americans inhabited the watersheds of what is now Gloucester County, living in seminomadic, hunter-gatherer communities. By the time the first Europeans arrived, these Lenape people, as they came to be called, were found residing in villages near the tidal portions of the streams that flow to the Delaware River. ("Lenape" is a term meaning "ordinary people.") Separate bands of Lenape people had various names. Amewamexes were found along the Big Timber Creek, the Manteses were along the Mantua, the Narraticons were located along Raccoon Creek ("narraticon" means "raccoon" in the Lenape language), and the Kagkakaini Sakins were residents of the Mosackas (Oldmans Creek) area.

Native Americans in the area employed a garden style of agriculture, in which crops in small plots were dug with hoes and digging sticks. They farmed and fished during warm seasons, moving in the winter to the more inland, headwater areas for hunting. Relations between the Lenape (or "Delaware Indians" as they were also called) and early Europeans were generally peaceful, although European diseases like smallpox and measles caused significant reductions in Native American communities. The legacy of Native Americans is represented by many place names that are still in use today such as "Narraticon" Lake, "Monongehela" Creek, and "Wenonah" Borough.

Early Settlement

When the first Dutch explorers sailed up the Delaware River in 1623, they called the river the Zuydt, or South River, to distinguish it from the North River, their name for the Hudson. Swedish, Finnish and Lapp settlers joined the Dutch in 1638 and founded small towns along the waterbodies of present-day Gloucester County. An early Swedish settlement was at the mouth of the Raccoon Creek and was named "New Stockholm" in honor of Sweden's capital city. This site is near modern-day Bridgeport. In 1664, the Dutch ceded control of their New World holdings to the English, and southern New Jersey became a proprietary colony. English and Irish Quakers had arrived in New Jersey in 1661 at the invitation of William Penn, with the first "official" group arriving in 1677 aboard the ship *Kent*. They renamed the large (Delaware) river in honor of Sir Thomas West, Lord de la Warr.

Under British authority, the settlers designated most of southern New Jersey as the Province of West Jersey and divided land into ten portions, or tenths, running from the Delaware River back into the Pineland forests. These lands were further divided and sold to individual settlers. The third tenth was purchased from the Indians in 1677. It extended from the Pennsauken Creek to the Timber Creek (the boundaries of modern Camden County). The fourth tenth, south of it, was also bought in the same year. It extended from Timber Creek to Oldman's Creek (modern Gloucester County boundaries), and stretched eastward all the way to the Atlantic Ocean. The third and fourth tenths were merged to become Old

Gloucester County in 1686. Gloucester Point (Gloucester City) was selected as the county seat. A century later, in 1786, county citizens voted to move the county seat from Gloucester City to Woodbury, a more centralized location in Old Gloucester County. In 1837, the New Jersey Assembly divided Old Gloucester County and formed Atlantic County. Later still, in 1844, Camden County was separated off.

Agriculture

Early settlers found a land with extensive marshes in the tidal portions of each small river, and large, virgin (uncut) forests on the higher ground. Wooded lands in southern New Jersey were extensive. An early record refers to Barnsboro, in modern Mantua Township, as being on the edge of the forest that stretched away toward the east. The Dutch and Swedish settlers were accustomed to water travel, and founded their towns along the creeks and rivers of Gloucester County as far upstream as boats could travel, such as to Swedesboro on the Raccoon Creek. The rich soils near the Delaware River, and on ground between the tributary creeks, supported productive forests. These were harvested for timber, which was moved to market along the creeks. The cleared land was then used for intensive agriculture. Early settlers employed a system of dikes and floodgates to drain rich marshland and to hold back flood waters of the Delaware River. Some of these structures still are in use today, principally in the Repaupo watershed.

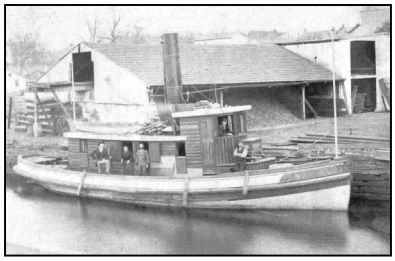
A roadside farm market

Source: Teacher's Guide to the Great Swamp Watershed

By the 1800s many sawmills and gristmills had been built throughout the County. These were powered by damming the smaller tributaries to form millponds and lakes. Indeed, all southern New Jersey lakes are man-made and were formed in this way, although most of the mills that they powered are long gone.

Farming has always been a principal industry in much of Gloucester County. There are good soils throughout the area. Some of the richest soils in all of New Jersey are found on the inner coastal plain in Gloucester County. From its beginnings, Gloucester County was rich in fruit production, especially peaches, apples, and berries (in Pinelands areas). Certain fruits and vegetables were developed in the County, including an important variety of the Red Delicious apple and several varieties of tomatoes. Sweet potatoes were also an important crop in the area, along with asparagus. Some of the earliest innovations in canning vegetables also occurred in Gloucester County, particularly through the endeavors of the Edgar Hurff Company in Swedesboro, which was also, at one time, the largest seed business in the world. Although peaches are still an important crop in Gloucester County, many changes have occurred that have substantially changed farming in the area. These include the rise of global markets and global competition and the decline of the vegetable and fruit packing plants that were once numerous in the region.

Passenger boat docked at the wharf on Wood Street, Woodbury, 1910.



Source: Gloucester County Historical Society

Transportation

Native Americans made the first footpaths through much of southern New Jersey as they searched for water sources and hunting grounds. Colonial travel, especially the movement of freight, was also carried out via streams. Boats plied the small rivers of Gloucester County, running along the Big Timber, Woodbury, Mantua, and Raccoon Creeks to Philadelphia. These vessels transported people, but were most important for the movement of food crops from the farmlands of Gloucester County to Philadelphia markets. Travel by road was very difficult

until bridges could be built. One of the earliest was authorized in 1687 over the upper branch of the Big Timber Creek. An early public road was the King's Highway, connecting Burlington City to Salem along the Delaware River in 1702.

Paulsboro Railroad Station, constructed in the mid-1870s.

Source: Gloucester County Historical Society

In the mid 1800s, railroads began to be built running from Camden City through Gloucester County. These served farmers, spurred the growth of towns, and supported mills and glassworks in towns such as Woodbury, Glassboro, and Malaga. Glass making was an important industry in these towns and others, such as Clayton, for many decades. Railroads were also the key to the growth of particular communities in the County. During the second half of the nineteenth century and into the twentieth century, the placement of railroad station stops served as the nucleus for land development projects that helped to create the towns of Woodbury Heights, Wenonah, Sewell, Pitman, and Newfield.

Modern industry in Gloucester County developed largely along the Delaware River and includes oil refineries and chemical plants. The suburban commercial and residential growth that has characterized the past 50 years has tended to follow the building of roadways, including Delsea Drive in the 1940s, the New Jersey Turnpike (opened 1961), Interstate 295 and Route 42 by the 1970s and, most recently in the late 1980s, Route 55.

Twentieth Century Growth and Effects on Water Quality

The development that occurred during the 1950s to 1970s increased the amount of paved surfaces throughout the county and the need to channel stormwater into local streams, in order to prevent flooding. This began to have major impacts on stream conditions. Local sewer treatment plants that handled wastewater (sewage) could not adequately accommodate the growth. Environmental regulations, in general, were weak during this period. Many Gloucester County streams became very polluted by sewage, and many lakes began to fill with sediment from construction runoff.

Following the adoption of the federal Clean Water Act in 1972, environmental regulations became stronger and environmental conditions began to improve. However, it was the opening of the Gloucester County Utilities Authority (GCUA) treatment plant in 1973 that had the greatest impact on reducing the pollution of Gloucester County's streams and lakes. Sewer lines were connected throughout much of the county, capturing sewage from residences, businesses, and industry, and allowing the shutdown of the inadequate local treatment plants. Today, these lines carry much of Gloucester County's sewage to the GCUA's treatment plant on the Delaware waterfront. Together with updated local treatment facilities in Logan and Harrison Townships and in the Borough of Swedesboro, the GCUA eliminated an enormous health hazard and environmental problem.

Stormwater runoff is now recognized as a primary source of pollution to area waterways. Reducing runoff, and the contaminants in it, is proving to be almost as difficult a challenge as the sewage and factory pollution of earlier decades. This is particularly true because reducing stormwater pollution depends on multiple factors: changing people's behavior, expensive retrofitting of

TO DO

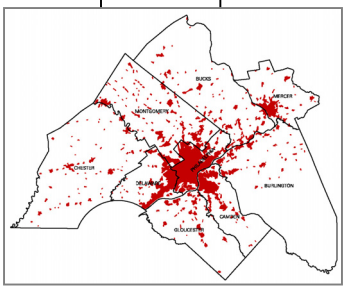
Have students carry out the activity, *How Does Your Watershed Grow?* (**Appendix E**). How much has the population of their town grown since 1950 and how might the increase in population affect the watersheds?

Students will be able to find 2000 census figures for their town using American Fact Finder™ at the website: http://landview.census.gov.

1950 census figures are included in Appendix E.

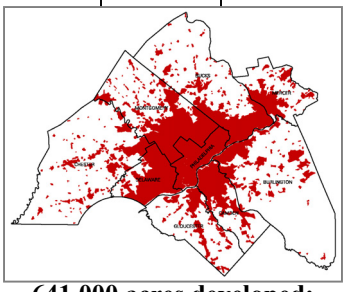
Development in the Philadelphia Metropolitan Region

1930



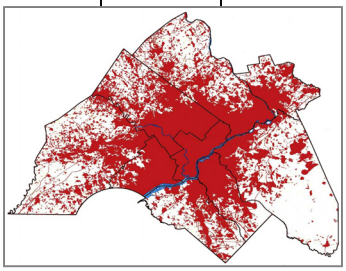
222,000 acres developed; 3.3 million people

1970



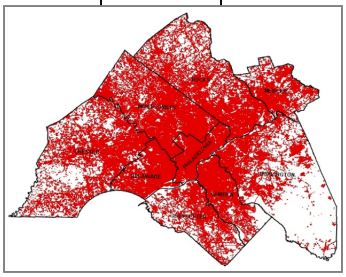
641,000 acres developed; 5.1 million people

1990



803,000 acres developed; 5.1 million people

2000



919,919 acres developed 5.4 million people

Source: DVRPC

stormwater systems, and better management of land. Recent national regulations require municipalities to begin controlling local stormwater systems so as to reduce pollutants within local stormwater. These regulations require public cooperation and understanding of the impacts of residential lawn care, litter disposal, pet waste and feeding of wildlife. They also require new development to manage stormwater so that less of it is carried to local streams.

The Pinelands

In the Pinelands regions at the center of southern New Jersey, there was recognition of the need for land-use management and groundwater protection as early as 1972. The Pinelands Comprehensive Management Plan, which was adopted in 1980, controls growth in parts of Monroe and Franklin Townships. The Pinelands protections arose, in part, because of proposals for transporting groundwater from beneath the Pinelands to other regions for water supply. Indeed, it was a similar plan in the 1800s – to utilize the groundwater as a source for Philadelphia – that led Joseph Wharton to acquire the extensive lands that are now named for him (the Wharton State Forest). It is also the groundwater, and its closeness to the surface in this area, that is responsible for the extensive wetlands found within the Great Egg Harbor River watershed in Gloucester County, with all its rich habitat and important species.

Suburban Sprawl

Suburban sprawl has been occurring in the Delaware Valley over the past fifty years, and threatens to destroy the farming communities in Gloucester County. The decline of industrial centers, combined with the expansion of automobile corridors, led to the growth of suburbia, which, in turn, resulted in further decline of urban centers and negative effects on first generation suburban communities. Gloucester County's population has grown during this period, as residents of urban centers (Philadelphia and Camden) moved to developing rural areas.

Since 1970, the population of the Philadelphia metropolitan region as a whole has remained stable (less than 1 percent increase) but the amount of developed land has expanded by nearly half (43.5 percent). These are the defining features of "sprawl," which continues to affect Gloucester County.

Source: DVRPC

6. DRINKING WATER

DEFINITIONS

Saturated zone: The underground area in which water is held in the pores and spaces within the sediments or rock. Sediments in southern New Jersey aquifers are made up of sand, silt, clay, and gravel particles. The water within the saturated zone is groundwater.

Unconfined aquifer: An aquifer that is close to the surface, in which the water table rises and falls freely with infiltration of rainwater. Also called a "water table aquifer."

Water table: The top of the saturated zone in an unconfined aquifer.

Outcrop: The area where an aquifer is present at or near the land surface – where it "crops out."

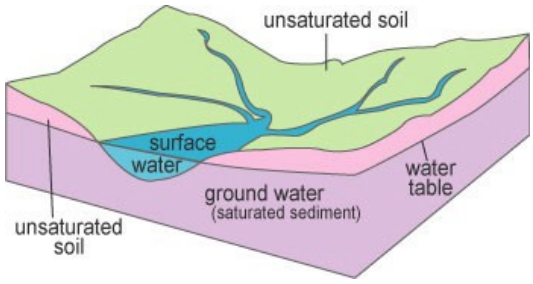
TO DO

Have students participate in the *Every Drop Counts activity* (**Appendix F**) to learn about conservation of drinking water.

SOURCES

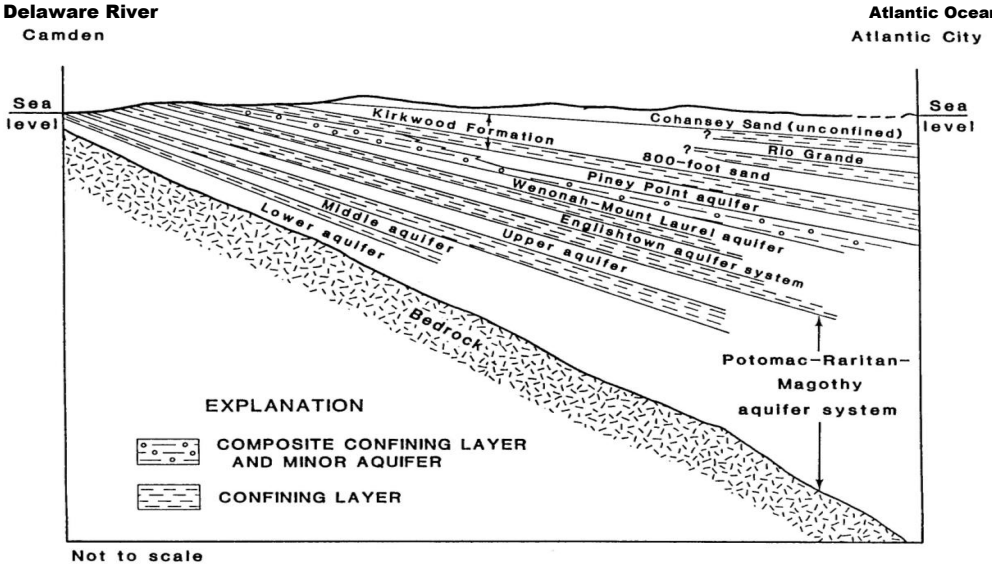
We all know that our drinking water comes out of the faucet, and that it is supplied by pipes, usually in the basement of a house or business. Depending on where you are in Gloucester County, these pipes are either hooked into a public water supply system – pipes running under the streets – or they come directly from an individual pump and well on the property itself.

Both the public supply system and private wells draw water from the ground. When it rains, water percolates, or seeps, down through the topsoil into the underlying layers of soil, gravel and sand, filling (saturating) the spaces, or pores, between the sediment particles. This water is called groundwater. There is a vast amount of groundwater found in these underlying layers.



Source: Modified from US Geological Survey

The geology of Gloucester County is that of a tilted "layer cake" or strata of gravels, sands, silts, and clays. The saturated gravel and sand layers, with their large pore spaces, are the aquifers, from which water is drawn through wells. The silt and clay layers, which impede the movement of water, are called confining beds.

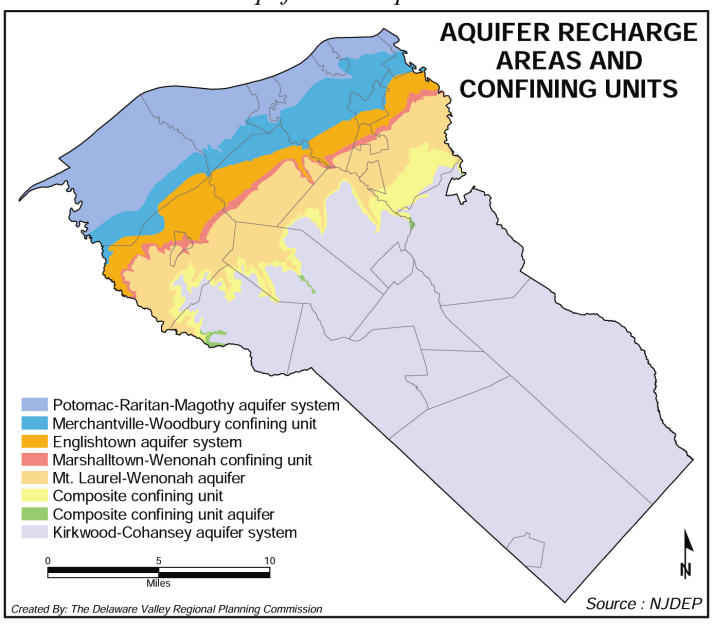


Source: US Geological Survey

Three major aquifers exist beneath Gloucester County. They are the Potomac – Raritan – Magothy (called the PRM), the Wenonah – Mount Laurel, and the Kirkwood – Cohansey. The first two are confined aquifers, meaning that there are layers of less permeable material (silt and clay), which generally isolate the water-bearing layers from each other. These confining layers also protect the aquifer from contamination that might seep down into the groundwater from the land surface. The Kirkwood – Cohansey is close to the surface in eastern Gloucester County. Because it is unconfined, rainwater can get into it easily and resupply (recharge) the aquifer. This also makes it more vulnerable to surface contamination.

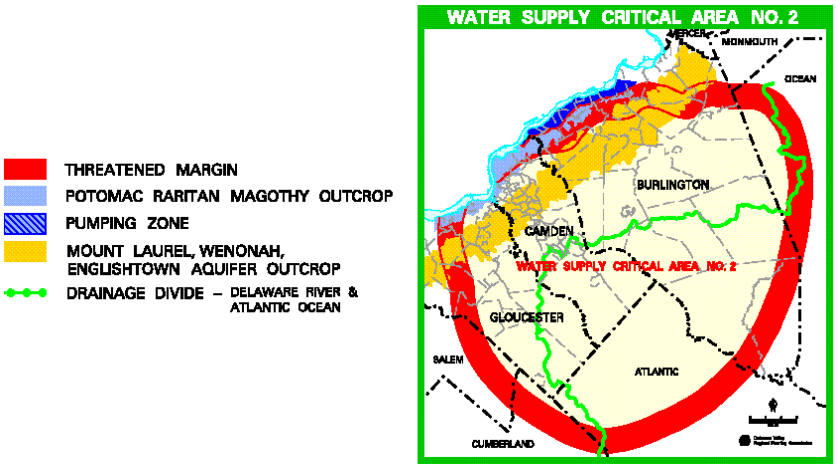
The Coastal Plain aquifers are not horizontal but tilt to the southeast, getting deeper as they cross southern New Jersey toward the Atlantic Ocean. Because of this tilting, each aquifer emerges on the land surface in a sequential manner. Water enters (recharges) each aquifer from rainfall directly on its outcrop.[1]

Aquifer Outcrop Areas



The PRM yields the most water of the three aquifers and is the primary water supply in the western half of Gloucester County, as well as in Burlington and Camden Counties and across the river in the heavily developed northern part of the state of Delaware. Because it supplies drinking water to so many people, there has been a significant decline in its water levels. This became so serious that the New Jersey Department of Environmental Protection established Water Supply Critical Area #2 in 1986. All water supply companies (companies and municipal utilities) within Critical Area #2 were given annual limits on water withdrawals in the PRM. Usage from the PRM was cut back by over 20 percent and no increases in pumping were allowed.

[1] Information on Gloucester County aquifers comes from an article by Anthony S. Navoy, PhD., U.S. Geological Survey, "Gloucester County Ground-Water Resources and Issues" in the early spring Issue 2001 of *Watershed Newsletter*; issued by the Federation of Gloucester County Watersheds and the South Jersey Land Trust.

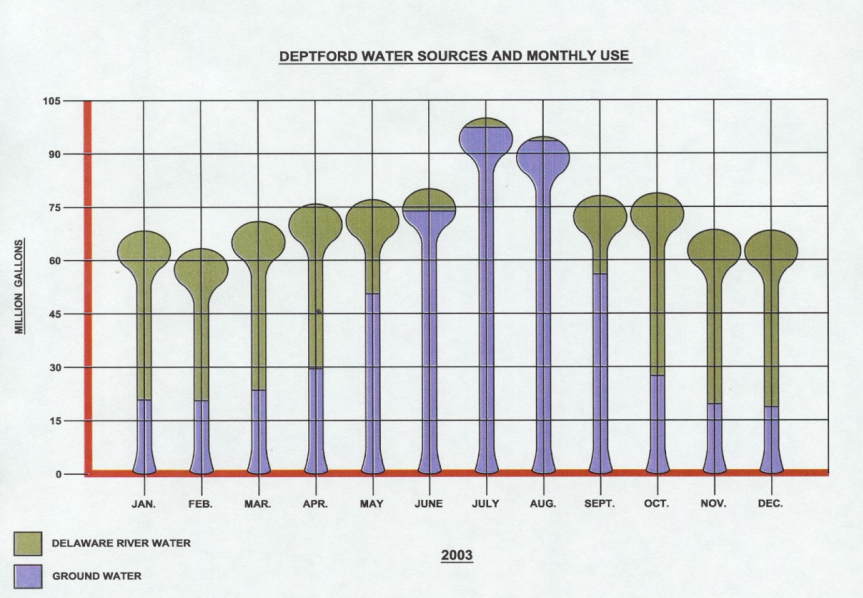


Source: DVRPC

Alternative water–supply sources were developed from the other two aquifers where possible and a pipeline was constructed by the New Jersey–American Water Company that draws water from the Delaware River. This water is thoroughly treated at the company's plant, tested for its purity, and then sent by pipes to local public water supply utilities. There it is used directly or mixed with groundwater drawn up locally and is piped along to customers.

In the course of the year, local **water usage** varies by season. Throughout the summer, as more people fill pools, wash cars, and water lawns, the usage goes up and more water is drawn from the aquifers.

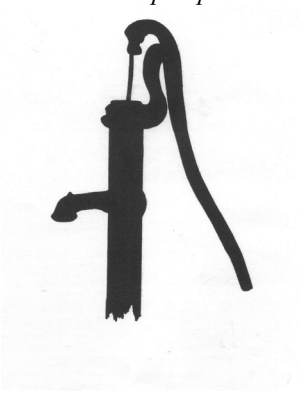
Deptford's water usage is typical of municipalities and private water suppliers in Gloucester County, all of which are drawing groundwater from the aquifers. Some water utilities, like Deptford, supplement their supply with treated Delaware River water. In the summer, Deptford uses more groundwater. In seasons when demand is lower, the more expensive treated river water is utilized to a greater extent.



Source: New Jersey – American Water Company

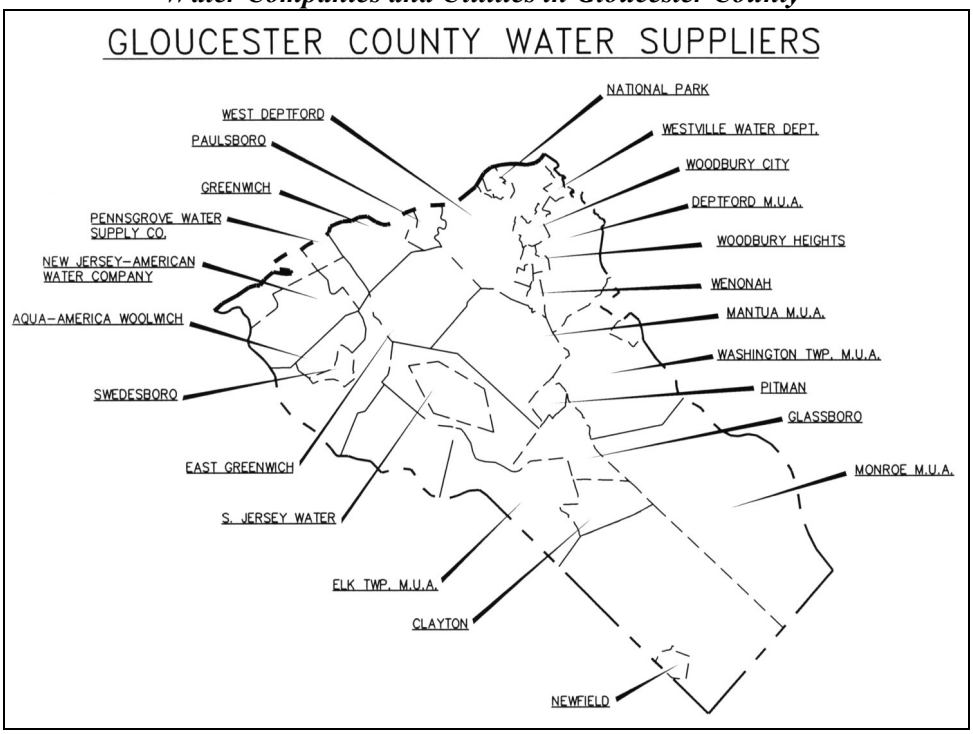
The western half of the County is served by various **public water utilities and companies** that maintain large pumping stations. These facilities usually pump water from several wells and often store it in a large water tank, from which it is sent by pipes to homes and businesses in the area.

An old-fashioned well pump



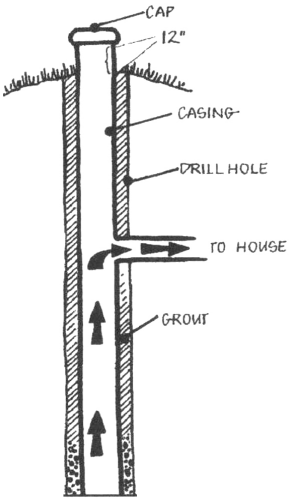
Modern well pumps are either part of the well in the ground or are separate enclosed cylinders that are attached to a water tank within the residence or business.

Water Companies and Utilities in Gloucester County



Source: New Jersey – American Water Company

The top of a modern drilled well



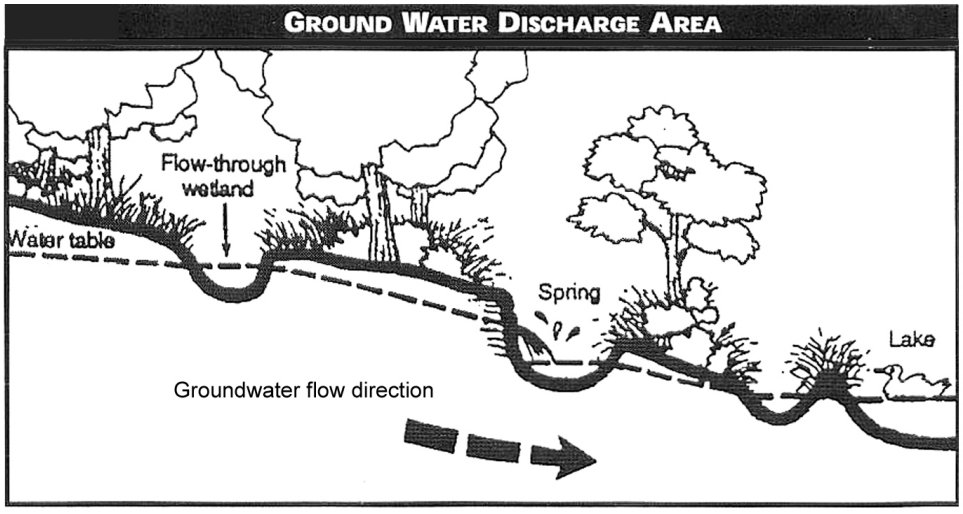
Many people living in the southeastern part of Gloucester County, including farmers who irrigate their fields, rely on **private wells** that draw water directly from the Kirkwood – Cohansey aquifer. A well is basically a hole drilled into an aquifer. A pipe and a pump on the property are used to pull water out of the ground and must be individually maintained by the resident. Protecting the groundwater under their property is an important responsibility for individual homeowners in these communities.

A barred owl – a species of forested wetlands

GROUNDWATER AND STREAMS

In areas where the aquifer is close to the surface, as in the southeastern half of Gloucester County, which is underlain by the Kirkwood – Cohansey aquifer, the relationship between groundwater and streams is very direct. Infiltrating water percolates down through topsoil to the water table. The water table is the top of the water held in the sediment and sand spaces (also called the saturated zone). Infiltrating water then begins to move with the groundwater flow, which follows a downhill, or down-slope direction. It moves very slowly, especially compared to water in streams or rivers. In southeastern Gloucester County, the general down-slope direction is to the southeast.

When the groundwater intersects with a water body such as a lake or stream, it emerges as a spring entering into and "recharging" the water body. It can also emerge from a hillside as a spring or seep. Streams and wetlands in southeastern Gloucester County are fed by groundwater. A large public well pulling groundwater from the same general region can diminish the flow to a local stream and may even cause it to dry up. This has happened in the Berlin area of Camden County.



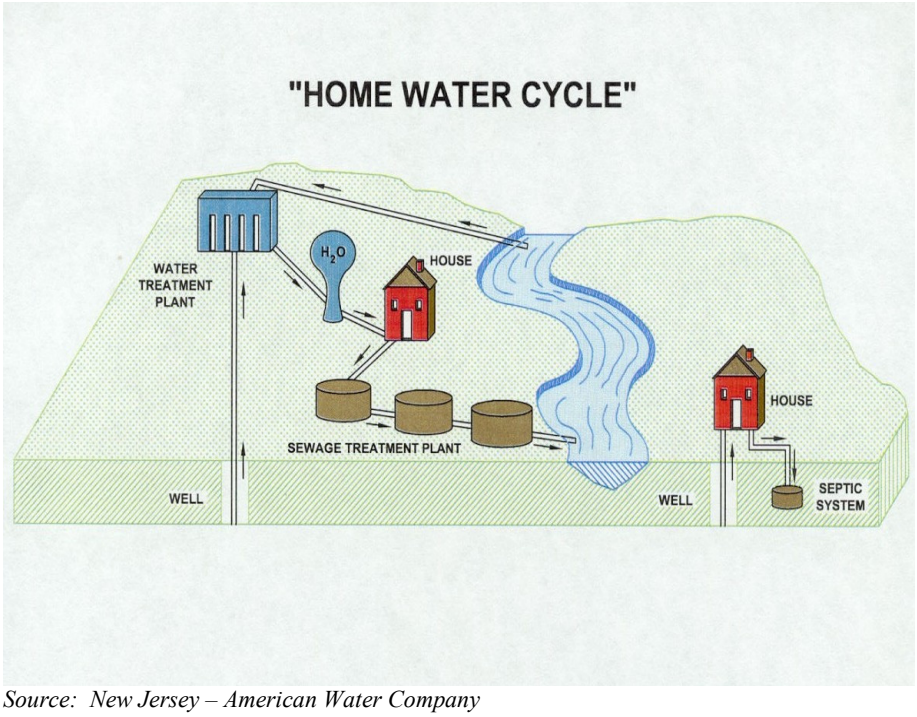
Source: Lyle S. Raymond Jr. *What is Groundwater?* Bulletin #1. Cornell University. July 1988

HOME WATER-USE CYCLE

The use of water by people is cyclical in its pattern, somewhat like the natural water cycle. Water is drawn from an aquifer and possibly supplemented from a surface source such as the Delaware River. The surface source water is cleansed by a treatment plant, and the aquifer water may be treated, before being piped to homes. Aquifer water is drawn up by a pump within a private home and may be conditioned or treated by equipment connected to the well. In any case, the water is used by residents and becomes wastewater. This used water then either flows to a sewage treatment plant or goes into the septic system on the property. From the treatment plant it is discharged to surface water. From the septic system it returns to the groundwater.

The home water-use cycle can alter the natural cyclical pattern because wastewater that goes through a sewage treatment plant is usually discharged at a spot far away from where the water was originally drawn out of the ground. In Gloucester County this discharge is to the Delaware River or the Raccoon Creek, while the withdrawals from groundwater are made within the municipality that used the water. This means that there is a net loss of water from the groundwater supply within most areas of Gloucester County.

The private well and septic system usage is less consumptive. Used water from such a system is discharged close to the point of origin, which replenishes the local groundwater supply. If properly cleansed by the septic system, and if no contaminants get into it, this water will be available for future use.



Source: New Jersey – American Water Company

7. THREATS TO GLOUCESTER COUNTY'S SURFACE WATERS AND DRINKING WATER

THREATS TO SURFACE WATERS (STREAMS, LAKES, AND WETLANDS)

DEFINITIONS

Impaired waterways: Stream segments or lakes that do not meet the water quality standards set for them by federal and state agencies.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers or septic systems.

TO DO

Plan a field trip: Go to the stream closest to your school, examine its condition, and have students figure out where it fits into the watershed, using the watershed maps in Chapter 4.

Look at the land use around the stream, at any outfall pipes, and at the stream banks. Are they eroded? How muddy is the water? Is there a buffer of trees and shrubs along the stream to help trap and filter stormwater runoff?

All of the watersheds in Gloucester County have some parts – either stream segments or lakes – that are classified by the state of New Jersey as impaired. That is, they do not measure up to the standards required for maintenance of healthy aquatic communities of wildlife, especially of fish and the smaller creatures at the base of the food chain. All Gloucester County waters are designated to be of sufficient quality for certain recreational use, such as boating, and most are supposed to be swimmable. Some do not meet the state standards set for these uses.

Monitoring Water Quality

Measurement of impairments is based on monitoring done by the New Jersey Department of Environmental Protection at specific sites along the streams, which are primarily along the main channels. Waterways may have levels of nitrates, phosphorus, metals, other chemical compounds, or bacterial contamination that are above state water quality criteria (allowable limits for particular substances.)

The status of lakes in Gloucester County is variable. Lake water quality is assessed by the Gloucester County Health Department if a lake is used for public swimming. Standards must be achieved or the swimming facility is closed. Several lakes in the County are in swimmable condition, but some have been impaired by polluted stormwater or bacterial contamination from geese.

Cause of Impairments

The main reason for water quality impairment in the County is stormwater runoff. In addition, some waterways have sediments that were polluted by industry or accident in the past. This latter type of pollution can only be removed by dredging and then removing the sediments, which is often prohibitively expensive.

Water quality degradation from stormwater runoff is primarily the result of haphazard land development. Growth in more developed parts of the County took place at a time when waterways were considered handy conduits for sewage disposal and stormwater management. Today, although raw sewage and industrial chemicals are no longer dumped into streams, lakes, and wetlands, development still has an impact on local waterways. Development covers the natural landscape with roads and buildings. Rainwater that once would have naturally filtered down into the earth becomes **stormwater runoff**, filling watershed streams with high quantities of pollutants from the land surface and raising their volume following rainstorms.

Older communities cannot easily alter the piping systems and impervious cover associated with earlier development. In municipalities with remaining open land areas, there is continuing extreme pressure from those who wish to develop the land for residential and commercial uses. Additional inadequately planned development will increase water quality problems in those areas.

The potential for excess sediment to enter streams is greatest during site preparation and construction of a new development.

Source: Gloucester County Soil Conservation District

Land development is governed by different regulations in each municipality. The success of each town in protecting its environment varies widely. Some towns are very proactive in protecting streams, wetlands, steep slopes and other sensitive environmental features, while other towns are slow to recognize the value of protecting their natural resources.

Parking lots accumulate pollutants such as oil, antifreeze, and litter, much of which is washed into storm drains during the next storm event.

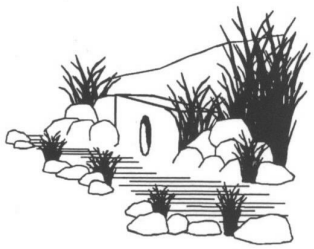
Source: Teacher's Guide to the Great Swamp Watershed

DEFINITIONS

Point source pollution: Pollutants discharged from an identifiable point, including pipes, ditches, channels, sewers, and containers.

Nonpoint source pollution: Stormwater runoff containing pollutants. The contamination does not originate from one specific location, but is pollution discharged over a broad land area.

OUTFALLS



Nonpoint source pollution stormwater outfall that delivers water and pollutants from a wide area.

Point source pollution outfall pipe discharging industrial waste.

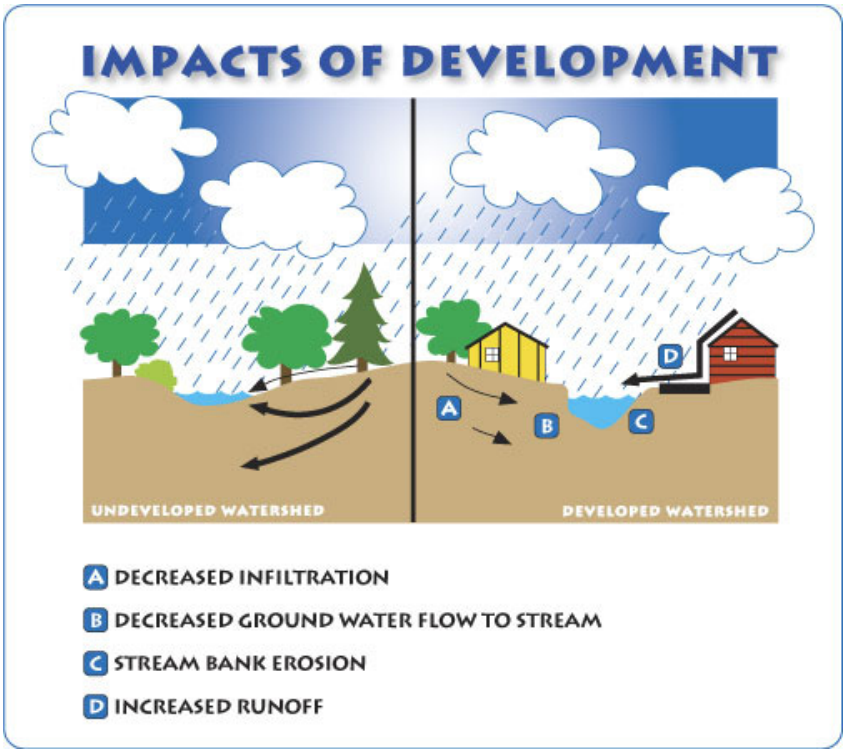
Source: Teacher's Guide to the Great Swamp Watershed

The following sections describe how human actions translate into water quality and quantity problems in Gloucester County's watersheds.

TWO TYPES OF WATER POLLUTION – POINT SOURCE AND NONPOINT SOURCE (STORMWATER RUNOFF)

When we think of water pollution, we frequently picture pipes discharging chemical wastes into our rivers, or oil spills such as the Exxon *Valdez*. These types of pollutants are known as **point sources of pollution** because the pollutant can easily be linked back to its source, or point of origin. Point sources of pollution are stationary locations or fixed facilities, such as an industry or municipality, that discharge pollutants into air or surface water through pipes, ditches, lagoons, wells, or stacks. Common sources of point source pollution to water are sewage treatment plants, leaking landfills, and industrial factories.

Nonpoint source pollutants, by contrast, are difficult to track to a specific location because they come from many sources, stemming from various activities such as agriculture, household lawn care, poorly managed construction sites, or road traffic. Nonpoint source pollution is equivalent to **stormwater runoff** pollution. It occurs when precipitation falls and moves over and through the ground, picking up and carrying away natural and manufactured pollutants. These pollutants are then deposited into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. Today, nonpoint source pollutants have surpassed point sources of pollution as the greatest threat to our nation's water quality.



Source: Adapted from NJDEP's The Clean Water Book

NONPOINT SOURCE POLLUTION OF SURFACE WATERS

DEFINITIONS

Fecal coliform bacteria: A group of bacteria that are used as indicators of possible sewage or waste contamination because they are commonly found in human and animal feces.

Impervious surface coverage: Surfaces that do not allow stormwater runoff (rainwater and snow melt) to seep into the ground, such as sidewalks, roadways, driveways, and rooftops.

Sedimentation: The settling of soil particles (sediment) to the bottom of a waterway.

Stormwater runoff: Precipitation that flows overland to surface streams, rivers, and lakes, either directly or through storm sewer pipes.

Some common **types of nonpoint source or stormwater runoff pollutants** include:

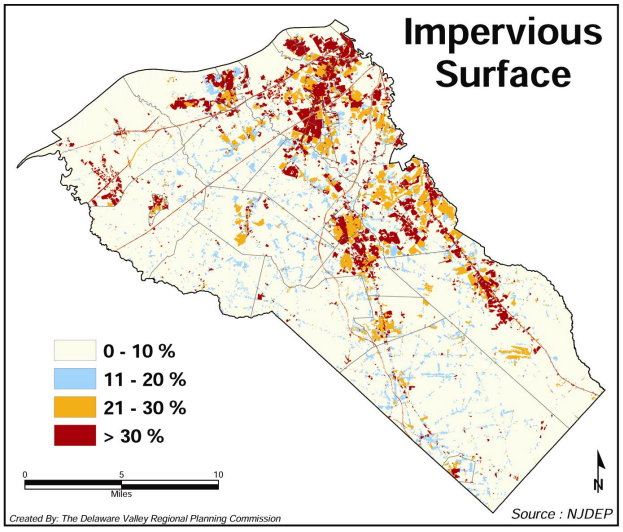
- Excess fertilizers, herbicides, and insecticides from residential areas, farms, golf courses, and other manicured lawn areas such as office parks and ballfields.
- Oil, grease, de-icing materials (road salt), toxic chemicals from roads, parking lots, truck washing facilities, and industrial sites.
- Sediment from improperly managed construction sites and eroding stream banks.
- Bacteria and nutrients from geese, livestock, pet wastes, leaking or misconnected sanitary sewer lines, and faulty septic systems.

Nonpoint source/stormwater runoff pollution is the greatest challenge to the environmental health of the waterways of Gloucester County. The following section provides an overview of the **four main sources of this pollution** in Gloucester County's watersheds.

1. Impervious Surface

As a rule, the greater the amount of impervious surface coverage in a watershed, the greater the threat to water resources from nonpoint source pollution.[1] Impervious surfaces are those surfaces through which water cannot drain. Driveways, roads, sidewalks, and rooftops are all examples of impervious surfaces. These surfaces collect pollutants that are emitted into the atmosphere,

Impervious Surface Coverage in Gloucester County



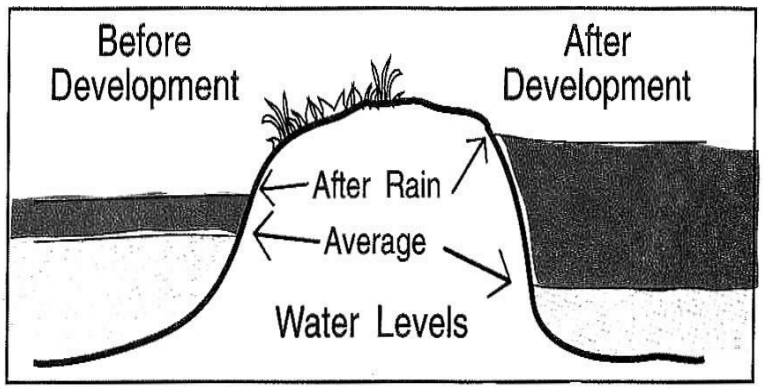
Source: NJDEP

[1] Scheuler, Tom. Site Planning for Urban Stream Protection. Silver Spring, MD: The Center for Watershed Protection, 1995.

leaked from vehicles, or from other sources such as runoff from lawns. During storms, accumulated pollutants wash off and are delivered to rivers, streams, lakes, and ponds.

Even relatively little impervious surface cover in a watershed can impact streams. Experts calculate that stream degradation occurs at levels of only 10 percent to 20 percent imperviousness. At present, roughly 20 percent of Gloucester County has an impervious level above 10 percent, according to the NJDEP's 1995/97 landuse/landcover analysis.

In parts of Gloucester County that were developed before the 1970s, stormwater was shunted directly to a nearby river or stream through a system of storm drains, located within the streets or curbing. These storm drains are connected to underground pipes that empty through outfalls into a waterway. Beginning in the 1970's, regulations required the construction of detention or retention basins in new subdivisions, which hold the runoff for a time and release it gradually to the waterway in order to prevent downstream flooding. This is still the method of managing stormwater from new development in New Jersey.

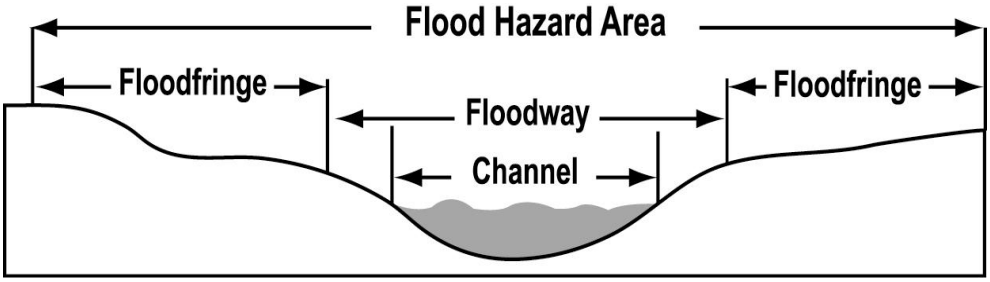


Source: The Streams of Washington Township

Neither direct discharge nor detention/retention basins control what gets into the runoff. Consequently, pollutants that wash off impervious surfaces or get dumped into a storm drain will end up in the stream or lake water.

Imperviousness also accelerates the speed at which water runs off, increasing erosion and streambank degradation. Where a detention/retention basin controls the speed, the quantity of runoff that hits a stream may actually be increased, because the basin concentrates water that would otherwise percolate down into the soil. As the runoff arrives at the stream after a rainfall, the force of the increased quantity of water can cause extensive erosion of the banks. This higher volume of water also temporarily alters the level of the stream, which causes major problems for the aquatic organisms that must adjust to this variability and find ways to prevent being swept away downstream. Many outfall pipes that empty into local streams have caused serious erosion that is expensive and difficult to repair.

Over time the force and volume of stormwater has downcut stream channels and made them deeper, so that water levels become lower than the floodplains adjoining them (the floodway and floodfringe areas). During a storm, excess water ordinarily washes across floodplains, which hold and even absorb some of the flow. When the channel and the floodway are no longer connected by a gradual slope, the floodplain cannot serve this function. This is also the case in areas in which buildings have been placed within the floodway or otherwise built too close to the edge of a stream or lake.



Source: The Streams of Washington Township

2. Animal Waste

Source: Teacher's Guide to the Great Swamp Watershed

Both wild and domestic animals create nonpoint source pollution problems through their waste products. One estimate is that an individual Canada goose can drop up to one–half pound of excrement per day, leading one local wildlife expert to comment that the handsome birds are "flying bags of Scott's Turf Builder." Large groups of birds make lawns and sidewalks a slippery mess, and their droppings contribute to high coliform bacteria levels in the lake areas they inhabit. Bacterial contamination is a major cause of lakes being closed to swimming.

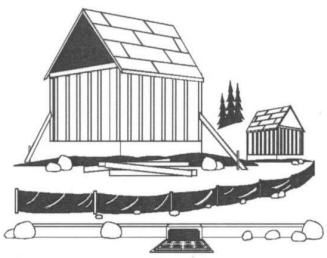
Residents can help reduce the problem of geese by planting shrubs instead of grass next to waterways. Geese prefer water bodies with lawns that come right to the edge, where they can enter and leave the water with a clear view of their surroundings. They dislike high grasses and shrubbery along the banks. In addition, visitors to natural areas and parks should not feed geese, as this encourages their presence and adds to the amount of waste produced.

Animal manure pollutes air, water, and land resources. Degraded stream water quality and fish kills resulting from animal manures and feed wastes are reported each year. Such pollution usually results from improper practices or careless management. Beyond the concern for pollution control and compliance with state and federal standards, most livestock producers are interested in retaining their animal manure because of its fertilizer value.

Even the family dog can contribute to pollution of the local watershed. What may seem like scant amounts of dog waste, when combined with other waste, becomes a major problem for a small receiving stream. Dropping dog waste in the storm drain may create bacterial and pathogenic problems in that storm sewer line and contribute to elevated fecal coliform levels downstream. Dog waste should always be "taken with you" and disposed of at home in the garbage.

3. Sediment

Nonpoint source pollution from sediment occurs when water runoff transports soil particles from land into a water body such as a stream or lake. Excessive sediment clouds the water, reducing the amount of sunlight available to aquatic plants. It also covers fish spawning areas and clogs their gills. Other pollutants such as phosphorus, pathogens, and heavy metals attach to soil particles and are transported via these particles into water bodies.



Properly installed and maintained silt fences erected around construction sites reduce the flow of sediment into nearby storm drains.

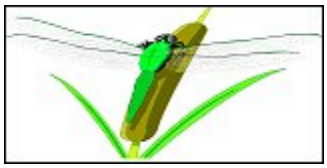
Source: Teacher's Guide to the Great Swamp Watershed

Severe soil disturbance around a storm drain. Any rainfall event will wash this sediment into the storm drain where it will then empty directly into a stream.

To contact the Gloucester County Soil Conservation District call 856-589-5250 or email to Gloucester@nj.nacdnet.org

The Gloucester County Soil Conservation District is responsible for approving Soil Erosion Control Plans for development sites larger than 5,000 square feet and for doing inspections. Municipalities can help reduce sediment runoff from smaller sites by enacting strong soil removal and sediment control ordinances and enforcing them. Residents should not dig or move soil near a water body or leave bare soil exposed to the elements for extended periods of time. Farmers can reduce erosion and sedimentation by 20 to 90 percent by applying management measures to control the volume and flow rate of runoff.

4. Pesticides and Fertilizers



Adult dragonflies feed on many flying insects, especially mosquitoes

Whether they are applied in residential or commercial settings, pesticides and fertilizers are easily transported via rainwater into nearby streams, lakes, ponds, and even underground aquifers or other groundwater supplies. In a review of studies around the nation in 1997, the US Geological Survey found that **pesticides** have been found in underground supplies in most areas studied. Chemicals that result from the original pesticide's breakdown may be even more common in our drinking water. Unfortunately, current testing requirements in NJ do not tell residents if these degradation products are present. This is a problem in a state where it is estimated that at least eight million pounds of pesticides are used annually (NJ Pesticide Resource Manual for Health Professionals, 12-1).

Many **pesticides** are toxic to pets, other animals, fish and plants, and beneficial insects. They may easily degrade wildlife habitat. Disturbingly, some of the most common herbicides in use today - Atrazine, Simazine, Alachlor, 2,4_D, and DCPA all pose a cancer risk, and the last two have been linked to birth defects (*Drinking Water and Health: Facts on Pesticides in Drinking Water*, NJ Department of Health, 4-5). And in a National Cancer Institute study, home pesticide use has now been linked with childhood leukemia (*Journal of the National Cancer Institute* 79[1]: 39-46). Residents should consider "least toxic" means to controlling lawn and household pests and should never engage in "calendar" methods of treating these problems (in which pesticides are applied on a regular schedule, rather than as needed).

For information about Integrated Pest Management (IPM) consult the Rutgers Cooperative Extension Service at 973-932-9801 or go to the website www.pestmanagement.rutgers.edu.

One method for controlling pests with minimal chemical use is called **Integrated Pest Management (IPM)**. IPM relies on a preventive approach: identifying pests when present in a building or lawn and determining a strategy for dealing with each one. This approach relies on managing pests by inspection, monitoring, site and sanitation improvements, and mechanical, biological, and "least hazardous" chemical controls. IPM can be utilized both on individual properties and on large sites such as farms, corporate parks and institutional grounds. Pesticide reductions of up to 90 percent have been achieved at federal facilities using IPM.

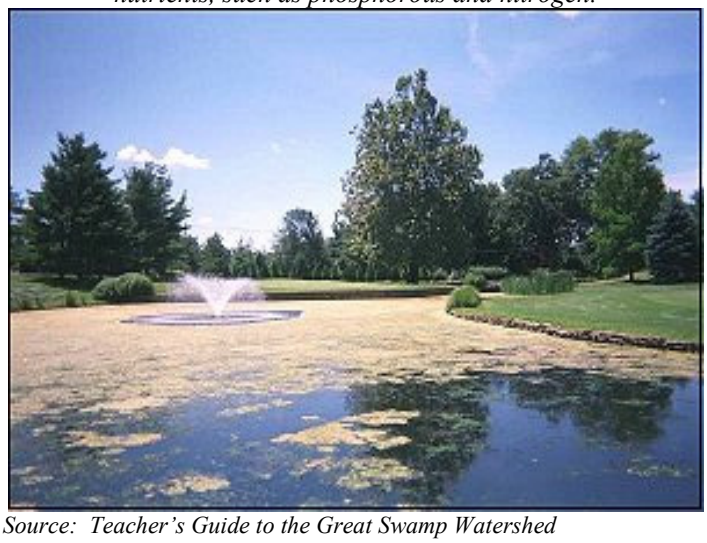
For purchase of soil test kits, and information on garden and lawn care, contact the Rutgers Cooperative Extension Service of Gloucester County at 856-307-6450 or go to the website www.gloucester.rce.rutgers.edu.

Fertilizers also contribute to water pollution problems in New Jersey. Excess nitrogen runoff into lakes and ponds causes "algae blooms" that cloud the water and deprive fish and other organisms of much-needed oxygen. Periodic fish "kills" throughout the state, particularly in the summer when oxygen demand is high, are the direct result of nitrogen runoff into the water. This problem begins at the level of individual homeowners, many of whom mistakenly think that "more is better" with fertilizer applications.

For identification of plant pests and diseases, call the Master Gardeners helpline at 856-307-6464 (AM only) or go to the website www.rce.rutgers.edu/mastergardeners/

Soil test kits, available at most garden centers and the Rutgers Cooperative Extension Service of Gloucester County, can identify pH and nutrient deficiencies and should be used before blanket or calendar fertilizer applications are made. Fertilizer should never be applied before a heavy rain. Apply the minimum amount needed.

An ornamental pond suffering from an influx of excess nutrients, such as phosphorous and nitrogen.



Source: Teacher's Guide to the Great Swamp Watershed

Traditional **lawn management** also contributes to impacts on water in Gloucester County. It does so in two ways: The use of lawn turf requires extensive watering, which draws on ever-scarcer water supplies; and the subsequent overuse of fertilizers and pesticides delivers excess phosphorus, nitrogen, and poisons to streams and lakes. Planting drought and/or disease-resistant native vegetation, reducing lawn area or replacing with other ground covers, and using hardier lawn turf species such as the fine fescue grasses, all reduce the need for fertilizers, pesticides, and watering.

Municipal Separate Stormwater Sewer System Program

Regulations originally enacted by the U.S. Environmental Protection Agency (EPA) and recently (2004) issued in detail by the NJ Department of Environmental Protection (NJDEP) require that municipalities take control of the stormwater runoff pollution within their boundaries over the course of the next five years. This program, also called the Phase II Municipal Stormwater Rules, gives municipalities the authority and responsibility to reduce the flow of stormwater flowing to streams from any new development by mandating the use of low impact design of the stormwater facilities. Designs must put as much rainwater as possible back into the ground and cannot allow any stormwater runoff to carry excessive loads of sediment.

The program also requires municipalities to reduce the effects of stormwater runoff from already developed areas by improving the maintenance of existing stormwater basins, and by enactment of ordinances to limit pet waste, litter, improper dumping, and feeding of wildlife (geese). In addition, towns must provide education to the public about stormwater pollution, and must label the town's storm drains with a "Don't Dump" message. Schools and other youth groups are encouraged to assist their municipality with the education and labeling requirements, wherever possible. See Chapter 8, What You Can Do to Protect the Watersheds of Gloucester County, for suggested activities.

Raccoon Creek Watershed

Source: DVRPC

POINT SOURCE POLLUTION OF SURFACE WATERS

The following section describes two main point source contributions of pollution today: contaminated sites and sewage discharges.

1. Contaminated Sites

There are 296 sites in Gloucester County listed on the New Jersey *Known Contaminated Sites* List. The Contaminated Sites list includes former factory sites, landfills, locations of current or former leaking underground storage tanks, sites where chemicals or wastes were once routinely discharged, and places where accidents have resulted in spills and pollution. The contamination has affected soil, groundwater, surface water, or a combination of these. The most dangerous sites, from a human health standpoint, are listed as Superfund sites, which make them eligible for federal cleanup funds. State or individual programs handle other sites.

As of September 2001, there were 27 Superfund sites in Gloucester County.

Two examples of **Superfund sites** illustrate the type of pollution problems and the difficulty of resolving them:

a. *Bridgeport Rental and Oil Services*

The Bridgeport Rental and Oil Services site, also known as BROS, is a 30-acre parcel of land, formerly used as a waste oil storage and recovery facility, located in Logan Township two miles southeast of the Delaware River. The property consists of a 100-vessel tank farm and 13-acre waste oil and wastewater lagoon. The lagoon was used for waste disposal between the 1960s and 1981. The lagoon became a "toxic soup" of waste material. Spills and leaks from the facility have contaminated groundwater and adjacent wetlands.

National attention focused on BROS when, in 1977, a welder's torch ignited an accumulation of chemicals at the waste storage facility, causing a large explosion. Fires raged for more than 10 hours, sending a plume of black smoke up into the sky. Six people died and 35 people were hospitalized due to the accident, as storage cylinders exploded, flying hundreds of feet through the air. Many environmental advocates, policy analysts, and historians see this event and several other similar events throughout the country as inspiring federal Superfund legislation.

Due to public health concerns, EPA tested the site and areas around the site and found groundwater contamination. In 1983, the BROS site was placed on the National Priorities List (the Superfund list). EPA authorized the first phase of remediation and cleanup in 1984, which consisted of determining the nature and extent of soil contamination and evaluating the remedial alternatives. In 1988, EPA initiated a second phase to determine the extent of groundwater contamination but never completed it, due to ongoing negotiations between the federal agency and the potentially responsible parties.

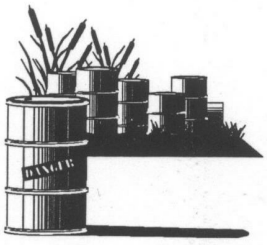
From 1992 to 1996, 172,000 tons of hazardous waste were excavated from the toxic lagoon. More than 190 million gallons of contaminated water were treated and 10,000 tons of contaminated debris were disposed off-site. The EPA and NJDEP learned a lot from their efforts at BROS, employing new technologies that were used subsequently at other sites in the United States.

While cleanup, demobilization, and stabilization efforts were completed in 1996, the second phase of testing groundwater and remediation has yet to be initiated. In 1996, EPA, with the aid of the U.S. Department of Justice and the State of New Jersey, reached a settlement with 90 companies and governmental agencies that had sent waste to the BROS site. These 90 entities will contribute more than $221.5 million to help cover expended and future cleanup costs and fund a complete study of the groundwater and wetlands contamination. BROS has proven to be the most expensive and technically challenging site of the Superfund remediation program.

b. *Lipari Landfill*

The Lipari Landfill, located in Mantua Township and bordering the municipalities of Pitman, Glassboro and Harrison Township, is a former sand and gravel quarry used as a 15-acre landfill and toxic chemical repository from 1958 to 1971. It accepted an undetermined amount of household wastes, chemical wastes, and industrial materials, an estimated three million gallons of liquid wastes, and 12,000 cubic yards of solid wastes. The landfill was closed by the State of New Jersey in 1971 after neighbors complained about respiratory problems, nausea, dying vegetation, and odors emanating from the dump site. In 1982, due to its potential impact on more than 11,000 Gloucester County residents, the Lipari Landfill was recommended for National Priority Listing (Superfund listing).

In 1982, EPA began its first phase of remediation, aimed at containing the contaminants on-site by inserting a 30-foot clay wall around the area and capping the landfill with a synthetic membrane cover. In 1985, the EPA released its plan for an on-site remediation program targeting the leachate and groundwater contamination. Those clean-up efforts ran from 1992 to 1993.



In 1988, EPA designed an off-site remediation program that would alleviate some of the serious effects on private property, surface and groundwater sources, and the four communities. A final step in the cleanup process was the installation of a monitoring system in 1995. The Philadelphia-based chemical company Rohm & Haas was legally found to be the primary polluter and thus responsible for cleanup costs. At the time of disposal, Rohm & Hass probably paid 75 cents for each barrel of chemical waste. The cost of removal of each barrel of contaminants has been estimated at about $2,000. Rohm & Haas paid more than $52 million of the $100 million remediation project. Other companies were also found liable and helped pay for the cleanup.

Although the Lipari Landfill is still being monitored, part of the site has been successfully remediated and is now a public sports field complex, with soccer, baseball, and other athletic fields. The recreational project is considered a major success in brownfield redevelopment. In addition, Alcyon Lake and Chestnut Branch marsh have been restored and the lake has been reopened.

Cleaning Up Contaminated Sites - Hazardous Site Remediation

The need for hazardous waste site remediation far outdistances the supply of funding and support that federal and state agencies can provide. Complicating matters is the fact that, with older sites, it is harder to determine who should be responsible for paying for cleanup, which is an essential component of the federal and state remediation programs.

There is a lot of public information about hazardous waste sites, much of which is on deposit at local libraries, as required by law. In addition, NJDEP's Site Information Program, sponsored by the Site Remediation Program, can be accessed at www.state.nj.us/dep/srp/siteinfo/. Detailed information about all known contaminated sites in New Jersey is available online and indexed according to county. Every site on the New Jersey *Known Contaminated Sites* List is assigned a case manager who can answer more detailed questions concerning the site.

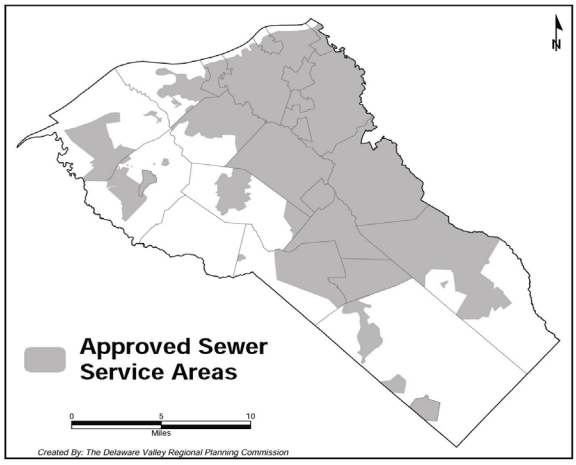
2. Sewage

In the past, household, commercial and industrial wastes were typically disposed of directly into our nation's streams, rivers, and oceans, under the assumption that they would simply be carried away and diluted by the fresh or salt water. However, as our knowledge of human health and sanitation grew, so did our understanding that this method of waste disposal was not only bad for human health, but for the environment as well. Today, sewage from our homes and businesses is disposed of in one of two ways: through sewage treatment plants, or through individual septic systems. Although not foolproof, the treatment of our sewage before it is released into surface waters has greatly improved the quality of our water resources.

TO DO

Arrange for a tour of the **Gloucester County Utility Authority**, which is the sewage treatment plant for most of Gloucester County. Call 856- 423-3500

Many of Gloucester County's residents and businesses are connected to a public sewer system where sewage is carried by a set of pipes to one of the treatment plants in Gloucester County. The Gloucester County Utilities Authority (GCUA) serves the largest number of public sewer users, followed by the Logan Municipal Utility Authority (MUA), which serves Logan Township and part of Woolwich. The Swedesboro MUA and Harrison MUA provide service to smaller, local regions.



Gloucester sewer service areas are those regions approved by NJDEP to have sewer service installed, or which already have sewers. Sewer lines may not have been laid in some locations of the approved area.

After sewage is processed at the treatment plant, the treated wastewater is discharged to a local waterway. From the GCUA and Logan MUA, the treated water is discharged to the Delaware River. From the Harrison and Swedesboro plants, the treated water is discharged to the Raccoon Creek. In all cases it flows away to the ocean. The sludge – everything that remains after treatment – is incinerated.

The following section describes two point sources of pollution from sewage:

a. Leaking Sewer Lines

Source: American Water Works Association

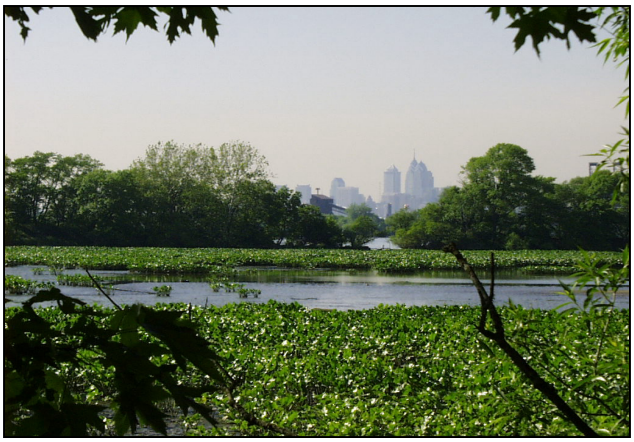
A water pollution problem that occurs in sewer service areas in Gloucester County is that sanitary sewer lines (pipes) sometimes leak sewage, through breakage at joints or collapse of older pipes. Sewer lines are always laid at low points in the topography, so that sewage being collected from residences and businesses can be moved by gravity, wherever possible, rather than being pumped. The lowest point in any neighborhood is often in a streambed, either beside or even in the stream channel. Consequently, when sewage pipes leak, their contents can easily contaminate stream waters.

Local utility authorities work to replace sewer lines on a regularly scheduled basis, before such breakages occur. However, given the miles of piping that exist throughout any sewer service area, it is difficult to prevent or even detect all leakages. A strong sewage smell near a stream can be evidence of such leakage, as can the presence of smelly runoff emanating from an outfall pipe on a dry day, although other causes are also possible.

b. Misconnected Sewer Lines

Improper connections between sanitary sewer pipes and stormwater pipes are sometimes made when a homeowner or a professional plumber hooks a sewage pipe into a stormwater main pipe under the street. This is usually done accidentally, but still requires correction to prevent raw sewage from flowing to the nearest stream or lake. The NJDEP's recently enacted Municipal Stormwater Rules require that, beginning in 2005, municipalities map all their stormwater outfall pipes, identify any sewage problems with the outfalls, and track the source of the sewage, including any pipe misconnections (called "illicit connections"). Corrections of misconnections will be fully or partially at the homeowner's expense.

Big Timber Creek, looking toward Philadelphia



Source: DVRPC

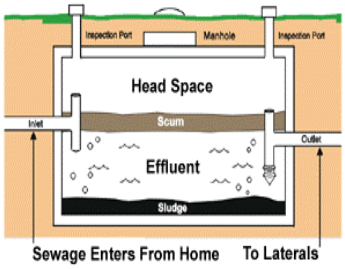
THREATS TO DRINKING WATER

THREATS TO SURFACE AQUIFERS

In the eastern part of Gloucester County drinking water is drawn from the unconfined Kirkwood-Cohansey aquifer. This surface aquifer is the top layer of the "layer cake" illustrated in Chapter 6 – Drinking Water. The Kirkwood-Cohansey does not have the impermeable layers above the water-holding sand and gravel strata that are found in the deeper aquifers underlying the County. Rainwater and snowmelt that enter the soil can percolate down to recharge the aquifer over a wide area.

Because of the lack of confining layers and the fact that the Kirkwood-Cohansey is closer to the surface, this aquifer is more vulnerable to the seepage of pollutants into the groundwater. These come from septic tanks, leaky underground fuel tanks, fertilizers and pesticides applied on farmland, septic tank additives, leaking landfills, and spills of contaminated substances on the land surface.

The following sections describe in greater detail **two of these threats to the Kirkwood-Cohansey aquifer**:

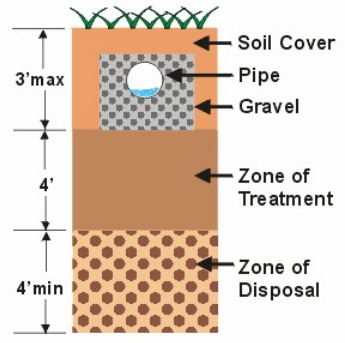


A septic tank needs to be pumped regularly in order to work effectively.

1. Septic Systems

In the less developed parts of the county, many residents rely on septic systems located on their properties. A septic system holds wastewater in a tank until the solids settle out, forming sludge on the bottom and a layer of scum on the top. The liquid part, or effluent, between these two layers moves from the tank into a dispersal bed that has pipes with holes in them, from which it percolates slowly out into the surrounding soil. The impurities and bacteria in the wastewater are filtered out in the soil as the liquid seeps downward and gradually reenters the groundwater.

Septic systems should only be constructed in certain types of soil, which can filter the water at an appropriate rate. This is why "perc" tests are required by state laws before new septic systems are created. Septic tanks need to be pumped out at least once every two – three years in order to operate efficiently and to maintain the life of the system.

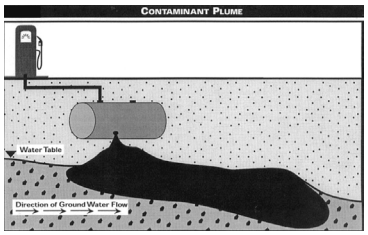


In the dispersal bed of a septic system, wastewater goes through several levels. The bottom of the bed must be at least four feet from the water table to be effective, and to prevent contamination of groundwater.

Septic systems are quite effective at cleaning wastewater as long as they are properly located and well maintained. Absolutely nothing should enter a septic system except natural (organic) wastes. Even these should be readily dissolvable. Larger particles from garbage disposals, larger wastes flushed down the toilet, and commercial "cleaning" additives can all clog or damage a septic system. No hazardous materials should be poured down the drain. These include substances such as household cleaners, bleaches, paint, oils, and greases.

2. Contaminated Sites

Leaking underground storage tanks and surface spills make up a large percentage of the listed *Known Contaminated Sites* in Gloucester County, described earlier in the previous section on Point Source Pollution. Most of these are located at former industrial sites, old gas stations or other commercial properties, and at roadway spill and other accident spots. Documented contamination sites are slowly being eliminated and cleaned. Today, local, county, and state Emergency Management Teams are quick to respond to new accidents.



A contamination plume from a leaking underground storage tank.

Unfortunately, there are still many private homes and businesses with old, leaking underground fuel tanks that do not become known until a problem emerges with local groundwater. Property owners with private wells have a responsibility to themselves and to their neighbors to identify and remedy these hazards.

THREATS TO DEEP AQUIFERS

Threats to the deeper confined aquifers, especially to the Potomac-Raritan-Magothy, are due to the tremendous draw on these aquifers by a large regional population, and the effects that this generates. **Two impacts** are described:

1. Overuse

Overuse has affected all of Gloucester County's deep aquifers, including the Wenonah-Mount Laurel and other smaller sources. It has generated the greatest changes in the Potomac-Raritan-Magothy (PRM) because that aquifer is so productive and thus so heavily used. In 1986 a New Jersey Department of Environmental Protection study showed that the water level in the PRM was dropping excessively, at a rate of 2.5 feet per year.

At the beginning of the twentieth century, water levels had been as high as 30 feet above sea level and water flowed from the PRM into the Delaware River. By 1986, water levels were down as low as 90 feet below sea level. By that time, water from the Delaware River was entering and recharging the PRM, as it continues to do today, along with the recharge occurring on the aquifer's outcrop area.

Because of the need to maintain and protect this major drinking water source, Critical Water Supply Area #2 was established (see the map in Chapter 6 – Drinking Water) and limitations were placed on the amounts that could be drawn from the PRM, as well as from the thinner, less abundant Wenonah-Mount Laurel aquifer.

Although water levels in the PRM have recovered somewhat since 1986, there is always pressure from new development to increase usage from the aquifers, especially since it is less expensive to pump groundwater than to treat and transport river water. Water conservation awareness by the public has also improved, although not to the degree that is needed.

2. Salt Water Intrusion

Another threat to Gloucester County's deep aquifers is salt water intrusion. Salt is already found in the lowest layer of the PRM. It is believed that this saline groundwater is ancient sea water trapped during the glacial era. It may also be partly a result of salt water migration from the Atlantic Ocean, to which the PRM is connected at great depths on its eastern side, or to entry from the Delaware River and Bay where the salinity level shifts northward during drought periods. The extensive pumping from the PRM may also have pulled this salt layer upward and westward toward Gloucester County.[3]

CONTAMINATION ON THE LAND SURFACE

A threat to all of Gloucester County's aquifers comes from contamination of the land surface. Even the deeper aquifers can be affected by pollutants to the ground within their outcrop areas, where these tilted aquifers are exposed. The emergence of the upper PRM layers to the surface occurs near the Delaware River (see the Outcrop map in Chapter 6 – Drinking Water.) It is precisely in those areas where past industrial sites were most heavily concentrated and where the preponderance of the County's Superfund sites are located.

Effects on private wells in the vicinity of major contaminated sites have been commonplace. Private wells close to Logan, Greenwich, and Mantua Superfund sites had to be abandoned, for example, because of contamination by volatile organic compounds (VOCs) and metals in the groundwater. Residences were connected to public water supplies that draw from the deeper layers of the PRM aquifer. Containment of the contaminated groundwater in these areas has been a major focus of cleanup efforts in order to prevent its movement into the aquifer's deeper layers.

For information on private well water testing, call 1–866-4PW-TEST or go to the NJDEP Private Well Testing Act website: www.state.nj.us/dep/pwta.

If your well water is found to be contaminated, contact the Gloucester County Health Department at 856-262-4220 and the NJDEP Bureau of Safe Drinking Water at 609-292-5550.

Some other Superfund sites, such as one in Newfield Borough, also involve contamination and closing of private wells. These pumped water from the Kirkwood-Cohansey aquifer. This aquifer is easily contaminated because its entire recharge area (or outcrop) is so broad and close to the land surface.

Some private wells in Monroe and Franklin Townships have been found to be contaminated with mercury, methyl tert-butyl ether (MTBE), or other substances. While mercury may not originate from surface contamination (it may be naturally occurring), it seems likely that the gasoline additive, MTBE, comes from surface spillage. To resolve these well problems, affected residences were connected to the public supply system or, where public water was unavailable, individual treatment systems were installed by the state of New Jersey. In most cases, the specific sources of contamination of these wells have been impossible to identify.

[3] Information taken from a speech on New Jersey Critical Area No. 2 by Arthur Shearson of the NJ American Water Co. to the Water Resources Association Conference, 1998.

8. WHAT YOU CAN DO TO PROTECT THE WATERSHEDS OF GLOUCESTER COUNTY

TO DO

Have students work with their parents to properly dispose of any unused hazardous chemicals currently stored in their home.

Have students find out whether their home has a septic system, and when it was last pumped.

Hazardous Household Products

Many common household products are toxic to people and the environment. Some oven cleaners, furniture polish, drain cleaners, and spot cleaners are examples of potentially hazardous household products.

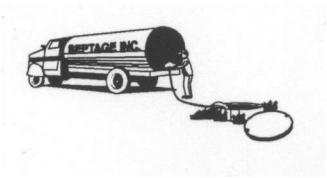
What you can do:

- Use alternative "green" products sold in many mainstream and health food stores.
- Buy only what you need or share the leftovers with others rather than storing them.
- Store materials in their original labeled containers.
- Dispose of unused materials and containers at hazardous waste disposal days (contact your municipal clerk for dates and locations).

Septic Systems

Many homes have septic systems to treat household wastewater. If the system is incorrectly maintained it can malfunction and pollute surface and groundwater resources.

What you can do:



- Know the location of your septic system, the tank(s), distribution box, and distribution lines.
- Do not dispose of large wastes or pour any hazardous materials, paints, solvents, grease, or oil down drains.
- Have the tank pumped every two - three years.
- Do not plant deep-rooted vegetation near the system because this could clog or crack the tank and piping.
- Do not use septic tank additives of any kind. They can cause damage and are not necessary in a properly maintained septic system.

Underground Storage Tanks

Some homes have tanks to store heating oil. Leaking tanks are a threat to ground water supplies.

What you can do:

- Homeowners should have a tank tightness test performed upon tank installation and periodically afterwards.
- Beware of leakage signs: odors in well water, petroleum smell in basement, dead vegetation near tank, or unusual increase in fuel usage.
- Opt for an above-ground tank with spill containment.

TO DO

Start a *Storm drain Labeling* project around your school. Find out what streams the storm drain leads to, and label with a decal stating "No Dumping - Drains to Waterways." (See **Appendix G**.)

Free labels and other equipment are available from the Scotland Run Nature Center at 856-881-0845.

TO DO

Have students test their soil for pH levels and other nutrients if it has not been tested in the past three years. Soil test kits are available from the Rutgers Cooperative Extension of Gloucester County at 856-307-6450. Website: www.gloucester.rce.Rutgers.edu

TO DO

Start a *Schoolyard Habitat* program to encourage native plant species and create beneficial wildlife habitat (see **Appendix H**).

TO DO

Encourage students to pick up after their pets and dispose of the waste properly.

Impervious Surface Coverage

Roads, rooftops, driveways and parking lots do not allow water to infiltrate. This impervious coverage creates increased runoff into streams that can worsen flooding and streambank erosion, and will transport litter and other pollutants to them.

What you can do:

- Allow stormwater to filter into the soil by installing a gravel driveway or permeable paths and patios.
- Divert gutter down spouts into dry wells or onto lawns, or capture in a barrel or cistern for watering your garden.
- Stencil the storm drains in your neighborhood with the message "No dumping - Drains to River."

Lawn/Schoolyard Care

Home gardeners use an array of products to keep lawns and gardens green and weed-free. However, if fertilizers or pesticides are misapplied, the materials can run off during a rainstorm and contaminate local streams and lakes.

What you can do:

- Reduce the lawn size and plant ground covers and native plants that require fewer chemical inputs, using techniques such as IPM.
- Test your soil every three years for pH levels and nutrients before applying fertilizers. Your county Rutgers Cooperative Extension Service sells inexpensive soil test kits and analyzes the soil samples at their labs.
- Avoid getting fertilizer on driveways, sidewalks and streets.
- Follow instructions for using pesticides carefully, for your own safety as well as for the environment. Consider using an alternative pest control method.
- Keep litter, leaves, and debris out of street gutters and storm drains – these outlets drain directly to lakes, streams, rivers, and wetlands. This type of waste contains high levels of nutrients that disrupt the natural balance of local water bodies.

Pets and Wildlife

Animal waste from pets, wildlife, and livestock is a source of water pollution. Animal waste contains a high concentration of nutrients and also a potential for pathogens and bacteria.

What you can do:

- Clean up after your pet and dispose of waste in the trash or toilet.
- Promote and comply with "pooper-scooper" ordinances.
- Do not feed ducks and geese.

Car Care

Antifreeze, motor oil, and batteries contain toxic chemicals that must be disposed of properly.

What you can do:

- Do not dump automotive fluids down the storm drain, on the ground, or in septic systems.
- Recycle used motor oil and batteries.
- Properly maintain your vehicle.
- Wash the car at a commercial car wash that recycles its water (check on this) or on a grassy area so water can be absorbed into the soil.
- Use public transportation whenever possible.

Soil Erosion

To contact the Gloucester County Soil Conservation District, call 856-589-5250. Website: www.gloucesterscd.org

Sediment is the number one water contaminant in the nation. It can carry water pollutants, smother wildlife habitat, and clog fish gills.

What you can do:

- Plant appropriate vegetation in areas that have bare soil.
- Contact your County Soil Conservation District for assistance with erosion problems.
- If you live along a stream or beside a lake, maintain or plant a buffer of shrubs and trees to filter runoff from your property.

Conserve Water

TO DO

Encourage students to share their *Water Meter Reader* activity (**Appendix F**) with their families.

Conservation of water is a voluntary activity except in drought emergencies. It needs to be practiced full time by residents if we are to have enough clean, healthy water for future uses.

What you can do:

- Monitor your own household use of water and identify ways to conserve at home, such as not allowing water to run while brushing teeth or shaving.
- Install a low flow showerhead.
- Take short showers instead of baths, when possible, because showers use less water.
- Run dishwashers only with full loads. Dishwashers use less water than hand washing when run just once a day.
- If your toilets are older, install a jug of water in each toilet tank to reduce the amount held there and used with each flush.
- Water lawns in the early morning or evening when water evaporates less.
- Consider replacing your lawn with a drought-tolerant species of grass or other ground cover so that watering is less necessary.
- Capture "gray water" – water from tubs and sinks – and utilize it for watering plants and lawns.
- Consider high-efficiency toilets, clothes washers, and dishwashers when remodeling.

TO DO

Have students put together a presentation or display for your school on conserving water in the home.

Join Your Local Watershed Association!

To contact the Federation of Gloucester County Watersheds call 856-478–2264. Website: www.sjwatersheds.org

For contact information on the Federation's member watershed groups, and for other organizations that protect water in Gloucester County, see **Chapter 9. Teacher Resources – Local Organizations**.

There are Watershed Associations for several of the watersheds in Gloucester County. They have joined together to form the Federation of Gloucester County Watersheds, one of the sponsors of this Teacher's Guide.

A watershed association is a private, nonprofit citizen's organization dedicated to the protection of a stream or river and its watershed. Watershed associations educate about watershed issues, monitor water quality and quantity, advocate for legislative and regulatory changes, conduct stream and lake cleanups, and carry out projects to restore waterways or replant stream or lake banks. A watershed association may also serve as a land trust in order to preserve watershed lands.

Some watershed associations have members who can work with school classes. All watershed associations need and welcome volunteers. Many can accommodate student participation in cleanup and restoration projects.

Get Involved with Your Municipal or County Environmental Commission

Several towns in Gloucester County have Environmental Commissions or Committees that help the municipality to identify and address environmental issues in the community. Environmental Commissions often have considerable information about local stream and lake conditions. The Commission may be able to assist class environmental projects relating to the community.

Call your township or borough to find out if there is an Environmental Commission or Committee and when they meet. Meetings are also listed in the newspaper of record for the town and all such meetings are open to the public. If your town does not have such a group, consider petitioning leaders to establish a Commission. For help in doing this, contact the Association of New Jersey Environmental Commissions (ANJEC) at 973-539-7547; website: www.anjec.org.

Native plants attract butterflies, birds, and other wildlife and can enhance the habitats of backyards, schoolyards, community and business parks, and golf courses.

Source: Teacher's Guide to the Great Swamp Watershed

9. TEACHER RESOURCES

Local Organizations

Delaware Riverkeeper Network
P.O. Box 326
Washington Crossing, PA 18977
215/369-1181
www.delawareriverkeeper.org
The Riverkeeper is a nonprofit, membership organization founded in 1988 to strengthen citizen protection of the Delaware River and its tributary watersheds. The organization works throughout the entire 13,000 square mile watershed area, which includes portions of NY, NJ, PA, and DE. Programs include an advocacy program, restoration projects, volunteer-based monitoring programs, pollution hotlines, and enforcement task force. Call 800-8-DELAWARE.

Delaware Valley Regional Planning Commission (DVRPC)
111 S. Independence Mall East
Philadelphia, PA 19106
215/592-1800
www.dvrpc.org
DVRPC is an interstate governmental organization, serving nine counties in the New Jersey/Pennsylvania area. DVRPC works to foster regional cooperation between city, county, and state governments and focuses on transportation, land use, environmental and economic development issues. DVRPC also provides services and advice to member governments through planning.

> DVRPC administers the
> **Tri–County Water Quality Management Program**
> This program, under the direction of the Tri-County Water Quality Management Board (WQMB), supervises the implementation and changes to the 208 Final Water Quality Management Plan, adopted on March 23, 1978, that coordinates water supply and sewer service for Burlington, Camden, and Gloucester counties. Members of the WQMB include representatives of county and municipal governments and citizens from the three counties. For additional information contact DVRPC or go to www.dvrpc.org/about/committees/wqmb.htm.

Educational Information Resource Center (EIRC)
606 Delsea Drive
Sewell, NJ 08080
856/582-7000
www.eirc.org
EIRC is a public agency specializing in education-related programs and services for parents, schools, communities and nonprofit organizations throughout New Jersey. It offers a great many resources for teachers under one roof including a resource library, programs, and training sessions on a wide variety of topics. Their website offers lesson plans and templates directly, as well as 5000 links to lesson plans and educational resources that support national, state, and local standards for language arts, science, social studies, and math in the K-12 curriculum.

Gloucester County 4-H
4-H Program Associate
1200 N. Delsea Drive
Clayton, NJ 08312
856/307-6450 Ext. 3
http://gloucester.rce.rutgers.edu/4H/
4-H, an informal education program for school-age boys and girls, is the Youth Development Program of Rutgers Cooperative Extension of Gloucester County. Programs and activities are designed to provide youth

with life skills such as public speaking, leadership and citizenship. The "School Enrichment program" offers free classroom presentations for grades K – 5 on some environmental topics. There are also 4–H curricular resources that can be found at www.n4hccs.org.

Gloucester County Department of Parks and Recreation
6 Blackwood-Barnsboro Road
Sewell, NJ 08080
856/468-0100
www.co.gloucester.nj.us/parks/parks.htm
Gloucester County Parks and Recreation is responsible for the organization and development of the recreational environment within the County. One of the objectives of the Parks Department is to acquire and develop parkland, which will enable the residents of the County to freely exercise their needs and desires for recreation in an atmosphere of open spaces. The other main objective is to schedule recreational programs and activities in order to meet the great need for leisure participation.

The Department of Parks and Recreation operates
Scotland Run Nature Center
980 Academy Street
Franklinville, NJ 08322
856/881-0845 or 468-0100
The Scotland Run Nature Center in Scotland Run Park, a part of the Gloucester County park system, offers educational programs such as a "Kid's Nature Club," "Nature Tots," and "Nature Detectives" and family and adult programs. The Nature Center also runs instructional teacher workshops. For more information, contact Jill Taylor, the Gloucester County Parks Naturalist, at 856/881-0845.

Gloucester County Historical Society
17 Hunter Street
Woodbury, NJ 08096
856/848-8531
www.rootsweb.com/~njglouce/gchs
The Gloucester County Historical Society is a nonprofit organization serving the Delaware Valley with a renowned library specializing in genealogy and various other collections such as 2,200 reels of microfilm pertaining to area census records, wills, newspapers, etc. An 18th century home houses the museum. The museum offers permanent and changing exhibits relating to Delaware Valley history, tours, and outreach programs to children, senior citizens and special needs audiences.

Gloucester County Nature Club
856/468-9272
www.gcnatureclub.org
The club strives to promote sound conservation practices and to educate others in the community about nature and the environment. It presents monthly programs on many topics and conducts a wide variety of field trips. It also sponsors "Bird Quest," a county–wide bird count and education event, held on the first Saturday in May. Teachers and classes are especially encouraged to participate. Training in advance is available.

Gloucester County Planning Division, Department of Public Works
Government Services Building
1200 N. Delsea Drive
Clayton, NJ 08312-1096
856/307-6650
www.co.gloucester.nj.us/plan/
The Planning Division creates the County Master Plan, does transportation and environmental planning, and serves as the representative agency and coordinator for regional and state planning projects. It also does subdivision and site plan reviews, serves as a data management resource center, and provides mapping services and maps to other agencies and to municipalities. A curriculum on water for four different grade levels, *Clean Water Works*, and an accompanying video are available by calling the Division.

Gloucester County Soil Conservation District
Victor DeVasto
District Manager
301 Hollydell Drive, Sewell, NJ 08080
856/589-5250; fax: 856/256-0488
email: gloucester@nj.nacdnet.org
www.gloucesterscd.org/
Soil Conservation Districts are special-purpose political subdivisions of the New Jersey Department of Agriculture, and are charged with implementing natural resource conservation and assistance programs. The Gloucester County Soil Conservation District provides conservation education, watershed planning, technical assistance, and regulatory enforcement. The District provides educational opportunities to K-12 students through classroom demonstrations, and participates in fairs and festivals.

Gloucester County Watershed Associations:

Federation of Gloucester County Watersheds
PO Box 233
Glassboro, NJ 08028
856/478–2264
www.sjwatersheds.org
The Federation is a county-wide membership watershed association and an umbrella organization for both the small associations in the County and those whose area extends beyond Gloucester (Great Egg Harbor WA and Oldmans Creek WA). The Federation focuses on protection of the surface and ground water of Gloucester through education, advocacy, monitoring, and land preservation.

Great Egg Harbor Watershed Association
PO Box 900
Hammonton, NJ 08037
609/567-4762
Email: gehwa.gehwa@verizon.net
www.gehwa.org

Mantua Creek and Woodbury Creek Watershed Association
PO Box 156
Glassboro, NJ 08028
856/582-9232
www.sjwatersheds.org

Oldmans Creek Watershed Association
1009 Lincoln Ave.
Mullica Hill, NJ 08062
856/478-6527
www.sjwatersheds.org

Raccoon/Repaupo Creeks Watershed Association
412 Ferrell Rd.
Mullica Hill, NJ 08062
856/478-4800
www.sjwatersheds.org

Upper Maurice River Watershed Association
803 Fries Mill Rd.
Franklinville, NJ 08322
609/881-0845
www.sjwatersheds.org

Old Pine Farm Natural Lands Trust (on Big Timber Creek)
340 Pine Avenue
Deptford, NJ 08096
www.bigtimbercreek.org
The Old Pine Farm Trust manages a 30-acre preserved property on the Big Timber Creek in Deptford Township and facilitates the preservation of other lands along the creek. It also provides educational materials and activities relating to the creek that are similar to those of a watershed association.

Nature Conservancy- Delaware Bayshores Office
2350 Route 47
Delmont, NJ 08314
609-861-0600
www.nature.org/wherewework/northamerica/states/newjersey/
The Nature Conservancy, established in 1951, is an international, nonprofit organization dedicated to preserving the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The New Jersey chapter has worked to protect over 47,000 acres of land in the State. The Delaware Bayshores office has worked to preserve many acres within the Maurice River watershed. For more information visit the website.

NJ Department of Environmental Protection:
To report environmental incidents, abuses, and complaints, call 1-877-WARNDEP.

- For information on water quality, visit the **Division of Water Quality** at www.state.nj.us/dep/dwq or call 609/633-1208.
- For information on watershed management, go to the Division of Watershed Management at www.state.nj.us/dep/watershedmgt.
- For information on the **Private Well Testing Act**, visit www.state.nj.us/dep/pwta or call 1-866/4PW-TEST.
- For information on Certified Water Testing Laboratories in New Jersey, visit www.state.nj.us/dep/dwq/labcert.htm.

See also the next section, *Teacher Resources – Websites*, for additional NJDEP information sources.

New Jersey Watershed Ambassadors Program
Invite a Watershed Ambassador to your class! AmeriCorps and NJ Department of Environmental Protection sponsor the Watershed Ambassadors Program, employing individuals committed to environmental and watershed education. There are 20 ambassadors for the 20 Watershed Management Areas in New Jersey. Ambassadors do school presentations on various watershed subjects, bring students out to local water-bodies, and organize community members into River Assessment Teams (RATs) and Biological Assessment Teams (BATs). Three watershed Ambassadors serve the watersheds of Gloucester County. Read more about the Watershed Ambassadors Program at www.state.nj.us/dep/watershedmgt/. Below is the contact information for the Ambassadors serving Gloucester County:

WMA 15 Great Egg Harbor	c/o Atlantic County Utilities Authority, 609/272-6997
WMA 17 Maurice, Salem, Cohansey	c/o Cumberland County Planning Department, 856/825-3700 ext. 4010
WMA 18 Lower Delaware	c/o NJDEP Southern Enforcement Office, 856/614-3657

Partnership for the Delaware Estuary
400 W. Ninth St., Suite 100
Wilmington, DE 19801
302/655-4990 or 800/445-4935
www.delawareestuary.org
This nonprofit organization works to increase awareness and understanding of the Delaware River estuary – that portion of the Delaware River watershed that is tidal, starting at Trenton through the Delaware Bay. The Partnership offers numerous free print materials, a free bimonthly newsletter, classroom presentations upon request, and a school yard habitat initiative, "A Sense of Place: Restoring Native Plant Communities." It also runs an annual weeklong "Delaware Estuary Teacher's Institute" with stipends and professional development credits and offers.

Project USE (Urban Suburban Environment)
76 East Front St.
P.O. Box 837
Red Bank, NJ 07701-0837
732/219-7300
email: projectuse@Monmouth.com
www.projectuse.com
Project USE is a private, nonprofit educational organization that strives to expose students to Experiential (Adventure) Education and serves the Tri-State area (New Jersey, New York, and Pennsylvania). USE runs a New Jersey Waterways

program in which groups explore New Jersey's watersheds by canoe. Ongoing projects with local high schools are in place in at least one Gloucester County district.

Rowan University
Department of Civil and Environmental Engineering
201 Mullica Hill Road
Glassboro, NJ 08028
856/256-5320
http://nebula.eng.rowan.edu:81/CEE.htm
A leading public institution, Rowan University combines liberal education with professional preparation from the baccalaureate level through the doctorate. Rowan provides a collaborative, learning-centered environment in which highly qualified and diverse faculty, staff, and students integrate teaching, research, scholarship, creative activity, and community service. Through intellectual, social, and cultural contributions, the University enriches the lives of those in the campus community and surrounding region. The Civil and Environmental Engineering program at Rowan University provides K-12 educational outreach in the areas of watershed science and engineering through classroom visits and field trips.

Rutgers Cooperative Extension of Gloucester County
RCE of Gloucester County
County Government Services Building
1200 N. Delsea Drive
Clayton, NJ 08312-1095
856/307-6450
www.gloucester.rce.rutgers.edu/
Rutgers University, working with County agencies, offers research-based information and advice to improve people's daily lives in the areas of agriculture and resource management, family and community health, programs for youth (4-H), and home horticulture assistance. The Agricultural Extension Agent and the Master Gardeners program at the Clayton office provide direct aid on gardening, pest problems, and other matters.

South Jersey Land Trust
229 Lake Avenue
Pitman, NJ 08071
856/589-2049
email: sjlt@bigfoot.com
www.sjwatersheds.org/otherorgs/sjlandtrust/SJLT.htm
South Jersey Land Trust is a private nonprofit land conservation organization that was formed in 1990 with a goal of preserving land in the fast developing southern region of New Jersey. Activities include land acquisition projects, conservation easements, and habitat restoration projects; support services to other entities that are attempting to carry out land preservation projects; support of land use planning projects such as greenway delineation and watershed management plans, and educational activities that encourage the preservation of the unique habitats and the environs of southern New Jersey.

Teacher Resources - Websites

Adopt-A-Watershed:
Adopt-A-Watershed offers curriculum ideas that educators can focus on local environments and use to encourage service partnerships with school children. Contact Colleen Gould, NJ Department of Environmental Protection, at 609-633-3855 for more information. www.adopt-a-watershed.org

Alliance for New Jersey Environmental Education (ANJEE)
A nonprofit organization serving teachers, professors, environmentalists, state agency staff, and others interested in promoting and enhancing education about the environment. An annual conference is held in January with sessions for teachers and many free materials available from exhibitors. www.anjee.net

Ben's Guide to U.S. Government for Kids
Parents, teachers, and other educators can access this guide for curriculum, informational, and activity links pertaining to U.S. government structure and services. "Kids" are also encouraged to access this website as it is geared toward all age groups and all educational interests. www.bensguide.gpo.gov

Building Environmental Education Solutions
BEES, a nonprofit organization of educators, government officials, for-profit businesses, and academic institutions, helps teachers explore environmental studies through the disciplines of history, literature, math, and health. The BEES website offers many education programs, curricula, and resources, including a "How To" guide for starting BEES programs in other communities. www.beesinc.org

Camden County Academy of Teaching and Learning
The Camden County Academy of Teaching and Learning is dedicated to the improvement of education throughout the state of New Jersey. The Academy hopes that teachers and administrators will use the website to create, manage, and share documents, plans, schedules, and ideas about effective educational practices. Membership is free to all teachers throughout the state. The Academy also meets four times a year to engage in roundtable discussion with educational and political leaders, workshops, and group discussions. www.ccts-ettc.org/ettc/top.htm

Delaware River Basin Commission
The DRBC is an inter-governmental organization focused on managing the natural resources of the Delaware River, the longest un-dammed river east of the Mississippi, and its tributaries. DRBC has many projects, including a developed online education guide (ed web) concentrated on all aspects of the Delaware River watershed.
www.nj.gov/drbc/edweb/edweb.htm

Discovery Channel – Teacher Lesson Plans Library – "Water: Good to the Last Drop"
This lesson, developed by the Discovery Channel, uses U.S. History to show students how water has played an important role in the development of American settlements. It also illustrates the threats of pollution and importance of conservation. http://school.discovery.com/lessonplans/programs/water/index.html

Earth Force
Earth Force is a national organization striving to mobilize youth to take action in protecting their community's natural environment. While its focus is on youth, it draws upon many environmental education resources and offers links to these resources online. www.earthforce.org/resources.cfm

Education Resource Information Center – Clearinghouse for Science, Math, and Environmental Education
The Clearinghouse (CMSEE) is one of 16 in the ERIC system, which is supported by the U.S. Department of Education. Its purpose is to encourage ongoing improvement in education in all areas at all levels. An Environmental Education index links to different types of resources like journals, conferences, and online guides. www.ericse.org/eeindex.html.

Environmental Concern, Inc.
Environmental Concern, a nonprofit organization dedicated to wetland education, protection, and restoration, is creator of *Project WOW*, a nationwide teacher resource guide available at www.wetland.org.

EnviroScape™
EnviroScape is a school supplies retailer providing tools, kits, posters, and materials for environmental educators. Of special note is the "Make Your Own Watershed" Kit. www.enviroscapes.com

Environmental Education Link
EE Link is an online newsletter supporting environmental education around the nation. It highlights interesting curricula available through the Internet. www.eelink.net

Envirothon
The New Jersey Envirothon competition is a one-day event that takes place at the end of the school year in which high school teams are tested on natural resource topics through hands-on interactive problem solving. The winning team goes on to the national competition. http://nj.nacdnet.org/envirothon

Forest Resource Education Center
Teachers can order a free copy of the *NJ Community Forestry Arbor Day Act Activity Guide*. The guide can be easily photocopied and used in class. Call 609/633-7597.

Geography - *My Community, Our Earth*
MyCOE invites groups of students to use geographic methods to study and propose sustainable development ideas in their own communities. This past year's projects focused on Latin American countries and environmental planning issues. Copies of projects in Spanish are available at www.geography.org/sustainable/index.html.

Give-Water-A-Hand
The Give Water a Hand website features the national watershed education program designed to involve young people in local environmental service projects. You can follow steps in the Give Water A Hand Action Guide (download it for free) and have your class plan and complete a community service project designed to protect and improve water resources. www.uwex.edu/erc/gwah/

Global Rivers Environmental Education Network (GREEN): Founded by Earth Force, GREEN lists links to other watershed education websites on the Internet. Water monitoring volunteers and students can also report and record their data on this site. www.green.org

Great Swamp Watershed Association
This watershed association was created in 1981 to continue protection efforts of the Great Swamp National Wildlife Refuge. The Association has grown into a well-organized and dedicated body of watershed management professionals and wildlife enthusiasts. The Association has also developed an influential teacher's guide focused on the unique Great Swamp habitat. This guide inspired the creation of *A Teacher's Guide to the Watersheds of Gloucester County*. www.greatswamp.org

The Groundwater Foundation
The Foundation is a nonprofit organization dedicated to teaching the public about groundwater through numerous programs and publications geared toward educational levels K-12. www.groundwater.org or call 1-800-858-4844.

Izaak Walton League of America's Save Our Streams
Save Our Streams has developed educational tools for communities to employ to improve water quality in their streams, rivers, and wetlands. They also publish training resources for teachers interested in teaching about water testing methods or carrying out stream sampling. www.iwla.org/sos

National Wildlife Federation's Backyard Wildlife Habitat
The Backyard Wildlife Habitat Program teaches participants how to restore their backyards, schoolyards, and even entire communities to wildlife habitats by planting natural and indigenous vegetation. www.nwf.org/backyardwildlifehabitat

The Natural Resources Conservation Service:
The NRCS offers many education features, including interactive questions answered by an earthworm and suggested lesson plans for teachers. A booklet entitled *Backyard Conservation* offers ways people can apply conservation practices to land around their homes (call 1-888-LANDCARE for a copy). www.nrcs.usda.gov/feature/education

New Jersey Department of Environmental Protection

- **Division of Water Quality:** www.state.nj.us/dep/dwq
- **Division of Environmental Education:** SEEDS (State Environmental Education Directory website) offers an introduction to and comprehensive listing of developed curriculum, environmental educators, and organizations in the state. www.state.nj.us/dep/seeds

- **Division of Watershed Management:** Information on watershed concepts, stormwater, and improvements to water quality. Education information and publications are listed. www.state.nj.us/dep/watershedmgt/
- **Division of Fish & Wildlife:** Offers education programs, workshops related to Project WILD and Project WET (see Teacher Resources – Activity Guides), and materials. www.state.nj.us/dep/fgw/educatn.
- **New Jersey Geological Survey:** Information on NJ geology, aquifers, groundwater, and wells. www.state.nj.us/dep/njgs.

New Jersey Pinelands Commission, On-Line Curriculum Project
The Commission, an inter-governmental agency, oversees the Pinelands Natural Preserve of 1.1 million acres of forest lands in New Jersey. The Commission has recently completed an online curriculum guide for teachers of grades four through eight that meets state educational standards. In-depth background information is supplied with the hope that teachers will adapt the content to meet different classroom needs. www.state.nj.us/pinelands/pinecur/

River Network:
River Network acts as a connection: linking individuals to organizations, and organizations to larger associations. River Network also has significant background information on streams and rivers and has developed training tools for grassroots organizing and educational outreach. www.rivernetwork.org

US Environmental Protection Agency
- **Office of Water:** www.epa.gov/safewater
- **What's Up with Our Nation's Waters:** EPA releases a National Water Quality Report entitled *What's Up with Our Nation's Waters* and available online at www.epa.gov/owow/monitoring/nationswaters or by phone at 1-800-490-9198.
- **Do-It-Yourself Home Cleaning Products:** Suggestions and recipes for nontoxic cleaning solutions, available online at www.epa.gov/grtlakes/seahome/housewaste/src/recipes.htm.
- **Water Sourcebook:** The Water Sourcebook offers 324 learning activities geared for specific age groups from Kindergarten to 12th grade. www.epa.gov/safewater/kids/wsb/
- **Curriculum Resources:** EPA's Curriculum Resources contains ideas, curricula, and activities on a variety of environmental topics. Many links to other helpful guides and activities are provided for Conservation, Human Health, Water, Ecosystems, Waste and Recycling, and Air. www.epa.gov/teachers/curriculum_resources.htm
- **Drinking Water for Kids:** This EPA Department of Water website provides online games and activities geared toward kids to encourage learning about drinking water. www.epa.gov/safewater/kids/wsb and www.epa.gov/OGWDW/kids
- **Wetlands, Oceans and Wetlands:** Provides information and links to teaching guides and activities, education programs, wetlands science, research, and other resources. www.epa.gov/owow

U.S. Geological Survey
- **New Jersey Water Resources:** USGS collects basic hydrologic data and makes interpretive investigations of New Jersey's water resources. The N.J. District information page describes permanent projects, publications, and ways to contact staff members about outreach activities. www.nj.water.usgs.gov. For quick facts about New Jersey's unique water resources, visit: http://water.usgs.gov/wid/html/nj.html.
- **Water Resources:** Create an attractive wall mural or bulletin board for your school or community with a message about clean water. USGS provides illustrated posters of water processes and communities, available at: www.water.usgs.ogv/outreach/OutReach.html.
- **Water Science for Schools:** USGS offers information on many aspects of water, along with pictures, data, maps, and an interactive center where you can give opinions and test your water knowledge. www.ga.water.usgs.gov/edu
- **Science in Your Watershed:** Science in Your Watershed helps you find scientific information organized by watershed. This information is coupled with observations and measurements made by watershed groups, about the status and health of a watershed. www.water.usgs.gov/wsc.

Water: A Never Ending Story
This website provides lesson plans for a two-week module on the water cycle, intended for students in third and fourth grades. The module includes activities that teach students about each different phase of the water cycle. It is a comprehensive site that provides background for teachers, discussions, questions, and activities. www-k12.atmos.Washington.edu/k12/ pilot/water_cycle/teacherpage.html. (Note the underline).

Teacher Resources - Print Sources (Sources Used in this Guide)

Boyd, Howard P. *A Field Guide to the Pine Barrens of New Jersey: Its flora, fauna, ecology and historic sites*. Medford: Plexus Publishing, Inc, 1991.

Brown, Michael P. *New Jersey Parks, Forests, and Natural Areas: A Guide*. New Brunswick: Rutgers Univ. Press, 1992.

Burton, Dr. Maurice and Robert Burton, editors. *The International Wildlife Encyclopedia.* New York: Marshall Cavendish, 1969.

Caduto, Michael. *Pond and Brook: A Guide to Nature in Freshwater Environments*. Hanover: UP of New England, 1990.

Collins, Beryl Robichaud and Karl H. Anderson. *Plant Communities of New Jersey. A Study in Landscape Diversity*. New Brunswick, New Jersey: Rutgers University Press, 1994.

Fair, William R. *Waterways of Camden County: A Historical Gazetteer*. Camden: Camden County Historical Society, 2002.

Kraft, Herbert C. *The Lenape. Archaeology, History, and Ethnography*. Newark: New Jersey Historical Society, 1986.

McMahon, William. *South Jersey Towns*, New Brunswick: Rutgers Univ. Press, 1973.

Navoy, Anthony S., U.S. Geological Survey, "*Gloucester County Ground-Water Resources and Issues"* in *Watershed News* Early Spring 2001. The Newsletter of the Federation of Gloucester County Watersheds and the South Jersey Land Trust, Gloucester Co., April 2001. www.sjwatersheds.org

NJ Department of Environmental Protection

- *The Clean Water Book: Lifestyle Choices for Water Resource Protection*, Trenton, NJ, 1997.
- Division of Water Quality, Bureau of Nonpoint Pollution Control, *A Homeowner's Manual for Septic Systems*, 1999.
- Division of Fish and Wildlife, *Field Guide to Reptiles and Amphibians of New Jersey*, Trenton, 2002.

Scheuler, Tom. *Site Planning for Urban Stream Protection*. Silver Spring, MD: The Center for Watershed Protection, 1995.

Simpson, Hazel B., editor. *Under Four Flags: Old Gloucester County 1686-1964*. Woodbury: Board of Chosen Freeholders, Gloucester County, New Jersey, 1964.

State of Connecticut, Department of Environmental Protection, Wildlife Division, "Endangered and Threatened Species" Fact Sheet Series, http://dep.state.ct.us/burnatr/wildlife/learn.htm.

Stokes, Donald and Lillian. *Stokes Nature Guides: A Guide to Bird Behavior Volumes I, II, and III*. New York: Little, Brown and Company, 1989.

Stokes, Donald and Lillian. *Stokes Nature Guides: Animal Tracking and Behavior*. New York: Little, Brown and Co., 1986.

Sutton, Clay C., John C. O'Herron, II, and Robert T. Zappalorti. *The Scientific Characterization of the Delaware Estuary*. The Delaware Estuary Program (DRBC Project No. 321; HA File No. 93.21), 1996.

Tyning, Thomas F. *Stokes Nature Guides: A Guide to Amphibians and Reptiles*. Boston: Little, Brown, and Company, 1990.

University of Wisconsin – Extension. Booklet: *Help Yourself to a Healthy Home*, 2002. www.uwex.edu/healthyhome/pdf

U.S. Environmental Protection Agency, Booklet 816-K-02-003, *Drinking Water from Household Wells*, January 2002. Available as a pdf file at www.epa.gov/safewater/consumer/wells/household_wells.pdf. (Note underline).

Washington Township [Gloucester County, NJ] Environmental Commission, *The Streams of Washington Township,* 1995.

Watt, Martha K. *A Hydrologic Primer for New Jersey Watershed Management*. West Trenton: US Geological Survey, Water-Resources Investigation Report 00-4140. Available as a pdf file at http//nj.usgs.gov/publications/WRIR/00–4140.pdf.

Wernert, Susan. *Reader's Digest: North American Wildlife.* Pleasantville: Reader's Digest, 1982.

Widmer, Kemble. *The New Jersey Historical Series, Vol. 19: The Geology and Geography of New Jersey.* Princeton: D. Van Nostrand Company, 1964.

Winter, Thomas, et al. U.S. Geological Survey, *Ground Water and Surface Water: A Single Resource*, Denver: 1998.

Teacher Resources – National Activity Guides

New Jersey Audubon Society's *Bridges to the Natural World* and *New Jersey WATERS*
The Audubon Society offers many resources and services for environmental educators. They host professional development workshops, publish teacher and nature guides, and deploy naturalists for class presentations and evaluations. Their teacher's guide, *Bridges to the Natural World*, provides extensive information on New Jersey habitats and wildlife. *New Jersey WATERS* was created in 1999 and focuses on topics and issues pertaining to watersheds, wetlands, and fresh and marine waters. Both guides meet state curriculum standards. www.njaudubon.org

The Orion Society
The Society is a pioneer of place-based education – using local knowledge to build stewardship and informed decision making. The Society works with educators to develop place-based models and interdisciplinary education and publishes educational resources, awards fellowships to teachers, and hosts regional conferences. To learn more about the Orion Society and its educational work, check their website at www.oriononline.org/pages/os/education/index_education.html. (Note underline).

Project Learning Tree
PLT is a popular environmental education program supported by the American Forest Foundation. PLT aims to teach students HOW to think, instead of WHAT to think, about the environment. Curriculum guides, complete with activities and materials, are available through the national website at www.plt.org

Project WET
Project WET (Water Education for Teachers) is a nonprofit water education program providing resources for education levels K-12. Contact: Wetlands Institute at 609/368-1211 and education@wetlandsinstitute.org. www.projectwet.org

Project WET in the City
WET in the City is an urban environmental education program funded through the Council for Environmental Education (CEE) and focuses on urban water resources in need of care and stewardship. WET in the City publishes a curriculum guide for grades K through 12 replete with activities centered on urban environmental issues. For a guide, contact info@wetcity.org. For more information on Project WET in the City: www.wetcity.org

Project WILD and Aquatic WILD
Project WILD is one of the most widely used conservation and environmental education programs for K through 12 students. The project emphasizes wildlife because of its intrinsic and ecological values and its importance for teaching ecosystems. *Project Aquatic WILD* is especially designed to educate on aquatic organisms and water habitats. A curriculum and activity guide is available by ordering online. For more information: www.projectwild.org

Wild School Sites A Guide to Preparing for Habitat Improvement Projects on School Grounds is a publication issued in 1993 by Project Wild that outlines the process of developing a schoolyard habitat. Based in Bethesda, MD, Project WILD can be reached by phone at 301-493-5447.

Teacher Resources - Watershed Field Trip Destinations

Below are a few ideas for taking groups out of the classroom and into natural areas that are illustrative of Gloucester County's watersheds and wildlife. These environmental centers are organized into geographic areas: Gloucester County, Delaware River, Atlantic Ocean, and the Pinelands. This listing is far from complete. Instead, we have chosen to focus on those education resources in Gloucester County or within about 25 miles of the County's borders.

Gloucester County

Glassboro Wildlife Management Area
Route 47
Glassboro NJ 08028
856/785-0455
Fax: 609/984-1401
In Gloucester County, the Glassboro Wildlife Management Area boasts 2,337 acres of woodlands and fields. This provides excellent opportunities for wildlife viewing (as well as seasonal hunting).

Mannington Meadows Wildlife Refuge, Salem
Owned by the NJ Dept. of Fish, Game and Wildlife, this refuge is excellent for viewing local and migratory birds and wildlife. Located on Route 45 Woodstown Road, between Salem and Woodstown.

Organize Your Own Stream Cleanup – New Jersey Community Water Watch
New Jersey Community Water Watch, a Public Interest Research Group (PIRG) and AmeriCorps partner, provides assistance in organizing, conducting, and manning stream cleanups. Water Watch recruits students from area universities (20 campus locations in New Jersey) to carry out cleanups and teach short environmental curriculum on water issues. To organize a cleanup, contact an educator, or learn more about Water Watch and its work in your community, contact Allison Cairo, the NJ Community Water Watch Executive Director, at 732/249-4108 or allison@waterwatchonline.org. For more information on New Jersey Community Water Watch: www.waterwatchonline.org/nj/index.html.

Red Bank Battlefield, National Park, New Jersey
Red Bank Battlefield and Park is located on the Delaware River, a few miles from the City of Camden, and is maintained by the Gloucester County Parks and Recreation Department. The American Revolutionary Fort Mercer, a sister fort to Fort Mifflin in Pennsylvania, once stood on this battlefield's grounds with the primary aim to deter British supply ships from reaching Philadelphia. In 1778, a calculated battle was fought between the revolting American colonists and the British-Hessian soldiers. The fort was so well designed that Hessian troops could not break the compound's walls. Over 500 Hessian soldiers died while only 14 colonial soldiers perished during the battle. The park hosts annual battle reenactments, community gatherings, and cultural and historical festivals in its restored Whitall House. To tour this historical site with an interpretive guide, contact Kathryn Dodson, Gloucester County's Museum Curator, at 856/853-5120.

Scotland Run Nature Center
980 Academy Street
Franklinville, NJ 08322
856/881-0845 or 468-0100
The Scotland Run Nature Center in Scotland Run Park, a part of the Gloucester County park system, offers educational programs such as a "Kid's Nature Club," "Nature Tots," and "Nature Detectives" and family and adult programs. The Nature Center also runs instructional teacher workshops. For more information, contact Jill Taylor, the Gloucester County Parks Naturalist, at 856/881-0845.

Supawna Meadows National Wildlife Refuge
856/935-1487
Fax: 856/935-1198
E-mail: FW5RW_SMNWR@fws.gov
The refuge lies along the Delaware River, north of the Salem River, in Pennsville Township, Salem County. Approximately 75 percent of the current 2,500 acres is brackish tidal marsh. As a part of the National Wildlife Refuge System, Supawna Meadows provides wintering and migrating waterfowl with an important feeding and resting area.

Delaware River and Delaware Bay

Garden State Discovery Museum
Museum on the Move
2040 Springdale Road, Suite 100
Cherry Hill, NJ 08003
856/424-1233 ext. 309
The Discovery Museum, voted one of the best children's museums in the country, offers traveling workshops for elementary-aged children (5 to 10 years old). Workshops are 30 to 60 minutes long and focus on special issues relevant to New Jersey like pollution, bugs, and dinosaurs. One such workshop, "Earth & You: Finding a Pollution Problem," employs an interactive Enviroscapes™ model that teaches about area watersheds, sedimentation, and pollution. For more information, visit: www.discoverymuseum.org.

Maurice Wild and Scenic River
The Maurice River corridor is a pristine Atlantic Coastal river and habitat to shorebirds, songbirds, waterfowl, raptors, rails, and fish. Historically, the Maurice River is home to a rich fishing, boating, and oystering community. Over 53 percent of the animal species New Jersey has recognized as endangered live along or in the river. For more information: http://mauriceriver.igc.org/ or www.nps.gov/rivers/wsr-maurice.html.

Palmyra Cove Nature Park
PO Box 6 (1300 Route 73 North)
Palmyra, NJ 08065
856/829-1900
The Palmyra Cove Nature Park is located just over the Camden County border in Burlington County. It is 350 acres of preserved natural lands in a highly urbanized area on the Delaware River. The site contains many different natural habitats, including woodlands, wetlands, a tidal cove, and a 1.6-mile river shoreline. An environmental education center opened in May 2003 and is the focal point of the park. www.palmyracove.org

Parvin State Park
701 Almond Road
Pittsgrove, NJ 08318
856/358-8616
Parvin State Park, in Salem County, sponsors a nature program that aims to inform and increase people's interest in natural areas. The program is designed to cultivate participants' sense of stewardship and powers of observation. Activities include guide walks, slide and video programs, nature crafts, scenic sketching, aquatic studies, birding seminars, and tree identification. There is no cost for this program and it can be adapted to all different age groups. For more information, contact the park's staff.

Philadelphia City Sail, Inc.
PO Box 43235
Philadelphia, PA 19129
215/271-3400
Philadelphia City Sail is a nonprofit organization with a focus on exposing economically disadvantaged youth in the Delaware Valley to sailing and the aquatic environment. City Sail uses math, science, environment, and maritime training to teach students about the area around them. Students learn teamwork, develop trust, and expand their horizons while sailing the Delaware River on the schooner *North Wind*. For more information: www.citysail.org.

Atlantic Ocean

Cape May Bird Observatory
600 Route 47 North
Cape May Court House, NJ 08210
609/861-0700
The Bird Observatory was founded in 1975 by the New Jersey Audubon Society and is a leader in research, environmental education, bird conservation, and recreational birding activities. Many environmental education programs are held at the facility. There is also an example of a backyard (or schoolyard) habitat and the Observatory has information on how to create your own. To organize an educational and instructional trip to the observatory, contact Dale Rosselet, the Vice President for Education, at 609/861-0700 or dale@njaudubon.org. For more information on the Cape May Bird Observatory and its services: www.njaudubon.org/Centers/CMBO/.

Edwin B. Forsythe National Wildlife Refuge
Great Creek Road
Oceanville, NJ 08231
609/652-1665
This National Wildlife Refuge is maintained by the U.S. Fish and Wildlife Service. More than 43,000 acres of coastal habitats in South Jersey are protected and managed for migratory birds. Driving trails are accessible for visitors to explore the refuge while protecting its "wild" character.

Great Egg Harbor Scenic and Recreational River
Atlantic County Parks
Estell Manor Park, Rte. 50
Mays Landing, NJ 08330
609/645-5960
The Great Egg Harbor starts in Berlin (Camden County), New Jersey and runs to the Atlantic Ocean. Almost all of the 129 miles of river flow through the Pinelands National Reserve. For more information: www.nps.gov/greg/index.htm.

New Jersey Coastal Heritage Trail
New Jersey Division of Travel and Tourism
PO Box 820
Trenton, NJ 08625-820
609/292-2470
The Heritage Trail was established in 1988 by the National Park Service and the State of New Jersey and extends from Perth Amboy to Cape May on the Atlantic Coast, and from Cape May to the Delaware Memorial Bridge in Deepwater along the Delaware Bay. The Trail has five themed paths: Maritime History, Coastal Habitats, Wildlife Migration, Historic Settlements (under development), and Relaxation and Inspiration (under development). The Trail is designed to be a driving route with significant stops along the way. For more information and trail brochures: www.nps.gov/neje/home.htm or www.state.nj.us/travel

Pinelands Area

Batsto Village
Batsto Village and Wharton State Forest
4110 Nesco Road
Hammonton, NJ 08037
609/561-0024
The New Jersey Department of Environmental Protection administers this historic village located in the South Central Pinelands. While Batsto Village is primarily a historic site, many environmental lessons can be learned about the people who toiled and profited in this area rich with natural resources. Area schools often schedule field trips and tours to the historic village, which is within the Wharton State Forest. For information: www.batstovillage.org.

Belleplain State Forest
County Route 550
PO Box 450
Woodbine, NJ 08270
609/861-2404
Belleplain offers many different large group camping amenities like campgrounds, lean-tos, and group cabins. There are also swimming facilities available at Lake Nummy, an interpretive center, boating and canoeing on East Creek Pond and the lake, picnic facilities, and many winter sports.

Brendan T. Byrne State Forest
PO Box 215
New Lisbon, NJ 08064
609/726-1191
The Byrne State Forest is a recovering ecosystem of pine trees. Byrne State Forest is a part of winter swan migration routes. In the nineteenth century, the Lebanon Glass Works cleared the land and used the pine and oak trees to power its furnaces. This state forest includes the historic Whitesbog Village, a cranberry– and blueberry–producing company town. Whitesbog Village offers guided tours upon request; The Batona Trail also passes through this park. Large group campsites are available. www.whitesbog.org.

Double Trouble State Park
PO Box 175
Bayville, NJ 08721
732/341-6662
The park includes the Cedar Creek, which provides water for cranberry cultivation, and more than 5,000 acres of Pine Barrens habitats. Canoeing is possible on the Cedar Creek. Double Tree Village is a historic cranberry community that still has active bogs operated by the New Jersey Devil Cranberry Company. This state park is also a site on the New Jersey Coastal Heritage Trail.

Camden County Environmental Education Center
Park Drive at Broad Avenue
Berlin, NJ 08009
856/768-1598
Email: dorleans@camdencounty.com
The Camden County Parks system through the Environmental Education Center offers indoor and outdoor programs for students on water-related and other environmental topics. Contact the Park Naturalist, Dave Orleans by phone or email.

New Jersey Pinelands National Reserve
New Jersey Pinelands Commission
PO Box 7 (15 Springfield Road)
New Lisbon, NJ 08064
609/894-7300
The Pinelands National Reserve was the first of its kind in the nation and established by a Congressional act in 1978. As a reserve, it is an area of nationally significant resources that are protected through land use management. It is also a United States Biosphere Reserve and acts as a laboratory for scientists to explore the relationship between humans and the environment. The Pinelands area is in seven counties, including a portion of Camden County. For more information about visiting the Pinelands area, visit: www.state.nj.us/pinelands or www.nps.gov/pine/index.htm.

Wharton State Forest
4110 Nesco Road
Hammonton, NJ 08037
609/561-0024
Two Headquarters: Batsto Village on Route 542; Atsion on Route 206
Wharton State Forest is a historic, cultural, and natural area encompassing thousands of acres of pinelands. The State Forest includes the historic Batsto Village, Batona Trail connecting Wharton, Lebanon, and Bass River State Forests, Batsto Natural Area bordered by the Batsto and Mullica Rivers, and the Oswego River Natural Area, which is a rare bog area and home to the Pine Barrens tree frog. Wharton State Park also has a very popular swimming area, Atsion Lake, interpretive visitor centers, and canoeing on the Mullica, Batsto, Wading, and Oswego Rivers.

10. Glossary

Aquifer: An underground bed of saturated sediment or rock that yields significant quantities of water. A **confined aquifer** has impermeable or nearly impermeable layers, formed of silts, clays, or shales, above the water-bearing strata. An **unconfined aquifer** is one that is close to the surface, in which the water table rises and falls freely with infiltration of rainwater. Also called a "water table aquifer."

Branch: A smaller stream that flows into ("branches" off from) a larger one.

Catchment: The smallest watershed area, usually defined as the area that drains an individual site, such as a school or small neighborhood, to its first intersection with a stream.

Drainage basin: A large watershed encompassing the watersheds of many smaller rivers and streams and draining to a major river, estuary, or lake.

Ecosystem: A community of living organisms and their interrelated physical and chemical environment; also, a land area within a climate.

Evapotranspiration: The return of moisture to the atmosphere by the evaporation of water from the surface and by transpiration from vegetation.

Fecal coliform bacteria: A group of bacteria which are used as indicators of possible sewage or waste contamination because they are commonly found in human and animal feces.

Floodplain: The land areas adjacent to a river or stream that are flooded during storm events.

Groundwater: Water found in spaces between sediment particles underground (located in the zone of saturation).

Headwaters: The small streams from which a creek or river "rises" or begins.

Hydrologic cycle: Also known as the water cycle, this refers to the paths that water takes in its various states – vapor, liquid, and solid – as it moves throughout Earth's systems (oceans, atmosphere, groundwater, streams, etc.)

Impaired waterways: Stream segments or lakes that do not meet the water quality standards set for them by federal and state agencies.

Impervious surface coverage: Surfaces that do not allow stormwater runoff (rainwater and snow melt) to seep into the ground, such as sidewalks, roadways, driveways, and rooftops.

Integrated pest management (IPM): A system of reducing pest problems using environmental information along with variable pest control methods. These methods include physical, mechanical, biological, cultural, and chemical means of controlling pests.

Macroinvertebrates: Animals that lack backbones (invertebrates) and are large enough to be seen with the naked eye (macro.) Includes insects, crustaceans (such as crayfish), mollusks (clams, mussels, and snails), and worms. They are good indicators of water quality because the most sensitive can only survive in areas of high water quality.

Marl: A clay–sand soil with a high percentage of the mineral glauconite, which sometimes gives it a green color. Useful as a soil enricher when mixed into less fertile soils.

Nonpoint source pollution: Widespread overland runoff containing pollutants. The contamination does not originate from one specific location but is pollution discharged over a broad land area. Water pollution that cannot be traced to a specific source.

Outcrop: The area where an aquifer is present at or near the land surface – where it "crops out."

Pesticides: Chemical compounds designed to control and kill pests. The term pesticides includes herbicides (chemicals to kill weeds), insecticides (chemicals to kill insects), and fungicides (chemicals to kill fungus).

Physiography: The study of a location in relation to its underlying geology.

Point source pollution: Pollutants discharged from an identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

Run: A smaller stream that flows into ("runs" to) a larger one.

Saturated zone: The underground area in which water is held in the pores and spaces within the sediments or rock. Sediments in southern New Jersey aquifers are made up of sand, silt, clay, and gravel particles. The water within the saturated zone is groundwater.

Sedimentation: The settling of soil particles (sediment) to the bottom of a waterway.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers or septic systems.

Stormwater runoff: Precipitation that flows overland to surface streams, rivers, and lakes, either directly or through storm sewers.

Sub-watershed: The land area draining to the point where two smaller streams combine together to form a larger, single stream.

Transpiration: The process by which water that is absorbed through plant roots is returned to the atmosphere from the leaves.

Tributary: A stream or river flowing into a larger stream or river.

Water cycle: See Hydrologic cycle.

Water table: The top of the saturated zone (see definition) in an unconfined aquifer (see definition under "aquifer").

Watershed: The land area from which surface runoff drains into a particular stream channel, lake, reservoir, or other body of water.

APPENDICES:
LESSONS AND ACTIVITIES FOR THE CLASSROOM

Section **Page**

Correlation of Activities to New Jersey Science Standards

Activity	New Jersey Science Standards
Appendix A. "An Incredible Journey Through the" Watersheds of Gloucester County"	5.12.1,4 5.10.8,10 5.1.2
Appendix B. "Create Your Own Watershed"	5.2 5.10.2, 3, 5, 6, 8 5.12.2-7
Appendix C. "What's Your Watershed Address?"	5.10.1, 6 5.12.1, 2, 4, 6, 7
Appendix D. "Who Am I?"	5.12.1 5.7.1, 4, 7, 9 5.6.4, 11 5.6.2, 1
Appendix E. "How Does Your Watershed Grow?"	5.6.1, 2, 11 5.1 5.5 5.12.1-6, 9
Appendix F. "Every Drop Counts"	5.12.5, 4 5.10.3 5.2.11, 9, 4, 2 5.6.2 5.5.3, 4
Appendix G. "Storm Drain Labeling"	5.1 5.10.2, 4 5.12.1, 2, 4, 6
Appendix H. "Starting a Schoolyard Habitat"	5.2 5.6.2, 6, 12 5.7.1-4, 7-9 5.12.7, 10

Appendix A. An Incredible Journey Through the Watersheds of Gloucester County

An Incredible Journey Through the Watersheds of Gloucester County is adapted from "The Incredible Journey" activity in the *Project WET Curriculum and Activity Guide* (see Teacher Resources section for more information on *Project WET*). In this activity, students act as water molecules, moving from one part of the water cycle to another based on clues they find at each "station."

Students will:

- Be able to describe the movement of water through the water cycle
- Be able to identify the states of water as it moves through the water cycle
- Be able to explain how water can become polluted as it moves through the water cycle

Materials:

Clues (provided with this exercise)
Symbol Key (provided with this exercise)
12 manila envelopes
Dark-colored marker
Tape
Contact paper or lamination materials to protect clue cards (optional)
Noisemaker (bell, whistle, buzzer, etc.)

To prepare the activity, cut the clues into individual squares or cards. Each clue has a station location written at the top. Label each envelope with a station name and place the relevant clues in the envelopes (e.g., all the Delaware River clues go in the Delaware River envelope). Students can illustrate the stations if they wish. Tape or place the envelopes around the room or activity area so that students can see and reach into them easily. Place a copy of the symbol key at each station.

Stations:
(1) Clouds (2) Suburbia (3) Lake/Pond (4) Person (5) Animal (6) Wastewater treatment facility/Septic system (7) Plant (8) Soil (9) Groundwater (10) Atlantic Ocean (11) Delaware River (12) Stream

Procedure:
1. Tell students that they are going to become water molecules moving through the water cycle. Have the students brainstorm different places water can go within the water cycle, and the state (vapor, liquid, or ice) that water molecules would be in at different stages of the cycle. Discuss the conditions that cause water to move. Water movement depends on energy from the sun, electromagnetic energy, and gravity. Students should discuss the form in which water moves from one location to another. Most movement from one station to another will take place when water is in its liquid form. However, any time water moves to the clouds, it is in the form of water vapor, with molecules moving rapidly and apart from each other.

2. Review the various stations water can move through in this particular activity: clouds, suburbia, etc.

3. Tell students they will be demonstrating water's movement from one location to another. When they move as liquid water, they will move in pairs, representing many numerous water molecules together in a water drop. When they move to the clouds (evaporate), they will separate from their partners and move

alone as individual water molecules. When water rains from the clouds (condenses), the students will take a partner and move to the next location.

4. Have students line up at the cloud station (the starting place for this activity).

5. Have the first student in line choose a clue from the envelope. If the clue says to "stay," he or she should go to the back of the line at that station and wait his or her turn to try again. If the clue says to go to another station (named in bold lettering on the clue), the student should latch on to the next person in line (because water in its liquid or frozen state must be made up of at least two molecules) and head for that station. The next person in line then chooses a clue (each clue should be returned to the envelope before the students move on to the next station), and so on.

6. When a student or student pair arrives at a station, the same procedure is followed: The student(s) choose a clue and either stay and wait for the next turn or travel to the station named on the clue card. If a student is solo and needs to partner (to travel in the liquid state), the next student in line or the next student who arrives at the station becomes that partner and does not take a clue. If two students are partnered and need to travel singly (in the vapor state), each student of the pair pulls a clue and then travels accordingly.

7. Students should keep track of their movements. Have them keep a journal, notepad, or "water passport" to record each move they make, including stays. Alternatively, students may record their journeys by leaving behind personalized stickers at each station. Another approach has half the class play the game while the other half watches. Onlookers can be assigned to track the movements of their classmates. In the next round the onlookers will play the game, and the other half of the class can record their movements.

8. Tell students the game will run for 30 minutes and will begin and end with the sound of a bell (or buzzer, whistle, etc.). Begin the activity!

9. After the activity, have a few students read aloud their lists of locations (stations) they traveled to as a water molecule. All students could total up the number of visits they made to each location and a chart comparing these numbers could be developed on the board. To follow up further on the exercise, students might write a creative story about their journey and what it was like to move from one place to another. Or they might discuss how their journey would have differed during another season (e.g., summer versus winter).

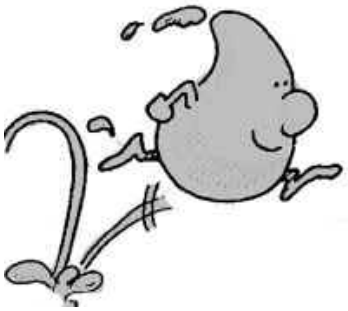
Adaptation:
Affix red stickers to the suburbia, cloud, and person clues that have been polluted with chlorine, manure, pesticides, fertilizers and oil or air pollutants to indicate pollution. If a student selects one of these clues, he or she becomes polluted (demonstrating how difficult it is to clean water once it has been polluted). Place a red sticker on those students. If a molecule (student) that has been polluted later joins up with another, unpolluted molecule, that second molecule will also become polluted and should have a red sticker placed on him or her. Students who are "polluted" and move through the wastewater treatment facility/septic system (station 6) can be "cleaned" and remove their red stickers. How many molecules (students) have been polluted by the end of the activity? How many molecules (students) visited the waste treatment facility and were cleaned?

To follow up, have students research how water becomes polluted and what opportunities exist for it to be cleaned as it moves through the water cycle.

Symbol Key for An Incredible Journey
Through the Watersheds of Gloucester County

One of these symbols is on each clue card. They indicate what action students should take in response to the clues. Students are instructed to stay or move (singly or in pairs).

Affix copies of these images to each station's envelope so students are reminded of the movement to make.



Move to the next station as liquid water, with your partner (or with the next student in line or the next student who arrives at the station).

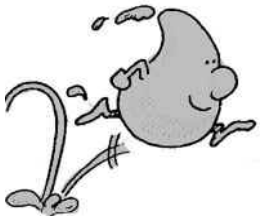
Stay at your station. Go to the end of the line, whether you are a single vapor molecule or have a partner in the liquid state.

Move to the cloud station **alone**, as a single vapor molecule.

Station 1: Clouds *(station location can be written on the back of the clues in this group)*

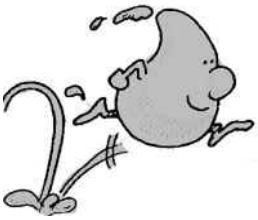
You are in a cloud:

Water condenses and falls as rain on **soil** in Gloucester County.



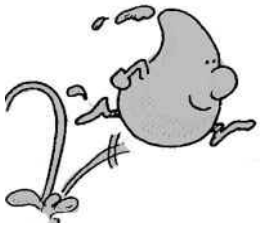
You are in a cloud:

Water condenses and falls on rooftops (in **suburbia**).



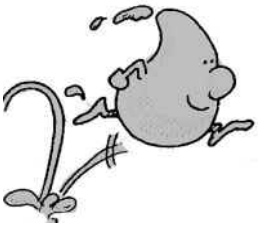
You are in a cloud:

Water condenses and falls into a **stream.**



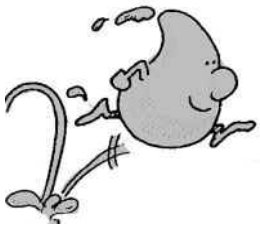
You are in a cloud:

Water condenses and falls into the **Atlantic Ocean**.



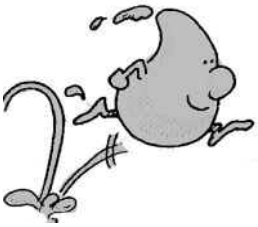
You are in a cloud:

Water condenses and falls into a **lake**.



You are in a cloud:

Water condenses and falls on rooftops (in **suburbia**).



Station 1: Clouds *(station location can be written on the back of the clues in this group)*

You are in a cloud:

As the water evaporated, it picked up air pollution from local traffic. The polluted water **stays** in the clouds.

You are in a cloud:

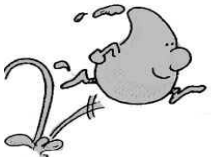
The water **stays** as a droplet clinging to a dust particle.

Station 2: Suburbia *(station location can be written on the back of the clues in this group)*

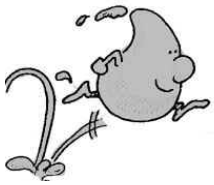
You are in suburbia:
Water is absorbed by a shrub (plant) on a residential lawn treated with pesticides. The pesticide pollution gets into the water and into the **plant**.

You are in suburbia:
Rain falls on a residential driveway, forming a puddle that evaporates (to a **cloud**) on a sunny afternoon.

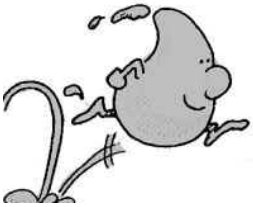
You are in suburbia:
Rain saturates ground at a Country Club recently treated with pesticides and fertilizers. The polluted water filters through the soil into groundwater and eventually goes to a **stream**.



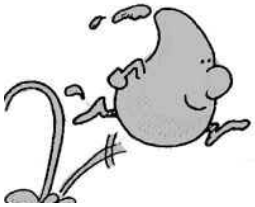
You are in suburbia:
Rain falls on the ground at a dairy farm and washes manure (pollution) into the **soil**.



You are in suburbia:
Rain saturates ground of a residential lawn recently treated with a lot of fertilizer. The polluted water filters through the soil into **groundwater**.



You are in suburbia:
Rain falls on a paved road covered with oil spots and travels to a storm drain. The storm drainpipe carries the polluted water to a **lake.**



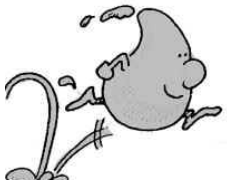
Station 3: Lake / Pond *(station location can be written on the back of the clues in this group)*

You are in a lake:

Heat energy is added to the water by the sun. The water evaporates (to a **cloud**).

You are in a lake:

Water is pulled by gravity; it filters into the soil and joins the **groundwater**.

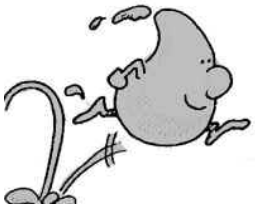


You are in a lake:

The water **stays** in the lake.

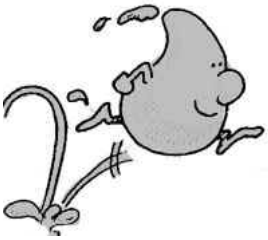
You are in a lake:

A gray squirrel (an **animal)** drinks the water.



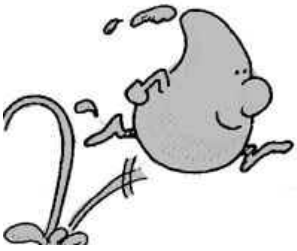
You are in a lake:

Water is absorbed by the roots of a willow tree (**plant**).



You are in a lake:

Water from the lake enters the **Delaware River**.



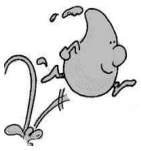
Station 4: Person *(station location can be written on the back of the clues in this group)*

You are in a person:

People treat groundwater from wells with chlorine and use it for swimming. The used water is released into a storm drain and ends up as pollution in a **lake**.

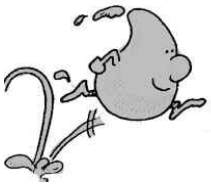
You are in a person:

Toilet water is flushed by a person and goes to a **septic system**, which filters and cleans the wastewater.



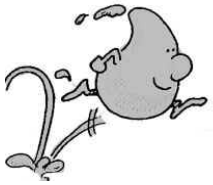
You are in a person:

Laundry water is discharged and goes to the **wastewater treatment facility** where it is cleaned.



You are in a person:

A person waters the lawn. Water filters into the **soil**.

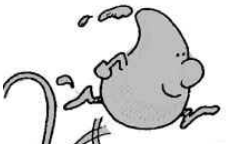


You are in a person:

Water is respired or evaporated (to a **cloud**) from a human body.

You are in a person:

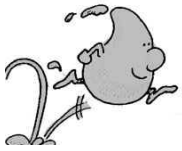
Bath water is emptied by a person and goes to the **wastewater treatment facility** where it is cleaned.



Station 4: Person *(station location can be written on the back of the clues in this group)*

You are in a person:

Toilet water is flushed by a person and goes to a **septic system**, which filters and cleans the water.



You are in a person:

Bath water is emptied by a person and goes to the **wastewater treatment facility** where it is cleaned.

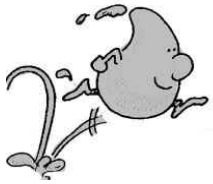
Station 5: Animal *(station location can be written on the back of the clues in this group)*

You are in an animal:

Water is respired or evaporated (to a **cloud**) from an animal's body.

You are in an animal:

Water, excreted by an animal, seeps into the **soil**.



You are in an animal:

Water, excreted by an animal, seeps into the **soil**.

You are in an animal:

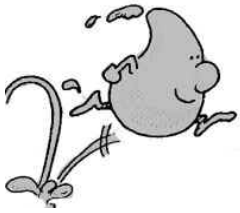
The water **stays** in the animal's body.

You are in an animal:

Water is respired or evaporated (to a **cloud**) from an animal's body.

You are in an animal:

Water, excreted by an animal, seeps into the **soil**.



Station 6: Wastewater Treatment Facility/Septic System *(station location can be written on the back of the clues in this group)*

You are at a Wastewater Treatment Facility or in a Septic System:

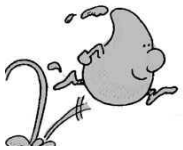
Wastewater is treated at a wastewater treatment facility and the cleaned water is released into the **Delaware River**.

You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater is treated at a wastewater treatment facility and the cleaned water is released into the **Delaware River**.

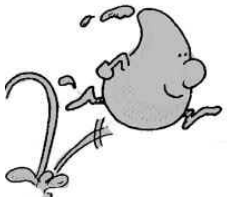
You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater is treated at a wastewater treatment facility and the cleaned water is released into the **Delaware River**.



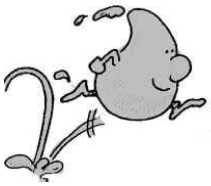
You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater goes through a septic system, is filtered and cleaned, and goes into the **groundwater**.



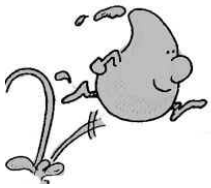
You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater goes through a septic system, is filtered and cleaned, and goes into the **groundwater**.



You are at a Wastewater Treatment Facility or in a Septic System:

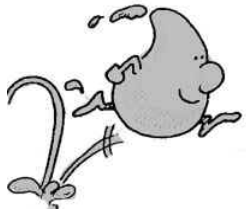
Wastewater goes through a septic system, is filtered and cleaned, and goes into the **groundwater**.



Station 7: Plant *(station location can be written on the back of the clues in this group)*

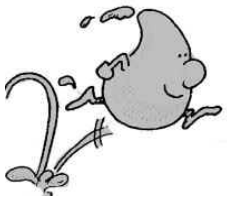
You are in a plant:

The plant is eaten by an **animal**.



You are in a plant:

The water is used by the plant to make its fruit. A **person** eats the fruit from the plant.



You are in a plant:

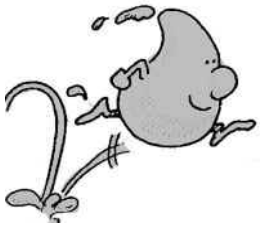
Water leaves the plant through the process of transpiration (to a **cloud**).

You are in a plant:

Water leaves the plant through the process of transpiration (to a **cloud**).

You are in a plant:

The plant is eaten by a **person**.



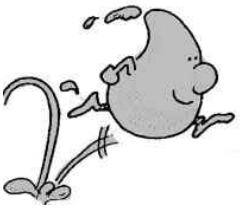
You are in a plant:

The water is used by the plant and **stays** in the plant cells.

Station 8: Soil *(station location can be written on the back of the clues in this group)*

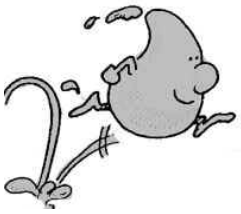
You are in soil:

Water is pulled by gravity; it filters through the soil and becomes part of the **groundwater**.



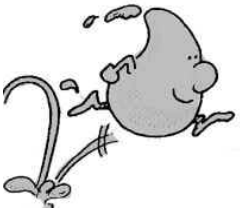
You are in soil:

The soil is so saturated that water runs off into a **stream.**



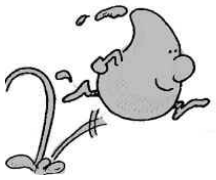
You are in soil:

Water is absorbed from the soil by the roots of a **plant**.



You are in soil:

The ground is so saturated that water runs off, carrying soil particles (pollution) to the streets of a Gloucester County town (in **suburbia**).

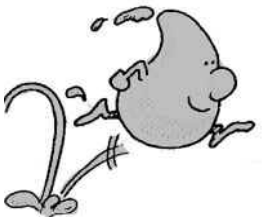


You are in soil:

Water **stays** on the surface of the soil in a puddle.

You are in soil:

The soil is so saturated that water runs off to the **Delaware River**.



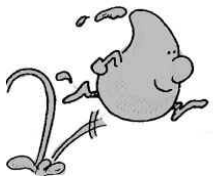
Station 9: Groundwater *(station location can be written on the back of the clues in this group)*

You are in groundwater:

The water **stays** in the groundwater.

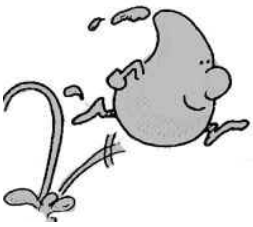
You are in groundwater:

The groundwater moves into a well and is used to water a family's lawn. A bird (an **animal**) drinks some of the water.



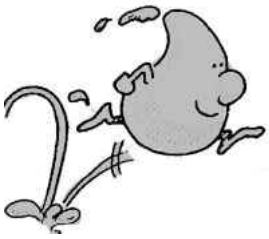
You are in groundwater:

Water filters into a **stream**.



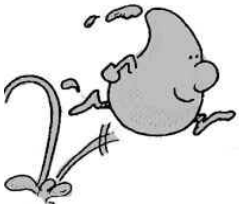
You are in groundwater:

Water filters into a **lake**.



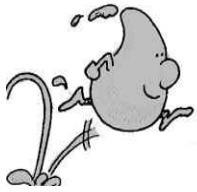
You are in groundwater:

Groundwater moves into a well and is used to wash a car in a driveway of **suburbia**.



You are in groundwater:

The groundwater moves into a well and is used as drinking water by a family. It goes into a **person**.



Station 10: Atlantic Ocean *(station location can be written on the back of the clues in this group)*

You are in the Atlantic Ocean:

Water **stays** in the ocean.

You are in the Atlantic Ocean:

Heat energy is added to the water in the ocean by the sun. The water evaporates (to a **cloud**).

You are in the Atlantic Ocean:

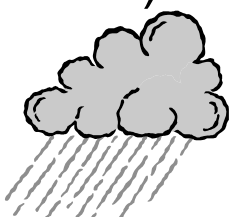
Water **stays** in the ocean.

You are in the Atlantic Ocean:

Water **stays** in the ocean.

You are in the Atlantic Ocean:

Heat energy is added to the water in the ocean by the sun. The water evaporates (to a **cloud**).



Station 11: Delaware River *(station location can be written on the back of the clues in this group)*

You are in the Delaware River:

Water **stays** in the Delaware River.

You are in the Delaware River:

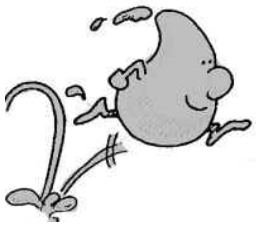
Water **stays** in the Delaware River.

You are in the Delaware River:

Heat energy is added to the water in the ocean by the sun. The water evaporates (to a **cloud**).

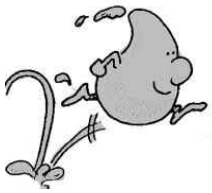
You are in the Delaware River:

Water flows to the **Atlantic Ocean**.



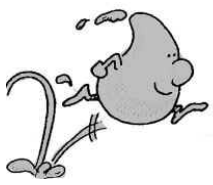
You are in the Delaware River:

Water is pulled from the river, goes through a water treatment facility, and the cleaned water is sent to a house. A **person** drinks the water.



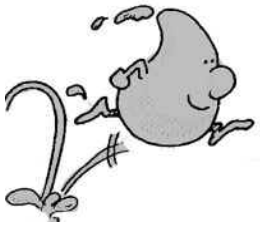
You are in the Delaware River:

Water is pulled from the river, and goes through a **water treatment facility** where it is cleaned**.**

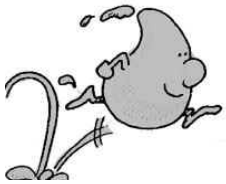


Station 12: Stream *(station location can be written on the back of the clues in this group)*

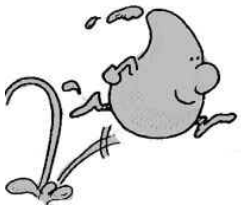
You are in a stream:
Water flows to the **Atlantic Ocean**.



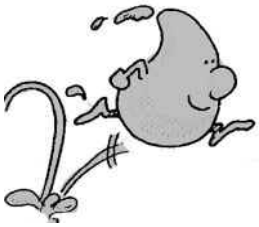
You are in a stream:
Water is absorbed by the roots of a willow tree and enters this **plant**.



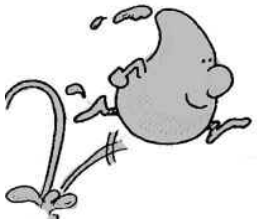
You are in a stream:
Water is pulled by gravity and filters into the **groundwater**.



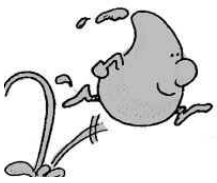
You are in a stream:
An **animal** drinks water from the stream.



You are in a stream:
Water flows to the **Delaware River**.



You are in a stream:
The stream overflows its banks during a heavy rainstorm and the water washes onto streets in **suburbia.**



Appendix B. Create Your Own Watershed

This activity is from "A Dynamic Watershed" activity in the New Jersey Audubon Society's curriculum guide, *New Jersey WATERS* (see Chapter 9, Teachers Resources, for more information.)

A three-dimensional model of a watershed is one of the best ways to demonstrate the watershed concept to your students. With a three-dimensional model, you can demonstrate how water runs from peaks and ridges to low points such as valleys, wetlands, and other depressions. In addition, with the use of water–soluble markers, you can demonstrate how pesticides and sediment are washed off the earth's surface during rain events and into our lakes, rivers, and streams. Prior to this activity, students should have an understanding of the water cycle.

Objective:
Students will be able to construct a landform model, identify geological and physical aspects of a watershed in relation to surface water, and observe and describe drainage patterns in a watershed.

Materials:

Model A (Paper Watershed):

- 2 sheets of paper per student or pair of students
- Masking tape
- Blue water-soluble markers
- Permanent markers

Model B (Watershed in a Basin):

- Newspaper
- Aluminum pan or plastic basin (at least 16" x 24") one per group of six students
- Plastic sheeting or wide aluminum foil, in sheets big enough to cover the top of the container plus about 10"

For both models:

- Spray bottles with water
- Paper towels
- Maps of Gloucester County Watersheds (provided in Chapter 4)

Select one of the following models for the students to construct:

Model A (Paper Watershed):

1. Give each student or pair of students two sheets of paper. Have students crumple one sheet of paper, open the paper, but not straighten it out completely.
2. Have students tape the edges of the crumpled paper to the surface of the other sheet of paper. The crumpled sheet resembles a relief map. The flat sheet is the base or stand for the paper model.

Model B (Watershed in a Basin):

1. Have students in each small group crumple up pieces of newspaper and place them in their aluminum pan or plastic basin. Have them leave one side or one corner without any newspaper. Explain that the newspaper pieces represent land forms and different elevation (topography.) The area without newspaper is a low point where a lake or wide river exists. (Other materials can also be used to help create the landforms: rocks, pieces of foam, paper cups turned upside down.)
2. Give each group a sheet of plastic (or wide aluminum foil) to lay over the entire model, representing the earth's surface. Have students "fit" and sculpt the material over the landforms, and tuck the edges into the container. If working with aluminum foil, warn students to work gently so as not to tear the foil.

Procedure:

1. Ask students to use their imagination and identify the different landforms represented in their watershed model. Where are the hills, mountains, valleys, plateaus, etc.?

2. Have students identify ridgelines. (Model A: have students trace these with blue, water-soluble markers.)

3. Explain the difference between "surface water" and "groundwater." Explain that the model is representative of a surface water system only, since it does not allow water to filter down into "groundwater." (These models are impervious surfaces, unlike soil.)

4. Ask the students to predict where the major rivers/streams might be and where, on their model, water would collect after a rainfall. (Model A: Have the students mark these features with permanent markers.)

5. (Model A: Put each model on newspaper, either outside or on the floor. Provide each group with spray bottles.) Instruct the students to "mist" spray their models (Model B: Add 2 – 3 drops of food coloring to the water in the spray bottles.) Discuss how the water flowed, where it accumulated, and how the simulated topography affected the drainage patterns of their model.

6. Introduce the definition of watershed as an area of land where water drains into a stream, river, lake, or other body of water. Drainage areas vary in size. Discuss how small catchment areas make up the watersheds of smaller streams, which flow into bigger streams of a larger watershed. Refer to specific Gloucester County watersheds to illustrate your points. Does one road in the school district regularly flood? Is there a stream or water body near the school? How does an abundance of rain affect the nearby streams?

7. Students can introduce their watershed models and discuss the different topography and the effects that pollution might have on each model. (Model B: have students line up their models on one table so all students can compare the different watersheds.)

Extension: Repeat the activity, but add the human aspect to the watershed:

1. Assume that this area (model) includes several towns. Where would be the best place to locate housing, the shopping mall, school and municipal buildings, recreation fields and parks, the water treatment plant, roads, the sewage treatment plants, landfills, etc.?

2. Model B: Place a drop of food coloring (other than blue) or colored powder (Kool-Aid) at each of the above sites on the model. Explain that the colored liquid (or powder) represents pollution. Ask the students to predict what will happen to water supplies the next time it rains. Spray mist the entire model and discuss the outcome and the cumulative effect of pollution. Students should be able to see quite clearly how the "pollutant" flows into the lake/wide river on the low side of their model.

Further Discussion:

1. List what the watershed's natural elements might be. (Soil, vegetation, animals, people, rocks, etc.) List what a watershed's human-made elements might be. (Buildings, roads, dams and lakes, parking lots, fences, airports, train tracks, etc.)

3. Discuss which of these watershed elements would shed water and which would use and/or absorb water. (Those that shed water would include the human-made elements, rocks, and some compacted soils; those that use and/or absorb water would be most soils, animals, and vegetation.)

4. Ask students: If this were your watershed, where would you like to live? Why? Where would your drinking water come from? Where would your wastewater go?

Appendix C. What's Your Watershed Address?

Most people are accustomed to thinking of their address as the street they live on, or the town they reside in, or maybe even the county. However, we all have a watershed address, as well. We might identify with a very large watershed, such as the entire Delaware River watershed, which covers over 13,000 square miles in New Jersey, New York, Pennsylvania, and Delaware, or we can identify with a smaller watershed such as the Oldmans Creek in Gloucester County. Within Gloucester County there are eight different watersheds. This activity will introduce your students to the concept of a watershed address, and help them figure out in which watershed they reside.

Students will:

- Define a watershed
- Locate their town on a Gloucester County watershed map and on specific watershed map(s)
- Identify and describe their watershed
- Describe possible sources of pollution
- Become familiar with their local waterways

Materials:

- Copies of Gloucester County-wide watershed map and specific watershed maps in which the entire school district is located (provided in this Guide, Chapter 4).
- Copies of Gloucester County road maps
- Copies of questions for narrative
- Pencil and writing paper

Procedure:

1. Provide students with a copy of the **Gloucester County watershed map**. Have them locate their town on this map and determine what watershed(s) their town is in.

2. Provide students with the relevant **maps of specific watersheds** (Big Timber Creek, Upper Maurice River, etc.) for your school district. Have them locate streams and rivers on the map and note where the streams and rivers flow together and/or merge into larger ones.
Streams in Gloucester County use various names such as: Run, Branch, Brook, or Creek (i.e., Chestnut Branch, Scotland Run, Raccoon Creek). Runs and branches usually "run" into creeks which "run" into rivers. In Gloucester County, all streams (creeks) flow toward the Delaware River/Bay or to the Atlantic Ocean. So either the Delaware River/Bay or the Atlantic Ocean would be downstream of any stream in the County.

3. Have the students locate the town where they live on a **Gloucester County road map**. They should be able to find their street and location of the school. These other landmarks will help them identify these same locations on the **watershed** maps. Have students mark their home and school locations on the individual watershed maps.

4. Using the **specific watershed maps,** have students find the stream closest to where they live and follow its pathway in both directions. The streams that run into each other and the surrounding land are all part of the watershed. The land "sheds" water into local streams and lakes during rain, snow melt, or when water goes down a storm drain.

5. Have students identify land use from a **Gloucester County road map** (ie: industrial parks, residential areas, etc.).

Watershed Story

Using the following questions as a guide, write a description of where you live according to the closest stream in your watershed. (Questions do not have to be answered in order, but all questions should be addressed in the narrative.)

Watershed questions (use the watershed maps and the Gloucester County road map):

1. What streams are closest to or in your town?
2. What other towns are upstream and downstream?
3. What other streams are connected?
4. Which watershed do you live in? Which watershed is your school in? Do you have to cross a watershed boundary to go from your home to your school?

About your neighborhood (use the Gloucester County road map):

1. What kinds of land uses (shopping malls, industrial parks, businesses, forests, recreation sites) are in your neighborhood?
2. Could any of the activities in your neighborhood or in your home affect your local stream?
3. If the activity affects your stream, can it affect the water downstream? Give examples.

Optional Follow-up Activity:

Visit the stream nearest your home with your parents. (Many streams run through local parks or can be viewed from roadways that cross over them.)

Answer the following questions:

1. If you have never seen the stream before, is it what you expected? How is it different?
2. If you have visited the stream before, how has it changed since the last time you saw it?

Appendix D. Who Am I?

This activity is adapted from the "Water Address" activity in the *Project WET: Curriculum and Activity Guide* and the *Great Swamp Watershed's Teacher's Guide* (See the Teacher Resources section for more information on *Project WET*). Every living organism needs water in one or more forms to survive. Some plants and animals have adapted to an abundance of water, such as those that actually live in streams, lakes, or oceans. Others survive with only minimal amounts of water, such as animals and plants living in deserts or other arid areas of the world. Often you can learn a lot about the habitats of animals or plants by the mechanisms or characteristics they utilize to deal with the amount of water they have available to them.

Objective:
The following activity will introduce students to some of the animals and plants that live in Gloucester County and its various watersheds. The ultimate objective of this activity is for students to recognize water-related adaptations of some animals and plants.

To prepare students for this activity, a general introduction to animal groups and to the general characteristics of plants should be given. Fact sheets are provided for further information on each animal and plant highlighted in the "Who Am I?" cards. After students take part in the activity, have them research how these organisms take advantage of the ecosystem that surrounds us.

Materials:
One set of ***Gloucester County "Who Am I?" cards*** for each group of students (these cards may be mounted on cardboard or laminated for durability)
Pencils and paper for scorekeeping
Fact sheets with pictures of organisms listed on the ***Gloucester County Who Am I? cards*** (for advance study). The Fact sheets are provided with this activity.
Map of Gloucester County and its watersheds (provided, though optional)
Encyclopedia or computer (optional)

Procedure:
1. To begin, discuss the importance of water to all life, particularly human beings. Some questions to ask students are: How long can an individual last without water? (Ans: About one week, depending on conditions. A person needs about 2.5 quarts of water /day from eating or drinking to maintain good health.) What percentage of our body is made up of water? (Ans: About 66% or 2/3). How do people in different parts of the world adapt to arid climates or excessively wet climates (such as catching rainwater in barrels or building houses on stilts)? What are some examples of plants or animals that have very distinct adaptations (such as cacti or camels in arid climates)? How many different ecosystems can students list with differing levels of water availability (e.g. deserts, rainforests, polar areas, etc.)? What kinds of special adaptations do animals that live in Gloucester County develop?

Distribute the fact sheets to students to learn about the animals and plants that the game will include and to find the answers to the last question.

2. Tell students they are going to play a riddle game in which they must guess an animal's or plant's identity. Divide the students into small groups.

3. Hand out a set of ***Gloucester County "Who Am I?" cards*** to each group. Instruct students not to look at the cards before the game starts.

4. Explain that each card lists four clues (some involving water, some not) for a certain animal or plant. Based on the clues, students will try to guess the name of the animal or plant.

5. Each group should initially pick one student as a "reader." This student will read clues, one clue at a time, until someone in the group can guess the animal or plant. Answers are listed at the bottom of each card.

6. The group receives points based on the number of clues that were read by the time a group member was able to guess the organism (e.g. 1 for one clue, 2 for two clues, etc). The group with the lowest number of points at the end of the activity "wins."

7. The student who correctly guesses the animal or plant becomes the reader and moves on to the next clue card. If the group cannot guess the identity, it can choose to pass and must add four points to its score. Continue the activity until all cards have been read.

8. This activity can be structured into rounds, with the teacher or facilitator signaling for the next card to be read, or students can move on to the next card on their own.

Extensions:
1. Have each student pick one of the animals or plants listed on a card and research that organism's adaptation to water.

2. Have each student write a creative story about an imaginary organism that has recently been discovered living in a Gloucester County stream or river. What water adaptations does this organism have that makes Gloucester County a good place for it to live?

Gloucester County "Who Am I?" Cards

WHO AM I? Card 1

1. I live in a variety of habitats including wooded areas, open fields, and marshes. I also coexist with humans and am often seen in Gloucester County backyards.

2. I breed quite often and have four litters each year, consisting of three to eight young. I leave my young in a nest in the ground and return several times a day to nurse them.

3. In the summer, I eat grass, herbs, and crops. In the winter I eat bark, twigs, and buds. I've been known to destroy backyard gardens.

4. Some researchers think that when I thump my large hind foot on the ground, I am communicating with other members of my species.

Answer: **Rabbit**
The Eastern Cottontail Rabbit, *Sylvilagus floridanus*, is often seen in the upland forest areas of Gloucester County as well as throughout our parks and backyards.

WHO AM I? Card 2

1. I have bumpy warty skin in a color pattern that allows me to blend into the background around me.

2. I breed in swamps and ponds in April and May, but I spend the rest of the year in trees, which confuses predators, as well as observers.

3. I have suction pads on my toes that enable me to cling to leaves and bark.

4. I start life in one form, in water, looking somewhat like a fish. I then grow legs, lose my tail, and become a leaping land–dweller.

Answer: **Tree Frog**

The Northern Gray Tree Frog, *Hyla versicolor*, is common in parts of Gloucester County and closely related to the Southern Gray Tree Frog, which is only found in the acidic water of the Pine Barrens outside of Gloucester County. Gray Tree Frogs breed in pools of water but can spend their adult life in a variety of land habitats.

Gloucester County "Who Am I?" Cards

WHO AM I? Card 3

1. Although I am a member of the rodent family, I build my nest with twigs and leaves in tree branches.

2. I eat a diet consisting mostly of nuts.

3. I can adapt to almost any environment and I thrive in an urban setting.

4. I am easily recognized by my grayish-brown fur and bushy tail.

Answer: **Squirrel**

The Eastern gray squirrel, *Sciurus carolinensis,* prefers upland forests but adapts to any environment. When few hollow trees are available, squirrels construct large, dry leaf nests in high tree branches, which are easily seen by observers. Gray squirrels are common in Gloucester County parks, forests, and neighborhoods.

WHO AM I? Card 4

1. In the wild, I build my burrow at the base of trees. In an urban setting, I take up residence under porches, houses, decks, and sheds.

2. I am known for my shiny black coat and large white marking.

3. I have very few predators because I am armed with a chemical defense.

4. My scientific name means odor.

Answer: **Skunk**

Striped skunks, *Mephitis mephitis*, are fairly common but rarely seen. Like many mammals, they are more active at night.

WHO AM I? Card 5

1. My name is attributed to the sound of my rapidly beating wings.

2. To stay alive, I must visit thousands of flowers each day.

4. I am the only species of my kind to live east of the Mississippi River.

3. I can fly backwards, beat my wings over 100 times per second, and hover in the air, usually over flowers.

Answer: **Hummingbird**

The ruby-throated hummingbird, *Archilocus colubris*, is the only hummingbird that lives in Gloucester County or the Eastern U.S. They can be viewed in the warmer seasons. Hummingbirds migrate in the fall to their wintering grounds in Mexico. Ruby-throats are only 3 inches long and weigh less than one ounce. The population is increasing at a rate of 1.5% per year.

WHO AM I? Card 6

1. My cousin is the beaver; but I am slightly smaller.

2. Like beavers, I am adapted to aquatic environments. I have waterproof fur and webbed feet, but a skinnier tail than a beaver.

3. I like to live in marshes and at the edge of ponds, lakes, and open bodies of water.

4. I build mound-shaped homes on the bank or burrows with underwater entrances.

Answer: **Muskrat**

The muskrat, *Ondatra zibethicus,* is abundant where water is present. Muskrats can be found by looking in marshes for large dome-like homes made of grasses and reeds.

Gloucester County "Who Am I?" Cards

WHO AM I? Card 7

1. I am a popular "big game" animal in North America.

2. I rub the bark off the lower trunks of trees.

3. I am the most common large mammal species (other than humans) in Gloucester County.

4. I get my name from the color of my tail.

Answer: **Deer**

Whitetail deer, *Odocolileus virginanus*, are very abundant in parts of Gloucester County. They are mostly seen in the early morning and evening. New antler growth has a tender velvet covering. Bucks rub their antlers on trees to assist the process of shedding the velvet and to mark their territory.

WHO AM I? Card 8

1. I am the only marsupial (pouched animal) found in North America. My cousins are the koalas and kangaroos.

2. I am a slow runner. I escape from predators by climbing trees. My hind paws look like human hands with thumbs.

3. My tail is strong enough to support my weight, but I rarely hang from it.

4. I am known for my behavior of playing dead to trick predators.

Answer: **Opossum**

Opossums, *Didelphis virginiana*, are commonly seen near streams and marshes that are located along or in forests. They eat plants and insects and will scavenge, feeding on dead animal remains. Because they move rather slowly, they are often struck by cars.

WHO AM I? Card 9

1. I spawn in salt water, though my offspring mature in fresh water.

2. I have long narrow dorsal (top) and caudal (bottom) fins that run more than half the length of my body.

3. Although I am actually a fish, I look somewhat like a snake and I move snake-like through swampy waters.

4. I am very slippery and extremely hard to hold.

Answer: **Eel**

The American eel, *Anguilla rostrate*, inhabits streams and rivers in Gloucester County. Eels prefer to live in the murky, muddy bottoms of fresh water bodies like the Raccoon Creek. Although eels rely on water, they have the capacity to travel over moist, muddy land to get from one stream to another. Eels migrate back to the ocean to mate and lay eggs. Young eels then travel back to freshwater streams.

WHO AM I? Card 10

1. Unlike other reptiles, my young are born alive, rather than hatched from eggs.

2. I do not have ears, but I "smell" my surroundings with my tongue.

3. When I eat prey larger than me, I unhinge my jaw and swallow things whole.

4. I am often found in gardens, which causes people to misinterpret my common name.

Answer: **Snake**

The Eastern garter snake, *Thamnophis sirtalis*, is common in moist forests, fields and marshes, including those in Gloucester County. An average nest of this snake consists of 50 to 60 young. If a young garter snake survives to adulthood, it can live for 12 years. Garter snakes are named for the elastic bands, or garters, that women once used to hold up their leg stockings.

Gloucester County "Who Am I?" Cards

WHO AM I? Card 11

1. I like to spend my days basking by the water in the sun to maintain a constant body temperature.

2. I lay my eggs (1-6 at a time) in a two-inch cavity dug in the bank, covered by clumps of vegetation for protection.

3. I am the smallest native species of my type in the United States.

4. Although I have a hard outer protection, I rely more on diving into water and swimming away, or burying myself in the muddy bottoms of streams, to escape from predators.

Answer: **Turtle**

The bog turtle, *Clemmy muhlenbergii*, is an endangered species that makes its home in parts of Gloucester County. Bog turtles are rare but do occur in bogs and swampy areas. They are very secretive and difficult to view. The carapace is the top half of a turtle's shell. The plastron is the bottom of the shell.

WHO AM I? Card 12

1. Unlike my cousin, the frog, I am never a tadpole. My body shape does not change; I only grow bigger.

2. I am cold-blooded like other amphibians, and have a smooth, slippery skin.

3. I mate and lay eggs in ponds in January and February.

4. If you turn over a rock by a stream, you might find me. I like to live in dark, cool, somewhat moist places.

Answer: **Salamander**

The Eastern tiger salamander, *Ambystoma tigrinum tigrinum,* is an endangered species. While development has threatened salamander populations, some species benefit from human-made ponds, which they inhabit during breeding season.

WHO AM I? Card 13

1. I get my name from the way I look when seen flying at a distance. I have a white head and brown body when I am an adult.

2. I am classified as a raptor because I hunt, especially for fish.

3. I soar through the air with my wings held horizontally.

4. I am the symbol of a large North American nation, and appear on almost all forms of that country's currency.

Answer: **Bald Eagle**

Bald eagles, *Haliaeetu leucocephalus*, are an endangered species, although their population is increasing in New Jersey. They have been sighted near all the streams and rivers of Gloucester County. Bald eagles soar with their wings held horizontally, compared to vultures, which raise their wings.

WHO AM I? Card 14

1. I can fly from tree to tree but I am not a bird or bat.

2. I live in tree holes or bird boxes. I scramble up and down trees.

3. I feed mostly at night on nuts but also on seeds, fruit, fungi, and insects

4. You've seen my cousins very often and I look very similar with gray fur and a white underbelly. I have furry skin that extends from my front leg to my back leg that helps me glide.

Answer: **Flying Squirrel**

The flying squirrel, *Glaucomys volans*, is common in large forested areas of Gloucester County, but rarely seen because it is nocturnal.

Gloucester County "Who Am I?" Cards

WHO AM I? Card 15

1. My call is very difficult for the human ear to detect. When I am hunting in the air near humans, they might hear a clicking sound.

2. I am found roosting in trees, tree cavities, and under leaves throughout most of North America.

3. I am nocturnal, I fly, and I have poor eyesight.

4. I use a type of radar (sonar) to hunt insects such as mosquitoes.

Answer: **Bat**

Little brown bats, *Myotis lucifugus*, are numerous in parts of Gloucester County but are rarely seen due to their nocturnal nature.

WHO AM I? Card 16

1. My paws resemble human hands, which give me agility and can get me into trouble.

2. I am an omnivore. I eat plants and animals. My diet includes fruits, vegetables, small birds, and insects. In an urban or suburban setting, I eat garbage.

3. I have been seen "washing" my food. But I really just enjoy the feeling of water running over my paws.

4. I am famous for the coloring around my eyes, which makes me look like a "bandit."

Answer: **Raccoon**

Raccoons, *Procyon lotor,* are abundant throughout the forested and suburban areas of Gloucester County.

WHO AM I? Card 17

1. Although I am a waterfowl, I often perch in branches. I nest in tree holes near the water.

2. The male of my species has a very brilliant color pattern to attract female mates.

3. You will only see me on ponds or lakes in or near forested areas and not in urban or suburban ponds and lakes.

4. You might expect me to quack but my call is more like a squeal.

Answer: **Duck**

Wood ducks, *Aix sponsa*, nest in tree holes and nest boxes next to lakes in parts of Gloucester County. They are most abundant in the spring, summer and fall.

WHO AM I? Card 18

1. I am the best-known broad-leaved tree next to Oaks. My leaves have 3 to 5 points on them

2. I grow in swamps, riverbeds, and moist hill slopes.

3. I got my specific name from my red buds, red and orange flowers, reddish twigs, and red leaves in the fall.

4. My winged fruits resemble helicopters when they are spinning through the air.

Answer: **Red Maple** (*Acer rubrum*)

Almost all parts of the maple are food for wildlife. Bark is eaten by beavers, twigs and buds by rabbits and deer, buds and flowers by birds, and seeds by squirrels.

Gloucester County "Who Am I?" Cards

WHO AM I? Card 19

1. I am a tree that grows in the coastal belt from Maine to Florida in peat swamps and bogs. I can be found in the Pinelands.

2. When my leaves are crushed, they smell good.

3. My wood is used for roof shingles, which is why I am so heavily harvested.

4. Despite my name, I am actually a type of cypress tree.

Answer: **Atlantic White Cedar**
(Chamaecyparis thyoides)

This evergreen tree doesn't have needles but , instead, has small branchlets covered with overlapping flat green scales.

WHO AM I? Card 20

1. I am the most widespread tree in the United States.

2. I come in many varieties, the most common being the black/red and the white types.

3. My wood is very valuable because it is hard and long-lasting.

4. My seeds are called acorns.

Answer: **Oak** *(Quercus)*

Acorns are fed upon by many animals, especially in winter. American Indians ground up acorns as flour and baked it.

WHO AM I? Card 21

1. I am a shrub or small tree. I help reduce streambank erosion by holding soil in my fibrous, matted roots.

2. Rabbits, deer and beaver use me as a source of food.

3. I never grow far from moist ground.

4. My twigs as well as my seeds can grow into trees if they fall onto a muddy bank.

Answer: **Black Willow** *(Salix nigra)*

Willows grow rapidly in their first year. This height and their matted roots help willows survive floods and fast-flowing water along streams.

WHO AM I? Card 22

1. I am a small tree. I come in both evergreen and non-evergreen (deciduous) varieties.

2. My prickly pointed leaves can stay on for up to three years.

3. My red berries are poisonous to humans but they attract songbirds.

4. I am often used as a Christmas decoration.

Answer: **American Holly** *(Ilex opaca)*

Holly is usually found in the understory (the lower layer of trees) in forests in Gloucester County, although it can grow to a height of 100 feet.

Gloucester County "Who Am I?" Cards

WHO AM I? Card 23

1. I am a plant. My fruits are consumed by many kinds of birds but cannot be eaten by people.
2. Sometimes I grow as a plant, sometimes as a vine, and sometimes as a shrub.
3. My three leaves are glossy green in summer and bright red in fall.
4. All my parts are poisonous and can cause skin irritation.

Answer: **Poison Ivy** *(Toxicodendron radicans)*

Poison ivy vines growing on trees or fallen logs are "hairy" in appearance when no leaves are present in winter. This makes them easy to spot.

WHO AM I? Card 24

1. I am a plant that lives in slow-moving woodland streams or swamps.
2. If I am present, the area where I grow can be defined as a wetland.
3. My flower buds begin to grow in late winter and produce enough heat to melt snow.
4. I smell like a combination of rubber tires and garlic, which is the reason for my name.

Answer: **Skunk Cabbage**
(Symplocarpus foetidus)

Unlike most familiar plants, skunk cabbage leaves only start to emerge after its flowers have grown.

WHO AM I? Card 25

1. I am a plant. Almost every part of me can be used as food.
2. My leaves can be woven into mats, chair seats, baskets, or used as roofing material.
3. I grow in lakes, ponds, marshes, ditches, and rivers.
4. I provide habitat for marsh birds and food for muskrats.

Answer: **Cattail** *(Typha***)**

Although cattails make seeds, most growth is through rhizomes (underground shoots that grow sideways), from which new stalks emerge. So, a group or colony of cattails may actually be only one "super" plant with many parts.

WHO AM I? Card 26

1. I am a plant that grows rapidly near wetlands and marshes and excludes other plant species by taking over an area.
2. I was once used to make pen points.
3. If I am cut or burned I will come back more vigorously than before, so it is hard to get rid of me.
4. My common name is reed.

Answer: **Phragmites** *(Phragmites communis)*

The underground shoots (the rhizomes), by which phragmites spreads, actually like to live in areas covered with stagnant and slightly salty water, where few other plants can survive.

Appendix D. "Who Am I?"
Animal and Plant Fact Sheets

Photo courtesy of Inch in a Pinch

Card 1: Eastern Cottontail Rabbit

- The cottontail rabbit is often seen in swampy forests, upland thickets, and farmlands as well as in backyards and parks. These habitats provide them with food such as bark, twigs, and buds. They also find food in backyard gardens.
- Cottontails live above ground in nests, not in underground burrows. The children's storybook character, Peter Rabbit, is a European rabbit, which makes its home underground.
- These rabbits thump the ground with their hind legs to warn others of threats.
- To avoid predators, rabbits will run in a zigzag pattern at 20 mph.
- Cottontails can live longer in captivity than in the wild. Over 85% die within the first year of their lives. This is why they reproduce often, having four litters a year of three to eight young each time.
- These rabbits do not often make sounds, unless caught by a predator, at which time they will emit a piercing scream.

Photo Courtesy of the Pennsylvania Herp Atlas Project

Card 2: Northern Gray Tree Frog

- The Northern and Southern gray tree frogs are identical except for their different calls. Observers can only tell the difference when their calls are recorded and then digitally slowed. The Southern gray tree frog is an endangered species in New Jersey.
- They grow to be one to two inches in size. They start their life in water as a fishlike tadpole and then move to land where their bumpy warty skin acts as camouflage.
- Gray tree frogs slow their calls when the weather is cool.
- The Northern species is found throughout the entire state. The Southern gray tree frog is found only in Cape May, Cumberland, Ocean, and Atlantic Counties in NJ. They make their homes in swamps and ponds in the spring but live the rest of the year in trees.

Card 3: Eastern Gray Squirrel

Photo Courtesy of the State of Texas Department of Parks and Wildlife

- This common squirrel is grayish brown and a member of the rodent family.
- Eastern gray squirrels reside in hardwood or mixed forests with nut trees, throughout the Eastern U.S. building nests in tree branches. They also live in urban settings. (They were recently introduced to San Francisco, CA and Seattle, WA.)
- Squirrels are often seen in the morning and evening hours, when they are most active.
- Eastern gray squirrels do not hibernate and brave the cold to hunt for nuts under snow.
- Squirrels find nuts and then bury them in another location. They rely on sniffing out buried nuts rather than on memory to find them. Squirrels will only recover about 85% of the nuts they bury. The remaining 15% usually sprouts into young trees.
- The squirrel uses its bushy tail to balance in trees, but it also uses it to act as a sunshade, an umbrella, a blanket, and a rudder when swimming. The tail gives lift when the squirrel leaps from branch to branch and slows descent should the squirrel fall.

Card 4: Skunk

Photo Courtesy of John Hasse, the South Harrison Electronic Natural Resource Inventory

- Skunks live about 7 years in the wild and 8-10 years in captivity. They build burrows at the base of trees and also can be found in urban settings under porches, houses, and other dark places.
- Skunks are a carrier of rabies, but the spray does not carry the virus.
- The skunk sprays its smelly musk as a defense from predators. Its scent glands mature at less than 1 month of age. The spray is aimed at the predator's face and causes severe irritation, especially to eyes.
- The skunk uses spraying as a last resort against predators because producing the substance takes valuable time and energy. Faced with a predator, it will first try to run away. If it is cornered or trapped, it will stamp its front feet and move backward. It will growl and hiss. Finally, the skunk will lift its tail, bend its rear toward the would-be predator, and spray.

Card 5: Ruby-Throated Hummingbird

Photo Courtesy of Wildbirds.com

- There are over 330 species of hummingbirds but the ruby-throated is the most widely distributed species and the only species found east of the Mississippi River.
- Hummingbirds are only found in the Western Hemisphere.
- Hummingbirds normally beat their wings about 60-80 times per second while flying and can fly both backward and forward. The sound of their wings beating is what they were named for.
- Their hearts beat 250 times per minute at rest and 1,220 per minute while flying.
- Most hummingbirds die within their first year of life due to the difficulty of migration, predators, and bad weather.
- A hummingbird needs about 10 calories of food a day to survive and finds nourishment in flower nectar, tiny insects, and spiders.

Photo Courtesy of Save the Prairie Society

Card 6: Muskrat

- Muskrats are a part of the rodent family, closely related to beavers but smaller and with a skinnier tail. They weigh between 3 and 4 pounds, and have webbed feet for swimming.
- They are often seen swimming in streams, ponds, and other wetland habitats.
- They prefer marshes that have an abundance of freshwater for swimming and sanitation. They dig at the marsh's bottom and create underground tunnels and runways.
- Their dens are above ground, although the entrances are underwater.
- If threatened, a muskrat can remain underwater for 17 minutes. Under normal conditions, it will swim underwater for 2-3 minutes.
- Muskrats are omnivores and will eat small animals like turtles, salamanders, and slow-moving catfish, as well as certain marsh vegetation.

Photo Courtesy of Dartmouth College

Card 7: Whitetail deer

- Deer are territorial animals, establishing a home area and never leaving it. When bucks get their antlers they rub them on trees to assist shedding and mark their territory. This practice removes the bark from the lower trunk of trees. They can live up to 11 years in the wild.
- Without the threat of animal predators or hunting, deer populations can double in size every year.
- Some researchers believe that high deer populations result in a high incidence of Lyme disease among humans.
- Due to human encroachment (resulting in the loss of animal habitat) and unregulated hunting, deer populations were at dangerously low levels in the 1890s. Now, due to strict game laws, the lack of natural predators, and the availability of suburban vegetation as food, there is an excess of whitetail deer making them the most common large mammal in Gloucester County. This is a detriment to farm crops and has increased auto accidents.
- Whitetail deer have highly developed senses of sight, smell, and hearing to escape from predators.

Photo courtesy of the Wildlife Center of Silicon Valley

Card 8: Opossum

- The opossum is the only marsupial mammal in North America.
- The female carries and nurses her young in her marsupium (pouch) until they are about 2-3 months old. Then, the young travel on her back for an additional 1-2 months.
- These animals travel alone and are usually slow moving. When frightened and unable to flee they fall into a shock-like state ("playing 'possum.")
- While the opossum is often depicted as hanging from a tree by its tail, it rarely does this. It uses its prehensile tail to stabilize its body while climbing.
- Few opossums live beyond 1 year, though they can live up to 10 years in captivity. Many animal predators including dogs, cats, and owls kill them. Motorists in suburban areas often strike them.

Card 9: The American Eel

Photo courtesy of State of Connecticut Department of Environmental Protection

- American eels are the only fish on the East Coast to return to the ocean to spawn. They live most of their lives in freshwater. Once they make this trip to the sea, they never return to freshwater, having lived out their lives. Young eels travel from the ocean to freshwater rivers and streams in Gloucester County.
- Adult eels are slippery and snakelike with long narrow dorsal (top) and caudal (bottom) fins that run more than half the length of their body.
- Juvenile eels (called elvers) are transparent, and some people along the New Jersey coast have dubbed them "glass eels."
- Eels feed mainly at night and eat almost any animal food. Cannibalism has been observed in crowded conditions.
- "Glass eels" are considered a delicacy in some Asian countries. Over 2,500 juvenile eels equal one pound. Once a juvenile eel has eaten its first meal, it loses its market price as a gourmet food.

Card 10: Eastern Garter Snake

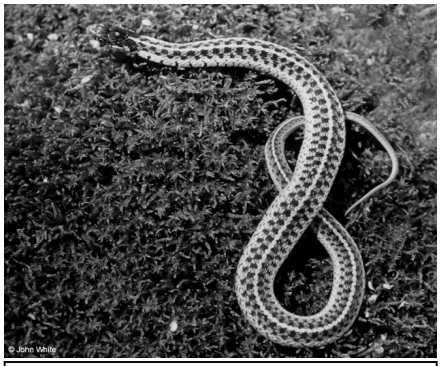


Photo courtesy of Virginia Tech

- The Eastern garter snake lives in a wide range of habitats, such as meadows, marshes, woodlands, hillsides, along streams, and in drainage ditches. It can even be found in gardens, city parks, and cemeteries.
- As an adult, this snake can grow to be 3-4 feet long.
- Some male snakes possess a seminal odor that is inserted into the female during the mating process. This repels other male suitors who come across the females smelling the odor with their tongues.
- Garter snakes are born alive, not from eggs.
- When startled, these snakes withdraw their head and neck under leaves or tree roots.
- Garter snakes sometimes hunt around the edge of a pond, preying on tadpoles, which are most vulnerable at this stage.
- Garter snakes are active daytime hunters and will eat earthworms, insects, frogs, salamanders, birds, and small mammals, unhinging their jaws in order to eat large prey.

Card 11: Bog Turtle

Photo courtesy of the State of Maryland Department of Natural Resources

- The bog turtle is an endangered species in many eastern states, including New Jersey. It is the smallest native species of its type in the United States.
- Bog turtles lay their eggs in stream banks and cover them with vegetation for protection.
- It is one of the most difficult animals to find, as it is rare, elusive, and often dwelling on swamp bottoms where they bury themselves in the mud to escape from predators. Its habitats are dwindling as wetlands are destroyed for human settlement. The greatest numbers of bog turtles are found in the wetland areas of agricultural lands in northwestern and southwestern New Jersey.
- The bog turtle eats mostly insects, and some seeds and berries.
- During the winter months, bog turtles hibernate underwater in deep areas of bogs in about 6 - 18 inches of mud. The turtles reemerge in late March and April.
- Bog turtles only feed during the day, but are inactive during the hottest and coldest parts of the day in order to maintain a constant body temperature.

Card 12: Eastern Tiger Salamander

Photo courtesy of the Conserve Wildlife Foundation of New Jersey

- The Tiger Salamander is an amphibian and is the largest land salamander in the world and a state endangered species in New Jersey.
- There are many subspecies of tiger salamanders in North America. Agricultural practices and urban development threaten populations and many states have put this salamander on their state endangered species list.
- It breeds and lays eggs in vernal (seasonal) ponds in January and February and then migrates upland in June to spend most of its life underground in burrows or underneath rocks.
- Salamanders can easily lose their tails to escape tenacious predators. Scientists choose to measure salamanders from their snouts to the beginning of the tail, which is called the "vent."
- Tiger salamanders cannot dig, so to avoid drying out (called desiccation), they try to stay under rotten logs or rocks and they also inhabit other animals' abandoned underground dens.

Card 13: Bald Eagle

Photo courtesy of the Associated Press

- The Bald Eagle is a national endangered species. While conservation efforts have helped the national population to increase, the birds are still recovering from overhunting, the weakening of eggshells from exposure to pesticides, and the encroachment of development on breeding habitats.
- Eagles are territorial raptors and choose nesting areas close to water that is rich with fish. Eagles will attack intruders (other predatory birds) by diving at them until they leave.
- Eagles usually are monogamous and enter into long-term relationships. However, if one partner dies, the other will usually find another mate. Eagle pairs stay together throughout the year.
- Female eagles tend to lay 1-2 egg clutches. The parents split the incubation duty, sharing day and night shifts in the nest.
- The first-born nestling (baby eagle) dominates and competes with the second-born nestling. If food is scarce that year, the second born may die due to starvation.
- The bald eagle can fly 20 - 40 mph in normal flight and can dive at speeds over 100 mph.
- The bald eagle is our national symbol. When it became threatened with extinction in the 1960s due to pesticide use, habitat loss, and other problems created by humans, people took notice. For years the bald eagle was listed as endangered under the Endangered Species Act. Now the number of bald eagles has increased so much that in June 1994 the U.S. Fish and Wildlife Service proposed that they be downgraded from endangered to the less urgent status of threatened in all but three of the lower 48 states. The success of the bald eagle is a tribute to the Endangered Species Act and is an incentive for increased awareness and conservation everywhere.

Photo courtesy of kidsworld.net

Card 14: Flying Squirrel

- There are 37 species of flying squirrels, of which only one is found in North America. The North American flying squirrel is also the most thoroughly studied.
- Flying squirrels are omnivores and feed mostly at night. Their diets consist of nuts, seeds, fruits, lichen, fungi, bark, and insects. They have been known on occasion to eat birds' eggs and small birds. The North American species is known to be a heavy water drinker and usually locates near water in tree holes or bird boxes.
- The North American flying squirrel does not hibernate. It will hoard nuts throughout the year to create a winter supply.
- During colder months, flying squirrels are known to rest in groups of two dozen to keep warm and to cooperate in hoarding food.

Photo courtesy of Yahoo! Kids

Card 15: Little Brown Bat

- The little brown bat is the longest living mammal of that small size. It can live to about 32+ years.
- A single little brown bat can catch up to 1,200 insects in one hour.
- Bats have been known to adopt orphaned young bats.
- Plants important to humans, including bananas, breadfruit, mangoes, cashews, dates, and figs, depend on bats for pollination and seed dispersal in tropical habitats.
- Bats survive the highest and lowest temperatures of any American mammal. Red bats can hibernate at 23°F and Little Brown Bats can rear young at 122°F.
- A hibernating little brown bat can reduce its heart rate to just 20 beats per minute and can stop breathing for 48 minutes at a time.
- It is a common misconception that bats are blind although they do have poor eyesight. They rely on sonar - emitting sound waves, which hit objects and bounce back, to determine distance and location of objects, including their prey. Their call sounds like a clicking noise to the human ear.
- Little brown bats live in trees throughout most of North America.

Card 16: Raccoon

Photo courtesy of the National Wildlife Foundation

- Raccoons are only found in North and Central America.
- The raccoon is a medium-sized mammal with a black, mask-like pattern on its face and a long bushy tail ringed with dark and light stripes.
- Colonial explorer, Captain John Smith (of Pocahontas fame), named the creature after the Indian name Aroughcun, which means, "He scratches with his hands."
- The scientific name for the most common North American raccoon is *Procyon lotor*. "Lotor" is Latin for "washer" and the raccoon has been observed by many to "wash" its food.
- An adult raccoon usually lives up to 6 years in the wild, but some may be as old as 13 years. Adults weigh about 20-25 pounds.
- Raccoons do not really hibernate but go into dormant periods during cold winter months.
- Raccoons can carry diseases, like rabies, that cats, dogs, and humans can contract. It is important to avoid physical contact with raccoons and discourage them from eating human garbage or pet food.
- Raccoons tend to create their dens near permanent water sources.
- When traveling from one spot to another looking for food, Raccoons tend to use fixed routes. Over time, these routes become narrow worn trails.
- Raccoons prefer to make dens in tree cavities. In urban and suburban areas, they may use chimneys.
- They are omnivores, which means they eat both plants and animals.

Card 17: Wood Duck

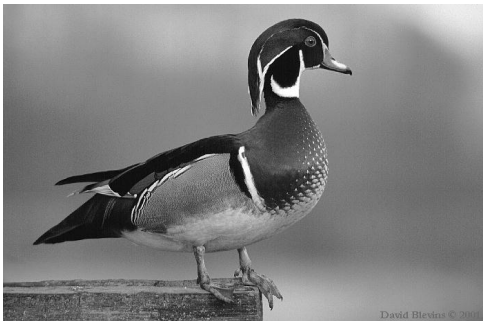


Photo courtesy of the University of British Columbia

- The wood duck is the only native "perching" duck in North America.
- The population of American wood ducks declined during European settlement as mature forests were cleared. Since the 1930s, conservationists and wildlife enthusiasts have encouraged the wood duck population to increase by providing nest boxes. Now, replanted forests are maturing, providing more hollow trees for nests.
- Some female ducks will "dump" their eggs in other ducks' nests (lay their eggs in a nest when the owner is away.) Researchers believe that this may be a strategy to ensure offspring survive. These ducks do not "have all of their eggs in one basket."
- The wood duck is considered to be "shy" compared to other ducks such as mallards. Therefore, sightings are more difficult.
- The males are very colorful in order to attract females.
- Their call is more like a squeal than a quack.

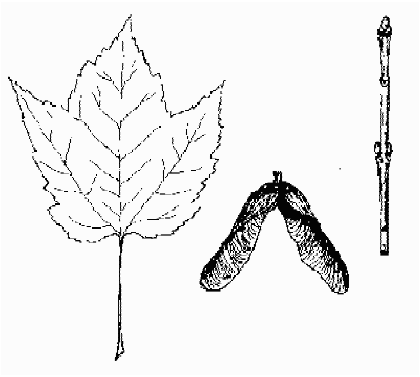


Image courtesy of State of Pennsylvania Department of Conservation and Natural Resources

Card 18: Red Maple

- Maples are the best-known broad-leaved trees next to oaks. The red maple is also called swamp maple because it grows in swamps, riverbeds, and moist hill slopes, especially in the lower half of Gloucester County where eight out of ten trees in a wet forest may be this species.
- The red maple gets its name because of its red buds, red and orange flowers, and reddish twigs, and the red color of its leaves in the fall.
- Red maples can grow to be 120 feet high and 5 feet in diameter although most are 75-90 feet high with a diameter of 1 ½ - 2 ½ feet. The leaves usually have 3-5 lobes and coarsely toothed margins.
- The winged fruits ,which resemble helicopters when they are spinning through the air, are eaten by birds, squirrels, and other small animals.
- On old trees, the bark is thick, dark gray, and separated by a vertical ridge into large platelike scales.

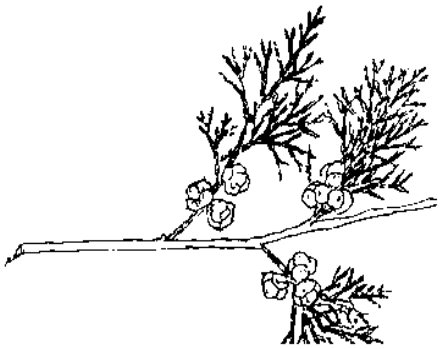


Image courtesy of National Arbor Day Foundation

Card 19: Atlantic White Cedar

- Atlantic white cedar is not actually a cedar. It is a member of the cypress family.
- This evergreen tree can grow to be 80-85 feet high and about 2 feet in diameter
- Atlantic white cedars grow in a narrow coastal belt from Maine to Florida in peat swamps and bogs. This is because it has a shallow root system and needs to be able to find water near the surface.
- The needlelike leaves have a strong, rich smell when crushed. The fruits are bluish-black and berrylike.
- The bark of the Atlantic white cedar is a slight reddish-brown color and peels off in long fibrous strips.
- The wood of Atlantic white cedar is decay-resistant and insect-resistant and has been used extensively as lumber for roof shingles and other purposes. It was so heavily harvested in the past 300 years that it disappeared from many areas. Today it is primarily found in the Pinelands region.

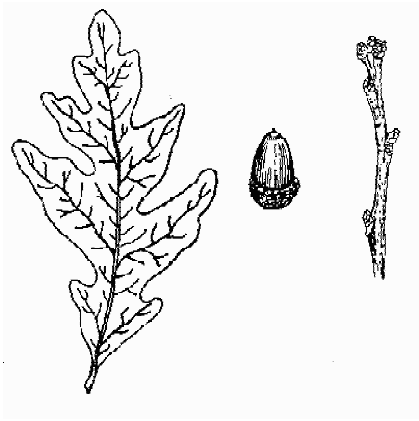


Image courtesy of State of Pennsylvania Department of Conservation and Natural Resources

Card 20: Oak (*Quercus*)

- Oaks are the most widespread tree in the United States, occupying the greatest variety of habitats and having the largest number of species.
- There are two groups of oaks: the red/black, which have leaves with points on them; and the white oaks, which have rounded leaves.
- Oaks are a broad-leaved deciduous (leaf-dropping) tree. They can grow to be 80-100 feet tall and are among the tallest trees in South Jersey forests.
- Oaks produce seeds in the form of acorns, which take from 6 months to 2 years to mature, depending on the species. Large seeds, such as acorns, provide more food for young seedlings as they struggle to grow in the shade of a forest.
- Squirrels and other rodents carry away and store acorns for food in the winter. Because they do not re–find all of the buried seeds, a certain number get to sprout as new trees.
- Oaks produce valuable hardwood and are often harvested from local forests.

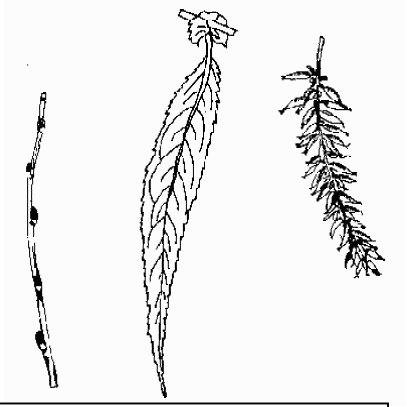


Image courtesy of State of Pennsylvania Department of Conservation and Natural Resources

Card 21: Black Willow (*Salix nigra)*

- Willows are a large group of species that grow as shrubs, small trees, and large trees such as the weeping willows that have been planted in backyards and parks.
- All willows prefer to grow near water and are never found far from moist ground.
- Willows have long, thin, pointed leaves with separate male and female flower clusters on the same plant.
- Willows help reduce erosion along stream banks by retaining soil in fibrous, matted roots.
- The wood from willows is often used in basket making and artificial limbs.
- Willow seeds float in water and grow very quickly when washed up on a muddy stream bank. Twigs that break off a mature tree and float to a muddy bank can sprout and start a new tree.
- Willow shoots are tasty. Rabbits and deer eat the twigs, foliage, and bark from willow trees. Beavers feed upon willows.

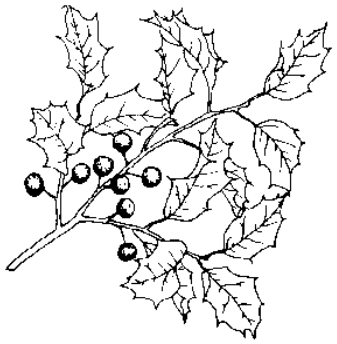


Image courtesy of National Arbor Day Foundation

Card 22: American Holly

- American holly is usually an evergreen tree, but there are both evergreen and deciduous (leaf-dropping) varieties of holly.
- Holly trees are either male or female, although a particular tree sometimes is both. The female tree bears bright red berries in autumn, which stay on the plant through winter.
- The leaves are thick and leathery and have small sharp points on them to prevent deer from eating the plant, especially since the evergreen types of holly stay green through the winter. Holly leaves can stay on trees for up to three years.
- Holly berries are poisonous for humans to eat, but they attract songbirds and are valuable winter food.
- Because of its red berries and green leaves in winter, holly is a popular Christmas decoration.

Card 23: Poison Ivy (*Toxicodendron radicans*)

Image courtesy of North Carolina Department of Environment and Natural Resources

- Poison ivy comes in three forms: low-lying plants, vines, and shrubs that can grow to tree size.
- Leaves come in threes ("leaves of 3, let it be"), are pointed and fine-toothed on the edges, and the center leaf is on a longer stalk. The leaves are glossy green in summer and can be bright red in fall.
- In moist shady forests, the plant grows into poison ivy vines that twine up tree trunks.
- In dry sunny places in the Eastern US, the plant develops into a shrubby form with slightly rounded (oak-like) leaf edges and is called "poison oak."
- The fruits are consumed by many kinds of birds with no harmful effects and are valuable as fall and winter food.
- All parts of the plant (leaves, roots, and stem) are poisonous to humans and can cause skin irritation. If burned, the smoke fumes can be very damaging or even deadly if breathed.

Card 24: Skunk Cabbage (*Symplocarpus foetidus*)

Image courtesy of the University of Connecticut Rose Thielans Memorial Ecology Walk Trail Guide

- Skunk cabbage has large pointed buds, large leaves, and no stem.
- The unpleasant smell that comes from this plant has been described as a combination of rubber tires and garlic.
- The flowers produce heat to keep the plant at a constant 70 degrees F.
- It is a perennial, which means it sprouts seeds in warmer months and produces leaves that die back every winter.
- It is used as an indicator to define wetlands ecologically and legally.
- Skunk cabbage thrives in slow-moving woodland streams or swamps.

Card 25: Cattail (*Typha*)

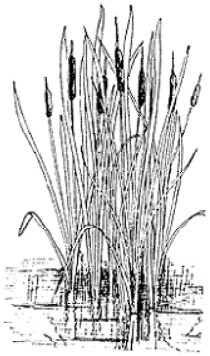


Image courtesy of Iowa State University Biology Department

- Cattails grow in lakes, ponds, marshes, ditches, and rivers.
- The cattail is a perennial plant (regrows every year) whose seeds can be dispersed through winter and wait to germinate in spring and summer.
- Cattails provide a habitat for many marsh-nesting birds, which build nests attached to cattail stems or make nests from the leaves. Muskrats use the roots as an important source of food.
- Almost every part of the plant can be used as food by humans except for the mature brown cattail. The immature flower spikes can be boiled and eaten like ears of corn and the starchy rhizomes (rootlike underground tubers) can be peeled and cooked like potatoes or dried and pounded into flour. You can even make cattail pollen pancakes, but they will be very yellow.
- The leaves of cattails can be woven into mats, chair seats, baskets, and roofs.

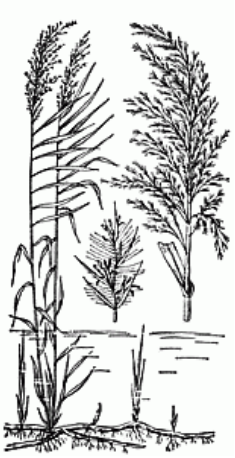


Image courtesy of website: www.agroportal.ru/manuals/plant/spisok/image9

Card 26: Phragmites (*Phragmites australis*)

- Phragmites is commonly called a reed.
- Phragmites are tall plants (up to 13 feet) with stiff wide leaves, coarse hollow stems, and big fluffy grasslike "flowers" at the top.
- Phragmites are widespread along the edges of tidal marshes. They have increased due to disturbance from industrialization and urbanization.
- Phragmites is of concern to wetland managers because it grows rapidly, excludes other plant species, provides little wildlife habitat, and is of little aesthetic or recreational value.
- This plant spreads quickly and is resistant to disturbance. If burned or cut it will come back more vigorously than before.
- In the past, phragmites were used to make pen points.

Sources

Britton, Nathaniel and Addison Brown. *An Illustrated Flora of the Northern United States and Canada*. New York: Dover, 1970.

Brown, Lauren. *Grasses: An Identification Guide*. New York: Houghton Mifflin, 1979.

Burton, Dr. Maurice and Robert Burton, editors. *The International Wildlife Encyclopedia: Vol. 5.* New York: Marshall Cavendish, 1969.

Caduto, Michael. *Pond and Brook: A Guide to Nature in Freshwater Environments*. Hanover: UP of New England, 1990.

Martin, Alexander, Herbert Zim, and Arnold Nelson. *American Wildlife and Plants*. New York: Dover, 1951.

State of Connecticut, Department of Environmental Protection, Wildlife Division, "Endangered and Threatened Species" Fact Sheet Series, http://dep.state.ct.us/burnatr/wildlife/learn.htm.

Stokes, Donald and Lillian. *Stokes Nature Guides: A Guide to Bird Behavior Volume III*. New York: Little, Brown and Company, 1989.

Stokes, Donald and Lillian. *Stokes Nature Guides: Animal Tracking and Behavior*. New York: Little, Brown and Company, 1986.

Tyning, Thomas F. *Stokes Nature Guides: A Guide to Amphibians and Reptiles*. Boston: Little, Brown, and Company, 1990.

USDA. *Important Trees of the Eastern Forest.* Atlanta, USDA, 1968.

Wernert, Susan. *Reader's Digest: North American Wildlife.* Pleasantville: Reader's Digest, 1982.

Zim, Herbert and Alexander Martin. *Trees: A Guide to Familiar American Trees*. New York: Simon and Schuster, 1956.

Appendix E. How Does Your Watershed Grow?

Comparing population sizes over time provides a sense of Gloucester County's growth. From this, students may better understand why waterways in the County are affected by pollution from stormwater runoff in developed areas.

Procedure:

1. Have students research the population trends in their hometowns, school district, or in the entire County. Students can find population figures from the year 2000 from the United States Census website at www.census.gov. Have them use the Search feature and type in a local address. Census data is also available on the website of the Delaware Valley Regional Planning Commission at www.dvrpc.org, under Data Services. Have students go to the data bulletins.

2. Have students compare the year 2000 population to the year 1950 population (provided here).

3. Ask students:
   - Which towns grew in population? Which towns lost population?
   - How might the increase in population threaten a town's watersheds? For example, Washington Township, with land falling in the Big Timber Creek, Mantua Creek, and Maurice River watersheds, had a 1950 population of 1,200. In the year 2000, the Township's population was almost 40 times larger with 47,114 residents.

4. To extend this activity into a project, have students research historic reasons why people moved out of cities and into new suburban communities.

City or Town	1950 Population
Clayton	3,020
Deptford Township	7,250
East Greenwich Township	2,340
Elk Township	2,100
Franklin Township	5,200
Glassboro	5,750
Greenwich Township	3,150
Harrison Township	2,240
Logan Township	2,250
Mantua Township	3,550
Monroe Township	5,500
National Park	2,420

City or Town	1950 Population
Newfield	1,010
Paulsboro	7,860
Pitman	6,850
South Harrison Township	870
Swedesboro	4,500
Washington Township	1,200
Wenonah	1,500
Westville	490
West Deptford Township	5,300
Woodbury	10,500
Woodbury Heights	240
Woolwich Township	1,200

Source: DVRPC

Appendix F. Every Drop Counts

Every Drop Counts is adapted from various sources, including the "Every Drop Counts" activity in the *Project WET Curriculum and Activity Guide*. The "Water Meter Reader" activity is from the US EPA's educational outreach website (see Teacher Resources for more information). In this combined activity, students will learn the value of water conservation and groundwater purity. This is a three-part activity intended for more than one class session.

Students will:

- Determine how water conservation practices save water
- Identify water conservation habits that individuals can change or adopt
- Recognize that water conservation is important

Materials:
Part 1: "Water Meter"

- Copies of "Water Meter Reader" student handout (provided)
- Copies of "Water Conservation Primer" student handout (provided)

Part 2: "Conservation Capers"

- Noisemaker (bell, buzzer, horn, whistle, etc.)
- Tape

Part 3: "Constructing a Water Flow Cup"

- Large paper cups (about 32 oz or 1 liter)
- Heavy tape
- Stopwatches
- Pins
- Nails
- 1/16-inch diameter nail

Background:

Earth has a finite amount of fresh, usable water. Fortunately, water is naturally recycled (collected, cleansed, and redistributed) through the hydrologic cycle. Humans have developed the technology to speed this process. However, because of diverse factors (drought, flood, population growth, aquifer contamination, pollution, etc.) water supplies may not adequately meet a community's needs. Conservation of water can ensure that supplies of fresh water will be available for everyone, today and tomorrow.

Water conservation involves changing habits. Since many of these habits evolved over a lifetime, they can be difficult to alter. The simplest habits involve turning off water whenever it is not being used. For example, when water is needed for rinsing dishes, it can be held in a sink rather than allowing it to flow unused down the drain. Other conservation efforts may initially require more effort and funds, but in the long run will save money and resources. For example, households can install low-flow showerheads with smaller holes that reduce water flow and increase pressure. A capped bottle weighted with stones and placed in a toilet tank reduces the amount of water used for flushing.

Some regions of the United States and other parts of the world do not perceive a need to conserve because water is plentiful. However, using water efficiently has both environmental and economic benefits. Environmentally, conserving water helps ensure that ample water will be available and reduces the amount of wastewater that must be processed. Economically, water saved (or not wasted) is water that does not have to be purchased or pumped. Water conservation programs can help a municipality avoid or delay building or upgrading new drinking-water or wastewater treatment plants, potentially saving millions of dollars.

Procedure:

PART 1: "Water Meter Reader" (Intended for 1-2 weeks)

1. Ask students to keep track of the water they and their families use over a one-week period using the "Water Meter Reader" handout. Students can convert this handout into a chart, recording how many gallons of water they use. Ask students: Did you use water wisely? Did you ever waste water? During this week, did you use less water because you thought about water?

2. Discuss reasons water should not be wasted. Do students consider future water availability? How have the recent years of drought affected Gloucester County?

3. Using the "Water Conservation Primer" handout as a guide, ask students to identify three to five water conservation habits they can individually adopt. Ask them to write these down. For the next week, they can practice these habits and monitor their progress with a new "Water Meter Reader" journal. How did their choices reduce water? How much water did they save?

PART 2: "Conservation Caper"
This activity is more appropriate for younger students or as a quick exercise with older ones, to be done in the same class period as Part 3.

Objective: Students will understand how much water toilets use. Students will demonstrate the difference in amounts of water used by a toilet with a weighted water bottle in the tank (Toilet A) versus one with a full tank of water (Toilet B).

1. Divide the classroom into two sides – Toilet A (or Bathroom A) and Toilet B (or Bathroom B). Toilet A uses three gallons of water. Toilet B uses five gallons of water.

2. All students stand up in the back of the room. They will each represent one gallon of water. The back of the room is a source of water for the local community.

3. Ask two students to volunteer to be water meters (one for each side). They will count the number of students (gallons) that pass through the toilet. They can record their observations on the chalkboard in the front of the classroom.

4. Construct the activity into rounds. Each round is equivalent to the two toilets flushing. In each round, three students move to side A and five students move to side B "flushing" out the students who came before. As each round passes, the students at each "side" move to the front of the room, which represents a wastewater treatment plant. Continue the process until all students have moved to the front of the room.

5. Have students compare the number of gallons needed by each toilet. If a household was limited to a specified amount of water, which toilet would make that supply last longer? Which toilet would contribute a higher water bill? Which would produce less wastewater?

Water Conservation Primer

Turn Off Water:

- Turn off the water when it is not in use. Don't leave it running when brushing your teeth. Turn off the water between soaps and rinses while you are washing your hands.
- Limit shower time to 10 minutes or less. Take showers instead of baths or, when taking baths, limit the amount of water used.
- When washing dishes by hand, use a sink full of rinse water rather than letting the water run.

Water-Saving Devices:

- Dishwashers use less water than washing dishes by hand. Make sure to run a dishwasher with a FULL load.
- Run a washing machine only with a FULL load.
- Install a low-flow showerhead.
- Install a low-flow toilet.

Plan Ahead:

- Keep a bottle of cold drinking water in the refrigerator instead of running water until it becomes cold.
- Water lawns in the mornings or evenings when water will not evaporate as quickly. Make sure the water lands on vegetation and not on streets or sidewalks. If possible, save rainwater in barrels for watering lawns.
- If you need to run water before it becomes hot, store the cool running water in a bottle for future use. Unheated water can be used for rinsing dishes, and washing vegetables by hand.

Quick Fixes:

- Fill up a half-gallon milk jug with water or a container with marbles and place in the toilet tank to reduce water use.
- Fix leaks!

Don't Abuse Water:

- Do not use the toilet as a trash can.
- Use a broom instead of a hose to clean sidewalks and driveways.
- When washing the car, use a hose with an on/off nozzle or use buckets of rinse water.

PART 3: "Constructing a Water Flow Cup"

1. Organize students into small groups.

2. Have students use a nail to punch five holes into the bottom of a large paper cup. Have students use a pin to punch five holes into a second cup. The location of the holes should be the same for each cup. Cover the holes of each cup with sturdy tape.

3. Have students fill the cup with the large holes with water.

4. Have one student remove the tape and another student, with a stopwatch, time how long it takes for the water to pour out of the cup. Instruct the students not to squeeze the cup. Repeat the procedure two more times; make sure the water level is the same for each trial. Calculate the average time.

5. Repeat the procedure for the second cup (timing the flow three times and calculating the average).

6. Compare the flow rates of the two cups.

7. Have students answer the following questions:

- What is the difference in the drainage times of the two cups?
- How do these streams of water from the cups compare?
- Would one cup make a better showerhead than the other?
- How could you use the flow restrictor data from this activity to help your family save water?

Name _____

Water Meter Reader

Directions: List how much water is used in your home. Indicate how many times each activity occurred for each of your family members and how much water was used. For example, if there are four people in your family, including yourself, and all four people take a shower some time during the day, write down "4" showers in the space provided. Compute a total for each day and then for the entire seven days.

Day 1 – Date _____

Shower (25 Gal)	X _____	Showers	= _____	gallons
Bath (35 Gal)	X _____	Baths	= _____	gallons
Dishwasher (15 Gal)	X _____	Loads	= _____	gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____	gallons
Laundry (20 Gal)	X _____	Loads	= _____	gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____	gallons
Toilet (4 Gal)	X _____	Flushes	= _____	gallons
Meals (8 Gal per day)			= 8	gallons
	Total gallons		= _____	

Day 2 – Date _____

Shower (25 Gal)	X _____	Showers	= _____	gallons
Bath (35 Gal)	X _____	Baths	= _____	gallons
Dishwasher (15 Gal)	X _____	Loads	= _____	gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____	gallons
Laundry (20 Gal)	X _____	Loads	= _____	gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____	gallons
Toilet (4 Gal)	X _____	Flushes	= _____	gallons
Meals (8 Gal per day)			= 8	gallons
	Total gallons		= _____	

Day 3 – Date _____

Shower (25 Gal)	X _____	Showers	= _____	gallons
Bath (35 Gal)	X _____	Baths	= _____	gallons
Dishwasher (15 Gal)	X _____	Loads	= _____	gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____	gallons
Laundry (20 Gal)	X _____	Loads	= _____	gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____	gallons
Toilet (4 Gal)	X _____	Flushes	= _____	gallons
Meals (8 Gal per day)			= 8	gallons
	Total gallons		= _____	

Day 4 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 5 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 6 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 7 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Appendix G. Storm Drain Labeling

Storm drains, or catch basins, are the square metal grates at the side of streets, usually next to or in the curb. They are designed to collect stormwater so streets and properties do not flood.

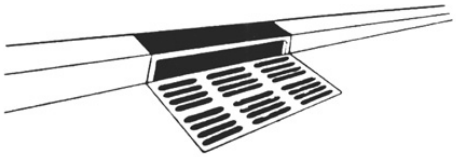
When it begins to rain, the first drops soak into the ground. But once the soil is saturated, or if the soil has been replaced by paving or a building, the rain runs along the surface until it comes to a storm drain.

Every storm drain is connected by a pipe to the nearest stream or lake.

Any debris or garbage from driveways, backyards, and streets that is picked up by the rainwater will go into the storm drains and then **into the stream, lake, or river.**

Anything dumped into these storm drains, such as oil, paint, pool water, soapy water, or home, driveway, and lawn contaminants, **goes directly into streams, lakes**, **and rivers,** too.

The principle cause of polluted water today is stormwater runoff.



Label storm drains with a "keep clean" message: NO DUMPING DRAINS TO CREEK

The Federation of Gloucester County Watersheds, working with the Gloucester County Division of Parks & Recreation, makes available labeling kits for interested community groups and school classes. These include instructions, labels, glue, informational door hangers, and all needed equipment **FREE OF CHARGE** to carry out storm drain labeling.

A storm drain label

To organize a storm drain labeling project for your class or group, **contact**:

Scotland Run Nature Center
856-881–0845.

Appendix H. Starting a Schoolyard Habitat

This activity is adapted from *"I'd like to start an outdoor classroom. Where do I begin?"* by Miriam Dunne of New Jersey's Division of Fish and Wildlife and was included in the *Teacher's Guide to the Great Swamp Watershed.*

Since each school is a unique community of learners and each schoolyard is a unique community of animals and plants, no one approach works for all. **Here is a basic** guide to get a schoolyard habitat started.

Tie the schoolyard habitat into appropriate curriculum:
Should you use the existing setting for environmental education? Or should you make physical improvements so that your curriculum and wildlife benefit? There are good arguments for either approach. It is less expensive to use the habitat "as is" (with no improvements or modifications), and perhaps, the site will be integrated with the curriculum as it slowly evolves. On the other hand, a developed outdoor classroom can be the focal point of and catalyst for new environmental education curriculum. Either way, be sure that the site and project ties into the curriculum and helps meet the state curriculum standards. Patti Howely, a Winfield teacher and facilitator for New Jersey Audubon Society's "Bridges to the Natural World," offers the following objectives for starting an outdoor classroom.

Start with observation:
1. Pick a site on the school grounds and get permission for it to go uncultivated (or remove the sod to deter the growth of invasive plant species).
2. Allow the plants in this area to grow freely. It should become a natural community of grasses and wildflowers.
3. Have your students use a KWL sheet (what we **know**, what we **want** to learn, and what we **learned**). Have them observe the site, write what they see and then fill in what they would like to know. They can compare what they observed in their first visit to what they observe in their subsequent visits.
4. Consistent observation is key. The plot should be examined as often as possible. Students can keep a journal or use photography to record changes. Keep a chart with recorded changes in the classroom to keep interest piqued.

Take a workshop:
The use and creation of an outdoor classroom should be viewed first and foremost as a learning experience. As a teacher, your education experience is also evolving. It is highly recommended that you begin by taking **a "Bridges" (NJ Audubon Society), WILD (Project WILD), or PLT (Project Learning Tree) workshop. The Division of Fish and Wildlife also offers WILD School Sites workshops**. These multi-hour workshops provide a wealth of resources, insights, and ideas on how to get started as well as introducing participants to a network of educators who can be called upon as projects progress.

Your site is unique:
Just as you and your students are individuals with strengths and limitations, your site has its own strengths and limitations. Work with your strengths. Don't expect to recreate a project at another school. There is no right way to undertake a schoolyard habitat project. Go for what seems to make sense with your faculty, administration, students, parents, and natural environment.

Developing your planning team:
If you take on a project by yourself, set up a solid framework in case you leave. Working with a team of

teachers is strongly recommended to ensure the success of a schoolyard habitat. The support of the administration, custodial staff, parents, community members, and students is critical. Make the process democratic and inclusive; it may go in a direction you do not expect or anticipate.

Let your students do the research:
What plants attract butterflies? What are natural plants in your area? How does one build a pond? It is okay if you don't know. Let your students do the research. Their learning is more important than the actual habitat itself. Teams of students can design the project, write letters requesting donations, and make presentations to the school board or other administrative or community groups. Empowering students from the outset will ensure the project is a success.

Enlist the help of specialists:
The New Jersey Coalition for Schoolyard Habitat is a corps of mentors founded by the Alliance for New Jersey Environmental Education. Experienced educators are available to provide advice on planting, design, curriculum connections, team building, and other aspects of the schoolyard habitat. They can help you take the initial steps – attending a workshop; creating a team; and connecting to environmental education curriculum. To locate a mentor, contact the Public Information Officer of the NJ Division of Fish & Wildlife, listed below.

The New Jersey Audubon Society also has naturalists on hand to help identify suitable sites for a schoolyard habitat. Naturalists can teach you and your students about which plants are appropriate for your area and which animals will be attracted to your new habitat. Visit the website www.njaudubon.org/education for services and contact information for their nine education centers in New Jersey.

Money isn't everything (but it sure does help):
Money to implement projects is always cited as a barrier to move forward. The USDA Natural Resources Conservation Service manages the Wildlife Habitat Incentive Program (WHIP) and offers $2,500 in matching funds for schoolyard habitats. To apply for a matching grant, a school or nature center must have at least one staff member participate in a WILD School Site workshop.

The Alliance for New Jersey Environmental Education (ANJEE) offers funding resources for teachers on its website: www.anjee.net/teachers/index.html.

Stay connected:
The New Jersey Coalition for Schoolyard Habitat is devoted to networking. Through the mentoring program, it is trying to build more links. Coalition events like workshops help to strengthen information channels. Other online organizations include: US Department of Agriculture's Backyard Conservation - www.ncrs.usda.gov; American Birding Association's Conservation tips - www.amercanbirding.org; National Wildlife Federation's Backyard Wildlife Habitat Program - www.nwf.org/backyardwildlifehabitat; and National Gardening's planting advice - www.garden.org.

For more information about any of these schoolyard habitat resources, contact:

Project WILD/WILD School Site Coordinator
NJ DEP Division of Fish and Wildlife
Pequest Trout Hatchery
605 Pequest Road
Oxford, NJ 07863
908-637-4125

TEACHER EVALUATION FORM for
A TEACHER'S GUIDE
TO THE WATERSHEDS OF GLOUCESTER COUNTY

Your input is needed! – Once you have had the opportunity to use this Guide, please complete and return this form to:

The Federation of Gloucester County Watersheds
P.O. Box 233
Glassboro, NJ 08028

DATE _____

PROFESSION ____ Teacher – grade level and/or subject: _____
____ Environmental – field: _____
____ Other: _____

SCHOOL OR ORGANIZATION _____

TOTAL NUMBER OF STUDENTS PARTICIPATING IN THIS GUIDE'S LESSONS AND ACTIVITIES: _____

Please answer each of the questions by checking the applicable response:	**Strongly agree**	**Agree**	**Disagree**	**Strongly Disagree**
1. The background information is a helpful introduction to watershed and water supply concepts.				
2. The information on Threats to Surface Waters and to Drinking Water is clear.				
3. The Teacher Resources information is useful.				
4. The student Lessons and Activities instructions are complete and easy to follow.				
5. The in-class Lessons and Activities are easy to integrate into daily lessons.				
6. The students achieved the objectives for the in-class Lessons and Activities.				
7. The students understood the concepts presented through the Guide's Lessons and Activities.				
8. The students enjoyed participating in the activities.				
9. The out-of-classroom Activities and suggested trips can be integrated into the school and classroom schedule.				
10. I will use the Teacher's Guide again next year.				

11. What I like best about the Teacher's Guide is _____

_____

12. Other Comments/Suggestions for Improvement _____

_____

_____

Thank You

DELAWARE VALLEY REGIONAL PLANNING COMMISSION

Publication Abstract

Title of Publication:	**A Teacher's Guide to the Watersheds of Gloucester County**	**Date Published:**	**September 2004**
		Publication No.	**04038**

Geographic Area Covered: Gloucester County, New Jersey

Key Words: environmental education, water cycle, watershed, drinking water, aquifer, pollution, non–point source pollution, stormwater, water conservation.

Abstract

This publication explores the local watershed environment in Gloucester County, New Jersey. With teachers of upper elementary and middle schools as the primary audience, it presents educational information on the water cycle, the specific watersheds in the county, the county's natural and human histories, groundwater and surface water, drinking water quantity, water quality, pollution and other threats to water, and water conservation. It includes extensive resource information for teachers, and an Appendix with lessons and classroom activities that fulfill the State of New Jersey Science Standards. This publication's objectives are to motivate and enhance classroom instruction and to instill local knowledge and understanding by the public, in order to increase stewardship of Gloucester County's water resources.

For More Information Contact:

Delaware Valley Regional Planning Commission
The Bourse Building – 8th Floor
111 South Independence Mall East
Philadelphia, PA 19106-2582
Phone: 215-592-1800
Fax: 215-592-9125
Internet: www.dvrpc.org

Staff Contact:	**Direct Phone**	**Email**
Suzanne McCarthy, Senior Regional Planner	215-238–2934	smccarthy@dvrpc.org