

Pennsylvania's Watershed Regions

Ohio

Great Lakes

Upper/Middle
Susquehanna

Lower
Susquehanna

Delaware

Potomac



Introduction

Each of Pennsylvania’s major drainage basins has an array of individual characteristics that distinguish it from other regions of the state. These include diverse geographic and geologic features as well as major differences in historical settlement, economic and land use patterns. To reflect these variations, six regional water resources committees were created by the Water Resources Planning Act to ensure that individual regional priorities were developed and highlighted in the plan. The priorities and actions of the Ohio Regional Water Resources Committee are significant and influence not only local streams and rivers, but also the Mississippi River.

The following goals have been identified by the Ohio Regional Water Resources Committee due to specific concerns regarding water quality and quantity in the region. These issues should be factored into any decisions that are made that may impact water resources, as we plan for the protection and restoration of water resources in the region.

- Reclaim water resources impaired by abandoned mines
- Identify water resources needed to promote and facilitate economic development, and provide job opportunities, while maintaining watershed integrity and recreational benefits
- Reduce and avoid impacts that may lead to contamination of groundwater and surface water sources available for residential water use
- Control stormwater runoff and promote groundwater infiltration
- Resolve problems associated with aging infrastructure and malfunctioning sewage systems that may lead to water pollution
- Develop plans for water resources during periods of drought or other water shortage emergencies
- Protect and restore water resources such as critical groundwater recharge areas, ecologically sensitive watersheds, aquifers, wellheads, lakes, wetlands and floodplains
- Develop and encourage the use of appropriate, applied technology to ensure clean and healthy water resources and encourage water conservation practices
- Identify water resources needed for economic development that address needs to maintain and enhance job base and maintain watershed integrity
- Distinguish the Ohio River Basin as a region that is different from other basins in the state while conducting public education and outreach on the importance of our water sources

The regional committee members will continue to work with DEP and other partners to make recommendations for attaining these goals.

The Ohio Region at a Glance

The 981 miles of the Ohio River drain 203,940 square miles in 15 states. Despite its large watershed, less than five percent of the land drains directly into the main stem; instead, most of the Ohio River is fed by numerous tributaries including the Allegheny, Monongahela, Kanawha, Wabash, Green, Cumberland and Tennessee rivers. The Ohio River starts at the confluence of the Allegheny and Monongahela rivers at Pittsburgh, Penna. and borders or travels through six states—Pennsylvania, Ohio, West Virginia, Kentucky, Indiana and Illinois—before emptying into the Mississippi River at Cairo, Ill. The Ohio River is the largest tributary by volume of the Mississippi River.

The Ohio Region is the second largest basin in Pennsylvania, covering 15,614 square miles, but the commonwealth only accounts for one-tenth of the entire basin. Approximately 25 million people (10 percent of the U.S. population) live in the Ohio River Basin, including 3.5 million Pennsylvanians, who rely on the river for transportation, water supply, and electricity generation.

Ohio River Facts

Called “La Belle Riviere” (The Beautiful River) by early French explorers
Basin Area:

Total – 203,940 square miles
Pennsylvania – 15,614 square miles

Headwaters: Allegheny River, Raymond, Penna. and Monongahela River, Fairmont, W. Va.

Mouth: Mississippi River, Cairo, Ill.

Ohio River Length:

Total – 981 miles
Pennsylvania – 50 miles

Major Tributaries (in Pennsylvania)

Allegheny River
Conemaugh River
Youghiogheny River

Beaver River
French Creek

Clarion River
Monongahela River

Watersheds in the Ohio Region

“Watershed” is a generic term used to identify an area of land that drains to a particular waterbody. Watersheds can vary in size, from the acreage that drains to a brook to a major river. For purposes of this atlas, watersheds are classified by a nested hierarchy based on landscape scale. A watershed is the land area that drains into a stream or river (or in some cases, two streams) and is the smallest in size in the classification hierarchy. Pennsylvania’s original State Water Plan divided the commonwealth into 104 watersheds, ranging in size from approximately 100 to 1,000 square miles, named for the major streams of the watershed. A subbasin includes all of the watersheds that drain into a particular reach of a larger watercourse. A basin encompasses all of the subbasins that drain into a major waterway. In Pennsylvania, there are six basins—Lake Erie, Genesee, Ohio, Susquehanna, Potomac and Delaware—each with a different outlet. The Lake Erie Basin empties into Lake Erie, the Genesee Basin contributes to Lake Ontario, the Ohio Basin drains into the Mississippi River, the Susquehanna Basin and Potomac Basin empty into the Chesapeake Bay, and the Delaware Basin drains into the Delaware Bay.

Kayaking on the Youghiogheny River, Ohiopyle State Park. Photo courtesy of Ryan Hale.



Introduction, continued

Did you know?

Pittsburgh's history is marked by many American firsts: movie theater, baseball stadium, gas station and commercial radio broadcast.

A particular tract of land can belong in multiple watersheds, depending on the scale of the landscape. For example, in Venango County, Sandy Creek is a tributary to the Allegheny River, which is a tributary to the Ohio River. The land that encompasses the Sandy Creek Watershed is part of the Upper Allegheny Subbasin, which, in turn is part of the Ohio Basin. The Water Planning Area map on the previous page depicts the 32 watersheds found in the five subbasins of the Ohio Basin.

Land Cover (Percent of Watershed)

Forest	63%
Pasture/Grass	14%
Row Crops	9%
Institutional/Industrial/Commercial/Transportation	3%
Residential	4%
Active Mines/Mined Areas	<1%
Bare	5%
Wetlands	1%
Water	<1%

Scenic Rivers

- Total: 142.6 miles
 - Bear Run, 4.3 miles
 - Allegheny River, 86.6 miles
 - Recreational – 86.6 miles
 - Clarion River, 51.7 miles
 - Scenic – 17.1 miles
 - Recreational – 34.6 miles

Points of Interest in the Region

- Route 6, the longest U.S. transcontinental highway – Erie, Warren, McKean and Potter counties
- Erie National Wildlife Refuge – Guys Mills, Crawford County
- Drake Well Museum at the world's first oil well – Titusville, Crawford County

- The Avenue of Flags – Hermitage, Mercer County
- McConnells Mill State Park – McConnells Mill, Lawrence County
- Frankfort Mineral Springs – Hookstown, Beaver County
- Meadowcroft Rockshelter and Museum of Rural Life – Avella, Washington County
- July 29th Rainy Day Festival – Waynesburg, Greene County
- Allegheny National Forest – Elk, McKean, Forest and Warren counties
- Hearts Content Scenic Area – Allegheny National Forest, Warren County
- Kinzua Bridge Viaduct, National Engineering Landmark – Mount Jewett, McKean County
- Coudersport Ice Mine – Coudersport, Potter County
- Oil Creek and Titusville Railroad – Oil City, Venango County
- Cook Forest State Park – Forest, Clarion and Jefferson counties
- Lake Arthur and Moraine State Park – Portersville, Butler County
- Elk State Park – Johnsonburg, Elk County
- Groundhog Day with Punxsutawney Phil – Punxsutawney, Jefferson County
- Christmas Tree Capital of the World – Indiana County
- Rachel Carson Homestead – Springdale, Allegheny County
- Point State Park, Three Rivers Area – Pittsburgh, Allegheny County
- Idlewild Park and Storybook Forest – Ligonier, Westmoreland County
- Johnstown Flood Memorial – Southfork, Cambria County
- Johnstown Inclined Plain – Johnstown, Cambria County
- Fallingwater at Bear Run Nature Reserve – Mill Run, Fayette County
- Mt. Davis, the highest point in Pennsylvania – Somerset County
- Quecreek Miner Rescue Memorial – Somerset, Somerset County
- Flight 93 Memorial – Shanksville, Somerset County
- Heinz Park and PNC Park – Pittsburgh, Allegheny County
- Raccoon Creek State Park - Frankfort Springs, Beaver County

Wetlands in Somerset County.



Did you know?

Tionesta Creek is best known for its scout camp where thousands of western Pennsylvania boy scouts have gone for weekends and weeklong summer camping sessions.

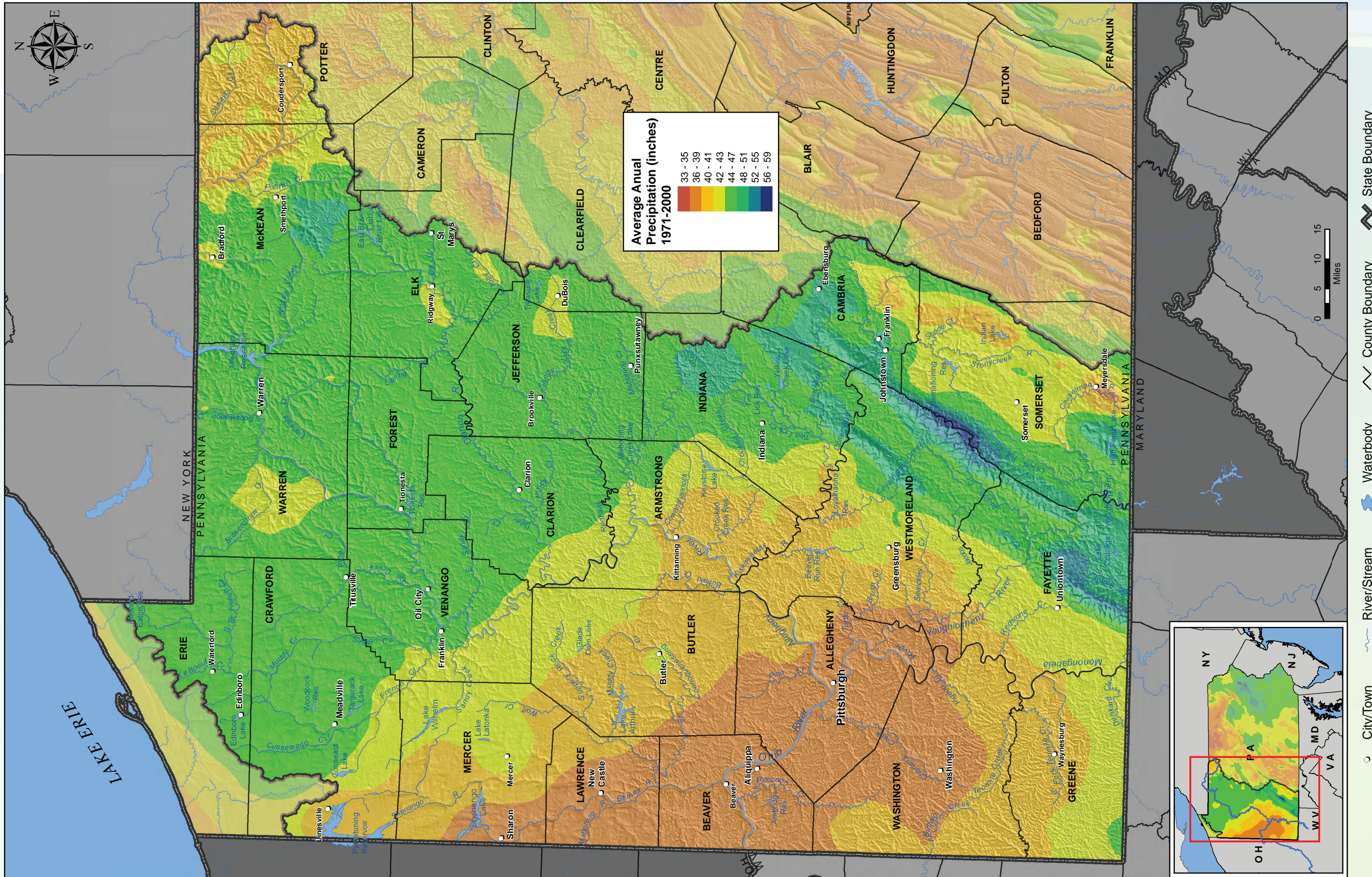
Regional Climate

The Ohio Region has a temperate climate pattern. Mean minimum temperature ranges from 9 degrees Fahrenheit in the north to 19 degrees Fahrenheit in the south. The mean maximum temperature ranges from 75 degrees

Fahrenheit in the east to 84 degrees Fahrenheit in the west. Average annual precipitation for the region ranges from 34 to 53 inches per year. In general, the northern and eastern areas of the region receive less precipitation compared to the western and southwestern area. Precipitation in the Ohio Region is varied from month to month. The northern part of the region receives the greatest amount of precipitation in June while the southern part receives the most precipitation during July. The least monthly precipitation usually occurs in November.

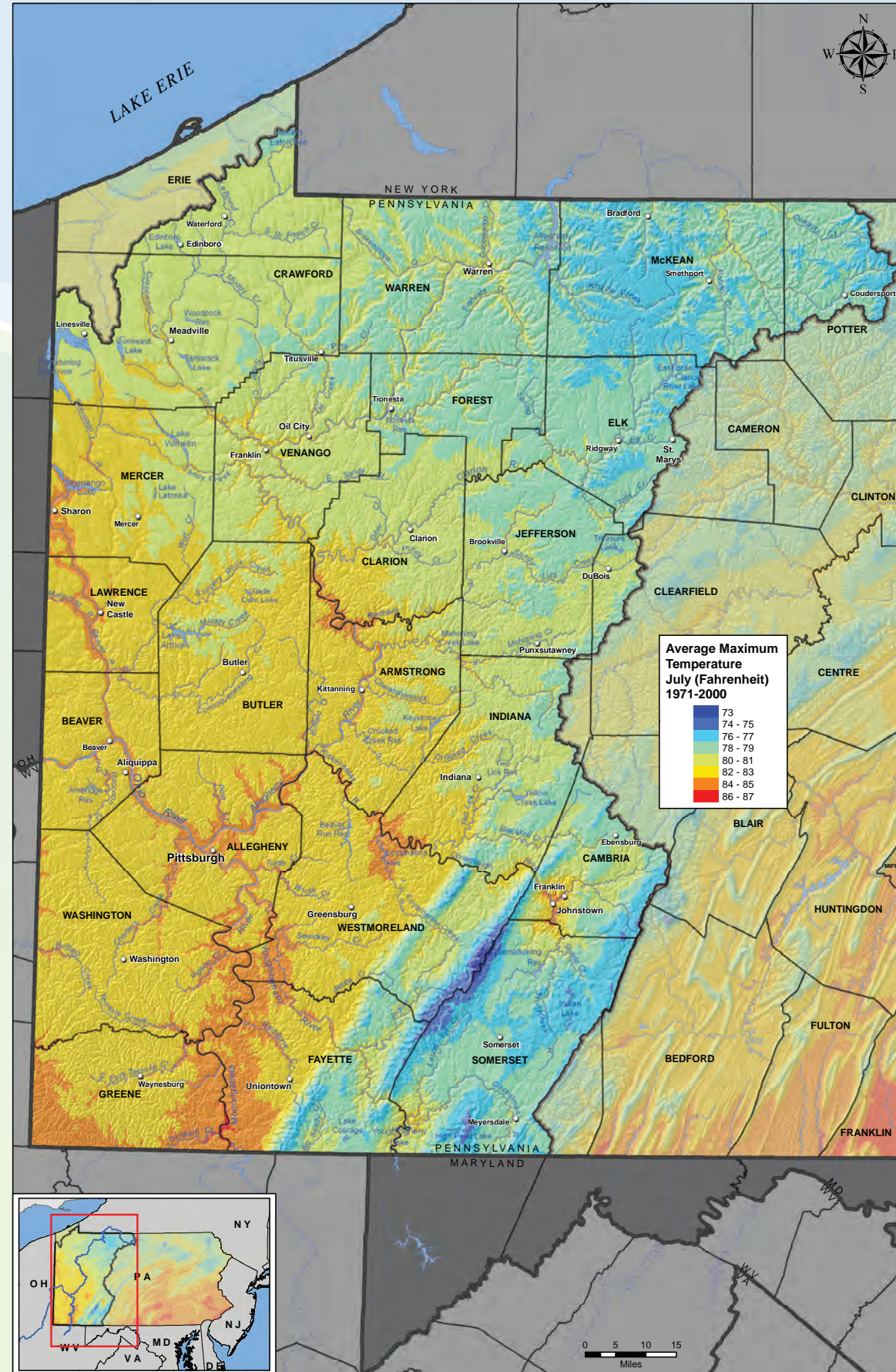
The maps on the next two pages show Annual Precipitation, Average Minimum Temperature and Average Maximum Temperature, averaged from 1971 to 2000, for the Ohio Region.

Precipitation

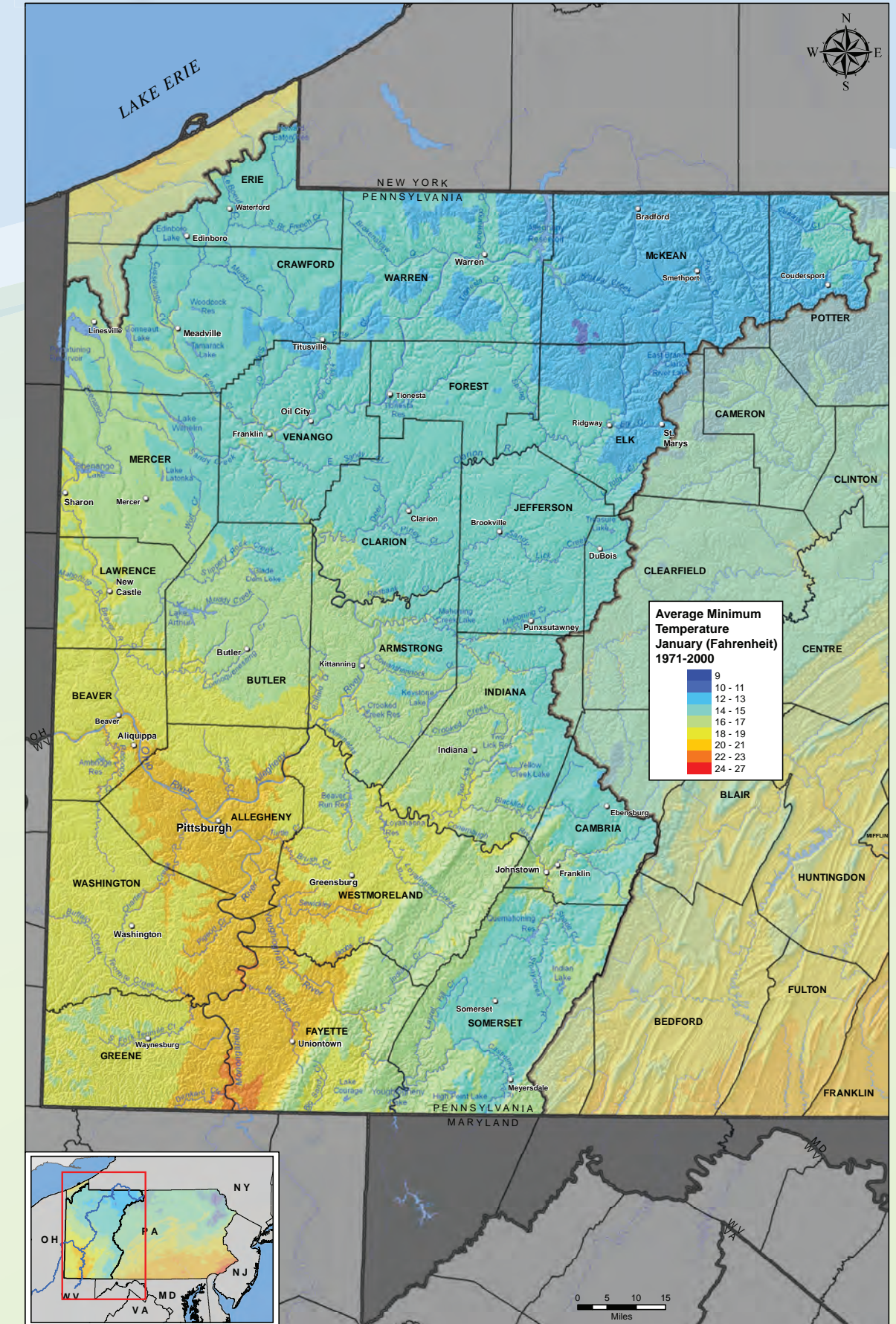


Average Temperature

Average Maximum Temperature



Average Minimum Temperature



Introduction, continued

Fallingwater

Fallingwater, considered Frank Lloyd Wright's most acclaimed work, was designed at the request of the Edgar J. Kaufmann family in 1935. Originally designed to honor the family's love of a waterfall on Bear Run, Fallingwater has become a national symbol of man's ability to live harmoniously with nature. Three years of construction started in 1936 resulted in a house constructed of a series of cantilevered "trays" rising 30 feet over the falls and consisting of as much floor space taken up by outdoor terraces as indoor rooms. The Kaufmann family used Fallingwater as a weekend and vacation home until 1963 when it was entrusted to the Western Pennsylvania Conservancy. Today, Fallingwater is the only great Wright house open to the public with its original art work and Wright-designed furnishings still in place.



Frank Lloyd Wright's Fallingwater over Bear Run, Fayette County.

Did you know?

Actor Jimmy Stewart was born and raised in the town of Indiana. Each year at Christmas the downtown area is decorated in the theme of the film "It's a Wonderful Life."

Allegheny National Forest, Warren County.

Extreme Weather Conditions: Ice Jams in Oil City

Oil City, located in Venango County, has suffered tremendous losses in the past as a result of spring and summer storm-type floods, and in particular, ice jam flooding. Located at the confluence of Oil Creek and the Allegheny River, the joining of the two bodies of water at Oil City has amplified flood events which result in hardships for the community. Heavy economic losses and personal losses have all resulted from local flooding of the two rivers.

Ice jam flooding has been a particular problem in the Oil City region which prompted the U.S. Army Corps of Engineers to search for a solution to control flood events. The outcome was the installation of an ice control structure on both Oil Creek and the Allegheny River.

Ice jam flooding occurs as the water cools to the point that slushy, water-logged ice forms within the river depths. Also known as frazil ice, the slush begins to attach to the stream banks and as it accumulates, the ice severely restricts the flow of water

to a small area under the frozen river surface. When melting occurs, the surface ice melts first and an ice flow occurs. However, since the river has been constricted to a small area by the slush, the ice and water have nowhere to go except over the banks.

After two winters of investigation, ice experts from the U.S. Army Corps of Engineers Cold Regions Research and Engineering Lab developed a solution. Their design of the ice control structure, simply put, is a collection of floating pontoons that are connected together with heavy steel cable and anchored on each stream bank. The pontoons are approximately 20 feet long and, when connected, span the entire width of the river. The structure collects the slushy, partially frozen ice upstream of Oil City, a more advantageous area rather than the confluence of both rivers. Allowing the ice to form upstream of the confluence of the two rivers prevents the slushy, frazil ice from collecting and constricting the river at Oil City, therefore reducing flood events.



Populations throughout the Region (2000 Census Estimate)

Pittsburgh 334,563	Edinboro 6,950
New Castle 26,309	Somerset 6,762
Johnstown 23,906	Punxsutawney 6,271
Sharon 16,328	Clarion 6,185
Greensburg 15,889	Titusville 6,146
Washington 15,268	Kittanning 4,787
Butler 15,121	Beaver 4,775
Indiana 14,895	Ridgway 4,591
St. Marys 14,502	Brookville 4,230
Meadville 13,685	Waynesburg 4,184
Uniontown 12,422	Ebensburg 3,091
Aliquippa 11,734	Coudersport 2,650
Oil City 11,504	Meyersdale 2,473
Warren 10,259	Mercer 2,391
Bradford 9,175	Smethport 1,684
DuBois 8,123	Waterford 1,449
Grove City 8,024	Linesville 1,155
Franklin 7,212	Tionesta 615

Population and Future Projections

The maps on pages 47 and 48 show populations in the year 2000 and population projections for 2000 through 2030 for the Ohio Region. As illustrated in the Population 2000 Map, municipalities in the southern half of the region are more populated than those in the northern half. Populations are highest in Pittsburgh and its adjacent communities and tend to decrease as you travel away from the city.

As shown by the Population Projection Map, noticeable changes in population trends are expected south of Pittsburgh and the central-eastern portion of the region. Historically, the area from Pittsburgh south to the Pennsylvania-West Virginia border has declined in population, but these areas are predicted to increase slightly

in the future. By contrast, the area north of Indiana has historically experienced minimal population increase but is expected to decrease in the future.

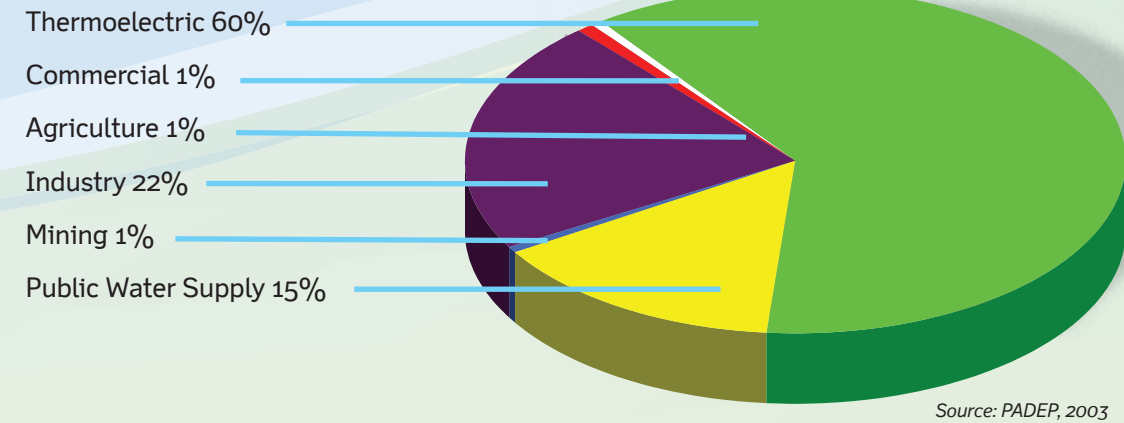
Regional Water Use

The demand for water throughout the region can be measured in part by compiling and mapping data contained in the registry of water users maintained by the DEP. All public water supply agencies and hydropower facilities as well as anyone withdrawing more than 10,000 gallons of water per day are to register and report their usage to DEP. There are no fees associated with registering and reporting.

Although this registry information does not account for all water demands of the region, it provides useful information to predict areas of higher and lower demand, as shown by the Registered Water Withdrawals Map on the next page. Consumptive water use, as defined by U.S. Geological Survey (USGS), is “that part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.” The amount of water consumed in a region becomes an important consideration for resource management during times of drought or water shortages. On the Registered Water Withdrawals Map, the pie chart within each subbasin depicts the percentage of each major sector of water use.

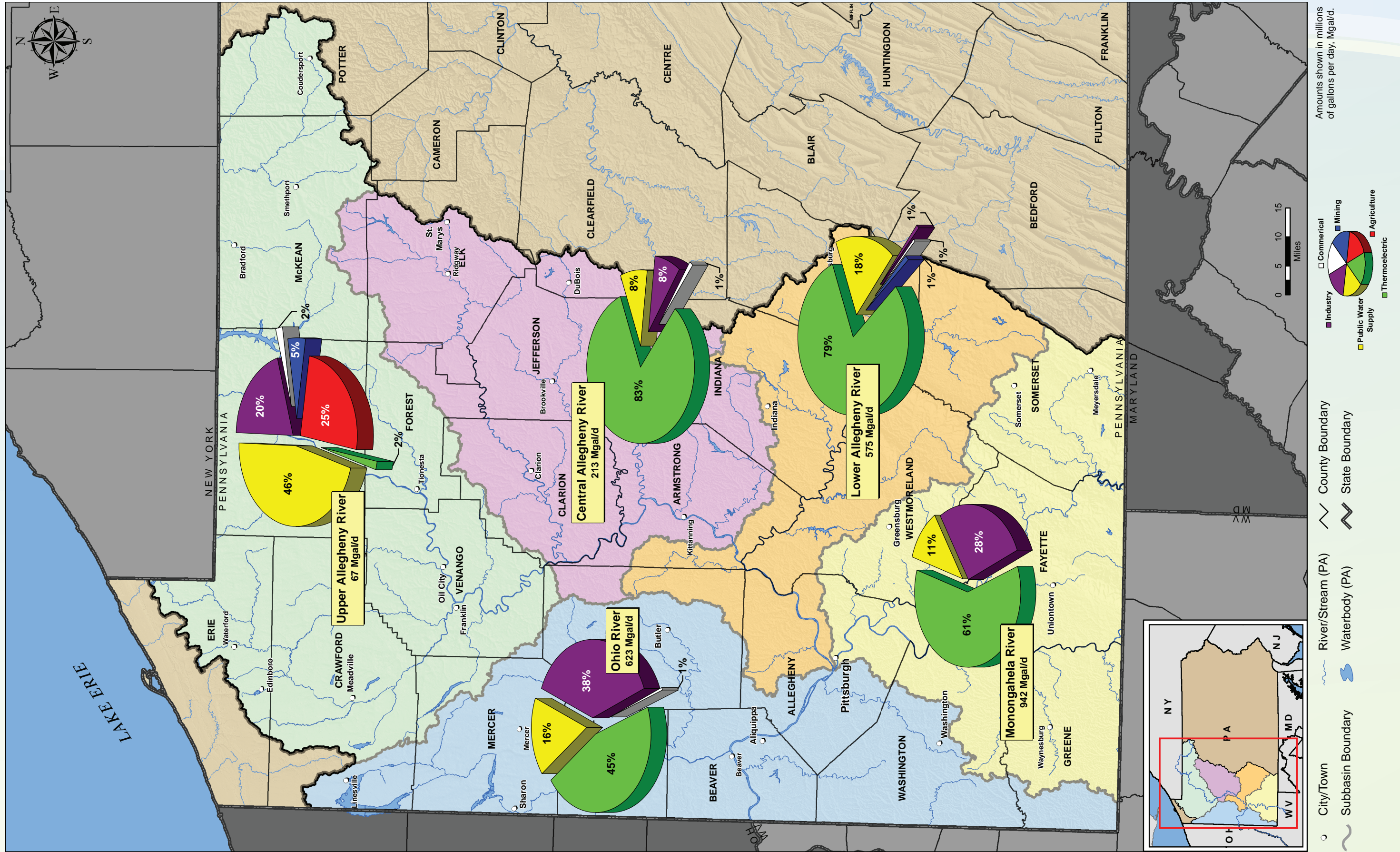
The pie chart on this page provides a breakdown of both consumptive and non-consumptive water use by sector for the Ohio Region. Approximately 60 percent of water is used by utility and thermoelectric (power-generating) facilities, 22 percent by industry, and 15 percent by public water suppliers within this region. Agriculture, commercial and mining each account for less than 1 percent of water use in this region. This data is based on information available primarily from registrations submitted to DEP in 2003.

Ohio River Basin Water Use

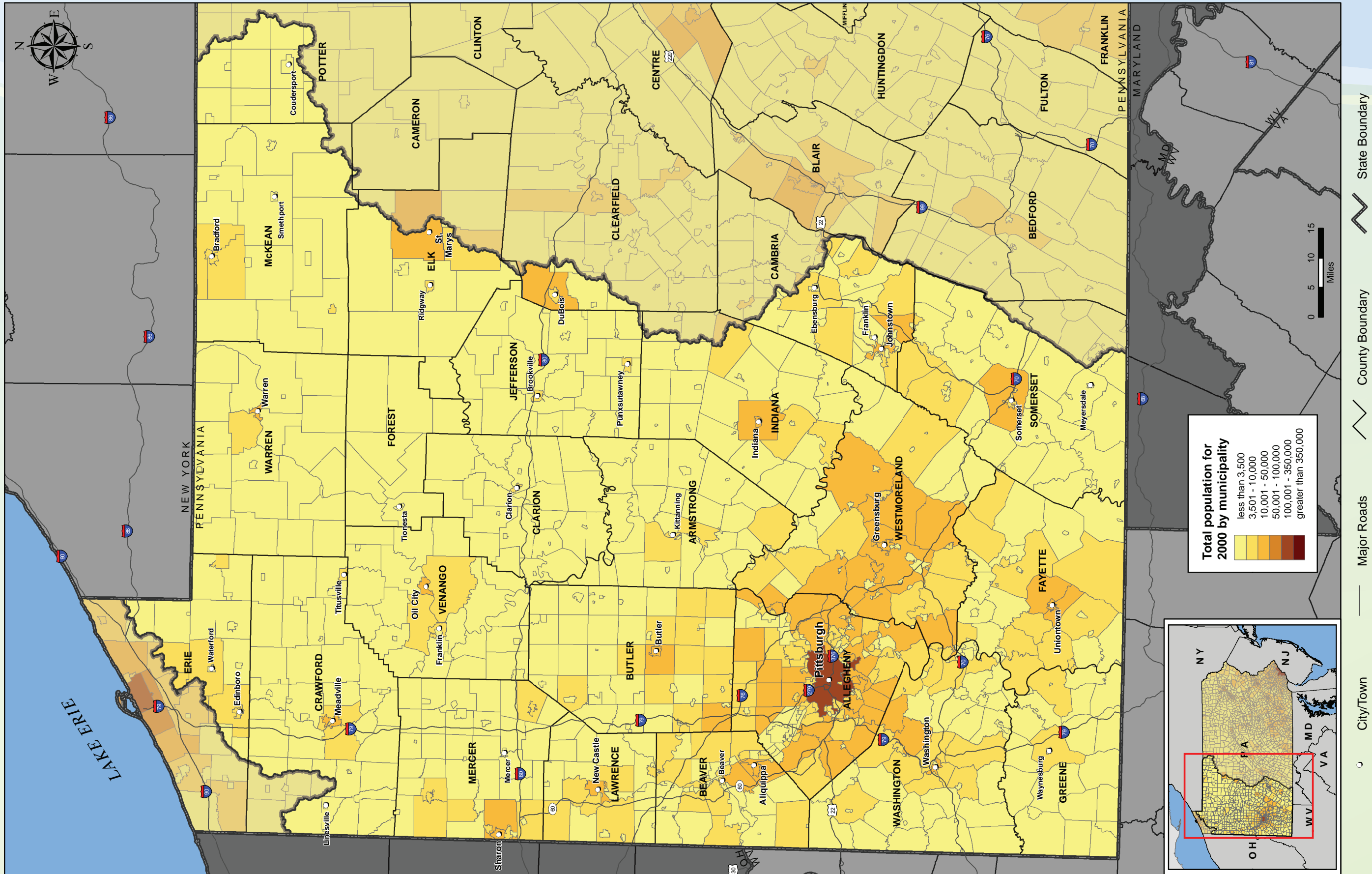


Raccoon Creek State Park
Frankfort Springs
Beaver County.

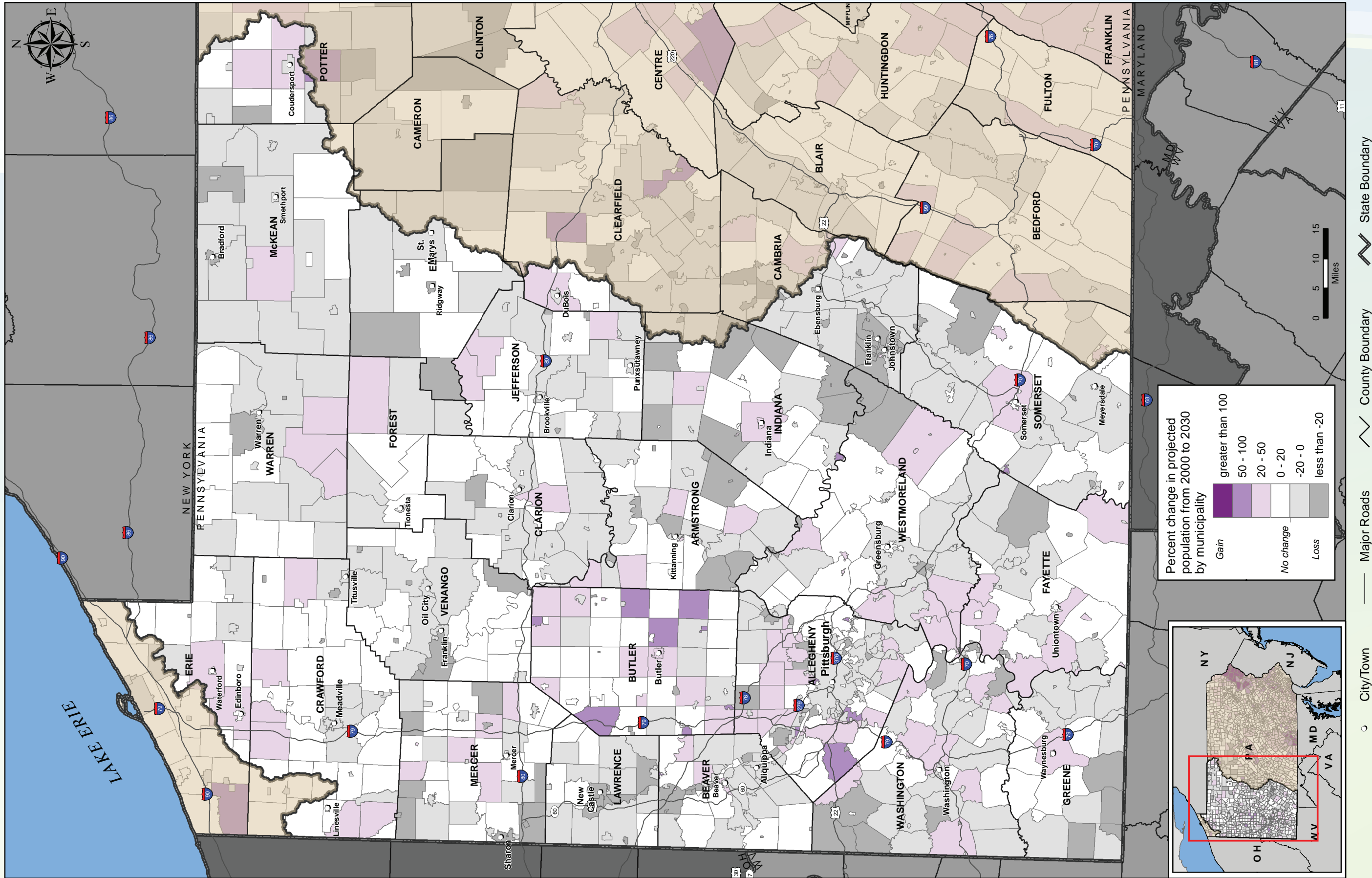
Registered Water Withdrawals



Population 2000



Population Projection



Water Resources

Once described as “La Belle Riviere” (the Beautiful River) by French explorer Robert Cavalier Sieur de La Salle in 1669, the Ohio River and its tributaries continue to be a remarkable resource for western Pennsylvania. Serving more than 13 million citizens with fresh drinking water, the basin also provides major transport routes for barge traffic, with tonnage estimated to be more than eight times that which is shipped on the Great Lakes System.

A map showing the larger streams, lakes and wetlands within the Ohio Region is provided on the next page. Streams and rivers can be classified according to their size based on a hierarchy of its tributaries. The hierarchy designates headwater streams as a first order stream. When two first order streams meet, the waterway becomes a second-order stream. When two second-order streams meet, the waterway becomes a third-order stream and so on. If

Swamp Forest and Black Jack Swamp

Two wetlands of interest in the Ohio Region include Swamp Forest and Black Jack Swamp. Swamp Forest is a 246-acre palustrine (containing no flowing water) wetland originating at the headwaters of Brown’s Run in Clarion and Forest counties. The area is noted for containing old-growth Eastern hemlock and white pine stands.

Black Jack Swamp is located in Crawford County near Pymatuning Reservoir and encompasses approximately 725 acres. Black Jack Swamp is classified as a scrub-shrub and emergent wetland that provides habitat for plant and animal species native to those types of habitat.

Both wetland areas are listed as State Parks Natural Areas by the Pennsylvania Department of Conservation and Natural Resources.

Bog community in Somerset County.



Surface Waters



Water Resources, continued

a lower-order stream flows into a higher-order stream, the order designation does not change. For instance, if a first-order stream meets a second-order stream, the waterway designation remains second-order. For purposes of making the map readable, only higher order streams of the Ohio Region are shown in the Surface Waters Map.

Streams

The Monongahela, Allegheny and Ohio rivers are the major water bodies in the Ohio Region. The major tributaries to the Monongahela include the Youghiogheny River, Tenmile Creek, Dunlap Creek and Redstone Creek. The tributaries to the Allegheny River listed from north to south include Tionesta Creek, Oil Creek, French Creek, Clarion

Did you know?

The angling state record walleye was hauled in from the Allegheny Reservoir in Warren County in 1980. The record fish topped the scales at 17 pounds, nine ounces.

River, Redbank Creek and Kiskiminetas River. The Ohio River, receiving the majority of its water from the confluence of the Monongahela and Allegheny rivers, has tributaries including Raccoon Creek, Beaver River and Chartiers Creek.

These surface waters are part of the 32 watersheds in the Upper Allegheny, Central Allegheny, Lower Allegheny, Monongahela and Ohio subbasins which make up the Ohio Region. The watersheds are shown on the Water Planning Area Map in the Ohio Region Introduction Section of this atlas.

Approximately 80 U.S. Geological Survey (USGS) gaging stations that monitor peak stream flow conditions, water levels, discharge and water temperature are located in the Ohio Region. Several gaging stations, including Connoquenessing Creek near Zelienople, Youghiogheny River near Sutersville, and Beaver River at Beaver Falls also monitor water quality.

Three Rivers at Pittsburgh

The meeting of the Monongahela, Ohio and Allegheny rivers at the city of Pittsburgh is commonly referred to as the “three rivers.” Millions of years ago, the rivers were created by glacial melting at the end of the Ice Age, and each river stands to have distinctive qualities in their own ecology, geology and hydrology.

Colonial settlers immediately fell in love with the site of the future city due to the access to so many different areas including the Great Lakes, the Gulf of Mexico, and eventually the Louisiana Territory. George Washington observed that “nature has well contrived this place” and found it to be an ideal location for a fort. Later, the *Discovery* expedition of Lewis and Clark to the Pacific Ocean was launched on the rivers.

The three rivers also served an important role in the industrial revolution, providing transportation for the iron and steel made in Pittsburgh. Unfortunately, the combination of barge and steamboat traffic matched with

industrial waste took a toll on the river, creating intense amounts of pollution and driving nearly every species of aquatic wildlife out of the area. Many people even moved away from the rivers to flee the waterborne diseases.

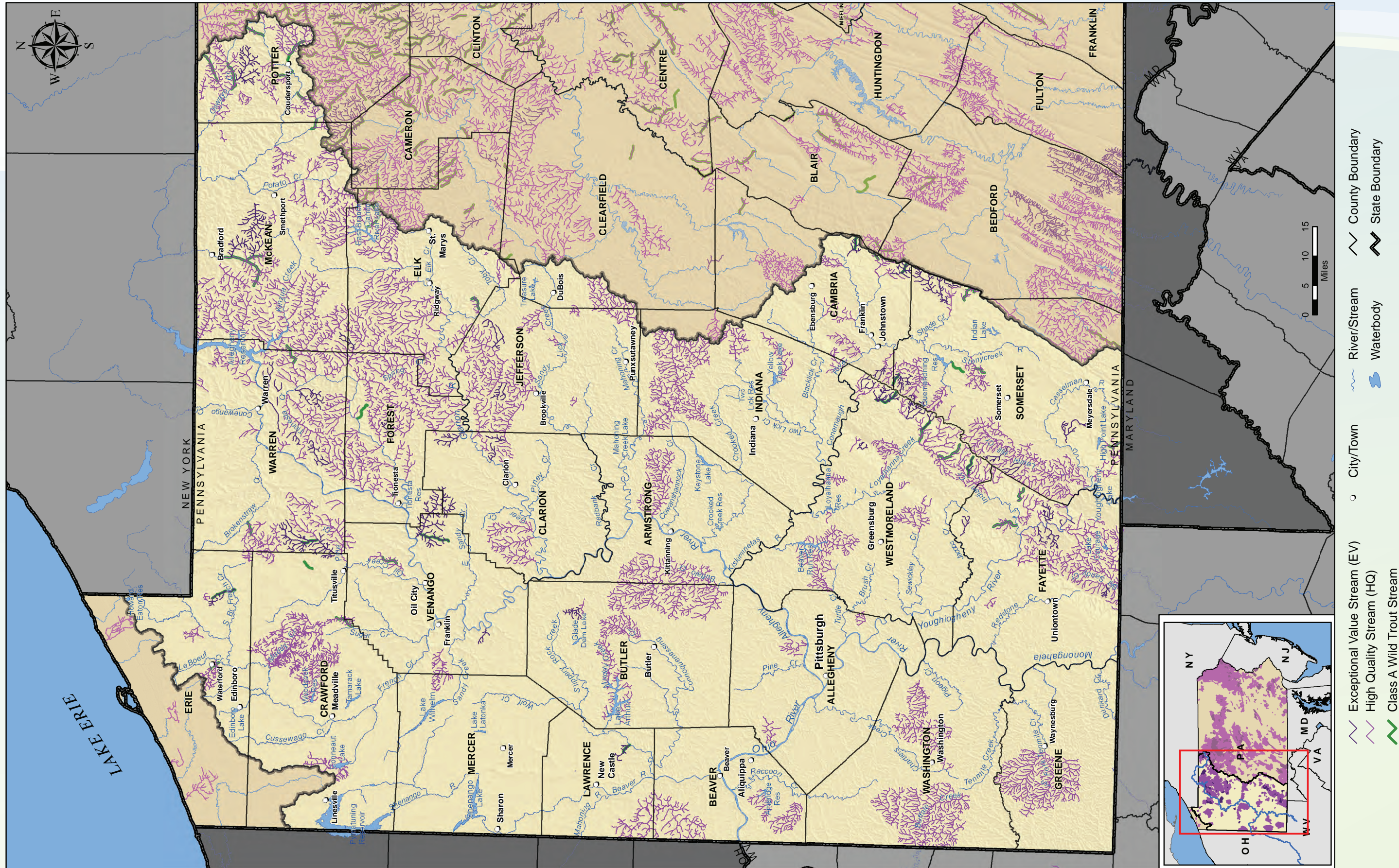
Eventually, the waters were cleaned up beginning in the 1970s with the Water Pollution Control Act Amendments and with the help of many state and local organizations, and much of the wildlife has been restored. Today, the Pittsburgh area is very affluent in industry, bringing more and more residents to the city and surrounding areas. The city is taking strides in increasing the awareness of the role of the rivers and ensuring the safety of the water by encouraging residents to do their part to keep it clean.

In 2005, ESPN selected the three rivers as the location for its CITGO Bassmaster Classic, showing the public’s confidence in the waters surrounding Pittsburgh. Many other recreational activities are enjoyed on the rivers, and the days of staying away from the waters are forever in the past.



Three Rivers Regatta, Pittsburgh.

Special Protection Waters



Water Resources, continued

Stream Releaf Program

DEP initiated the Stream Releaf Program in 1996 to restore streams and riparian areas in order to reduce and prevent stream bank erosion and sedimentation. The Stream Releaf Program has helped to create riparian buffers (vegetated areas along stream banks) along Fairbanks Run in Warren County, Wolf Run in Lawrence County, and Blockhouse Run in Greene County. These are just a few of more than 650 projects found in the Stream Releaf database for this region.

For more information on this program, see “Stream Releaf” under “DEP Programs” at www.depweb.state.pa.us

Lakes and Dams

Lakes are a well-known feature in the Ohio Region, especially river-lakes that are created by the placement of dams on rivers in the region. Examples such as Shenango River Lake and the Conemaugh River Lake were formed by the installation of dams. The Pittsburgh District of the U.S. Army Corps of Engineers maintains and operates 16 flood control projects throughout the region with many lock and dam features on the Allegheny, Monongahela and Ohio rivers.

One example is the C. W. Bill Young Lock and Dam located on the Allegheny River near New Kensington. The facility consists of a single lock chamber and a fixed-crest concrete dam, which is basically a concrete wall spanning the width of the river. This example of a lock and dam maintains a river depth of approximately nine feet, suitable for navigation up and down the river.

The Emsworth Locks and Dam are located on the Ohio River near Emsworth and Avalon. The dam is controlled with two large gated dams that control the water level upriver. Mainly intended for navigation

purposes, the locks and dam also contribute to the surface water supply for industrial and municipal needs. The Emsworth Locks and Dam average nearly 550 commercial lockages every month with an additional 350-400 lockages of pleasure craft during the busy summer months.

Wetlands

Wetlands are areas where water covers the soil or remains at or near the surface for an extended period of the year. These habitats provide a hydrologic link between land and water resources (either surface water, groundwater or both). Wetland types differ according to characteristics such as topography, climate, hydrology, water chemistry and vegetation.

The U.S. Fish and Wildlife Service provides information on the nation’s wetlands and deepwater habitats—including location, type and status—through the National Wetlands Inventory (NWI). There are two general categories of wetlands: coastal (including estuaries) and inland (including rivers, lakes and riparian areas). The NWI classifies inland waters according to the amount and type of vegetation present:

- Open water (rivers and lakes)
- Emergent/herbaceous (marshes, wet meadows and fens)
- Scrub-shrub (swamps and bogs)
- Forested (swamps and bogs)

Numerous swamps and wetlands exist within the region and are even more prevalent in the post-glaciated areas in the northwestern sections of the region. Many wetland areas border streams and rivers including Muddy Creek, Little Sugar Creek and Conewago Creek.

Wetlands provide unique habitat to many species of plants and animals and also serve as natural filters to surface and groundwater supplies. Many wetlands in the region including bogs and swamps have the ability to eliminate contaminants such as nitrates and phosphates as water flows through the wetland. The vegetation present in the wetland utilizes the excess waste, eliminating it from the water and reducing negative

For more information on wild trout streams in Pennsylvania, visit the Pennsylvania Fish and Boat Commission’s Web site at www.fish.state.pa.us/.

impacts to the environment. Wetlands also have the excellent ability to remove sediment from surface runoff. The vegetation plays a large role in reducing sediment as the sediment particles are captured and slowly removed as the water progresses through the wetland.

As illustrated in the Ohio Region Surface Waters Map, the northwestern portion of the region has a high concentration of wetlands. These wetlands, as described, provide a natural defense against harmful contaminants in water supplies. Precaution should be taken to eliminate the destruction of these wetland areas. Allowing them to remain will protect our water sources and provide habitat for many plants and animals.

Special Protection Waters

Certain water bodies are designated special protection to prevent activities that could degrade water quality and therefore prevent these waters from meeting their uses. These special designations include federal or state Scenic/Recreational Rivers, High Quality and Exceptional Value Waters, and Class A Wild Trout Waters.

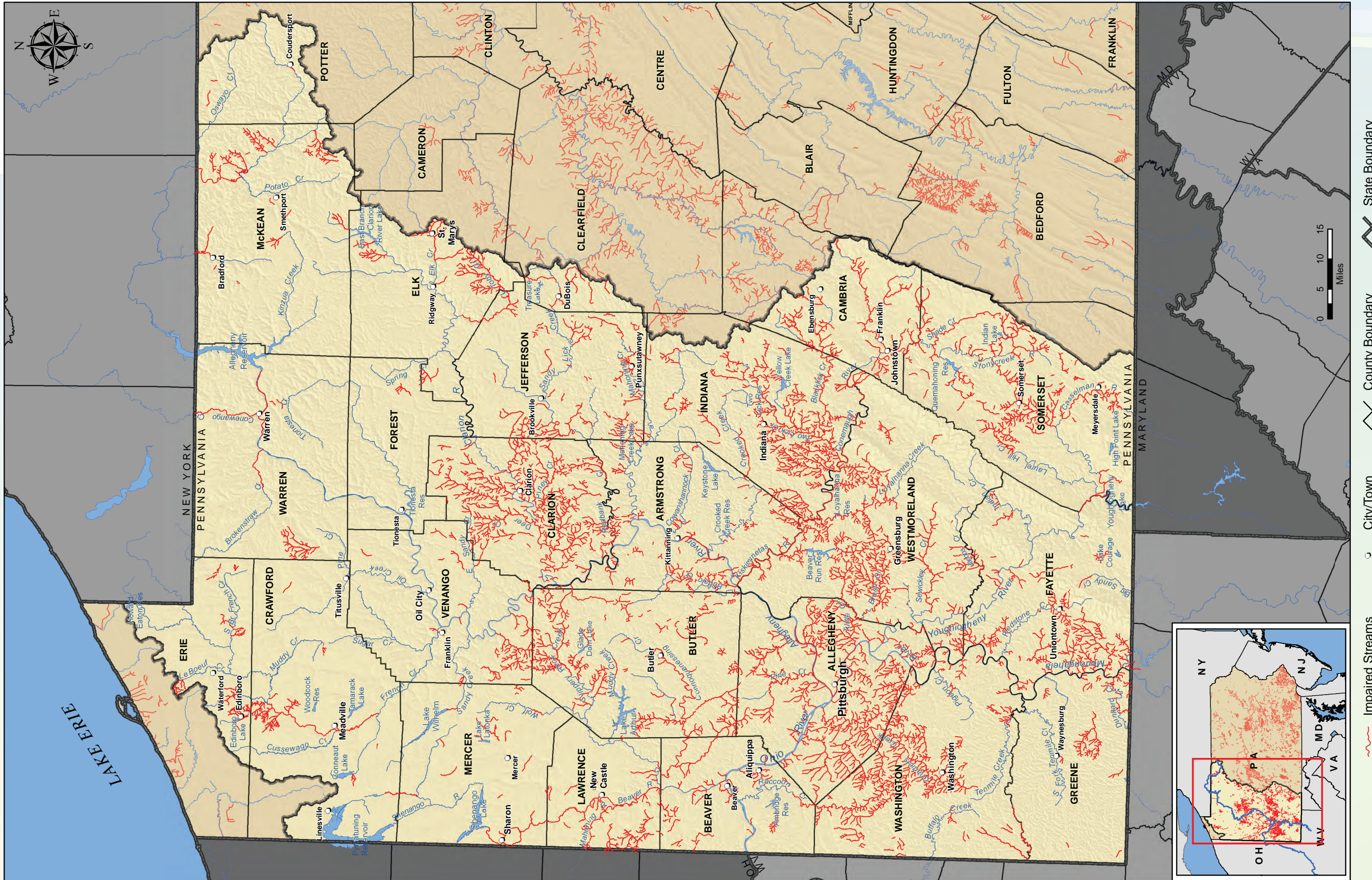
Scenic Rivers

Scenic rivers in Pennsylvania are designated for their exceptional aesthetic, pastoral or recreational value and must be maintained for these values. There are more than 140 miles among three scenic rivers in the Ohio Region. More detailed information about the Scenic Rivers program is included in the Statewide section of this atlas.

HQ and EV Waters

There are two types of special protection waters classifications according to guidelines listed in Pennsylvania Code Title 25, Chapter 93 Water Quality Standards: High Quality (HQ) and Exceptional Value (EV). The Special Protection Waters Map on the previous page shows the HQ and EV waters in the region.

Impaired Waters



Water Resources, continued

- HQ waters are designated as such based on the water chemistry and the presence of a high quality aquatic community. Approximately 323 streams or stream sections are designated as HQ throughout this region.
- EV waters are designated based on water quality and are waters of substantial recreational or ecological significance. There are approximately 55 streams or stream sections designated as EV in the Ohio Region. Many waters are designated as EV based on the fact that they are classified as Class A Wild Trout Waters. These designated streams are primarily found in the eastern half of the region.

The classification of EV or HQ to a stream requires that new or expanded earth-disturbance does not degrade existing water quality. It is important to know that this does not mean that development will stop, but proposed projects will undergo a more detailed permit review by DEP and may result in meeting more stringent requirements to protect water quality.

Wild Trout Waters

Approximately 62 waters in the Ohio Region are designated by the Pennsylvania Fish and Boat Commission as Class A Wild Trout Waters. These waters support a population of naturally-produced trout of sufficient size and abundance to support a long-term and rewarding sport fishery. These streams are not stocked but are supported in full by the spawning of the wild trout populations, further illustrating their outstanding quality and protection they receive. Class A Wild Trout Waters include wild brook trout fisheries, wild brown trout fisheries, mixed wild brook/brown fisheries and wild rainbow trout fisheries. The largest majority of the wild trout waters are brook trout fisheries, while brown trout waters are second largest. Four counties, including Venango, Westmoreland, Fayette and Somerset, contain wild rainbow trout fisheries.

The Special Protection Waters Map on page 52 shows the location of Class A Wild Trout Waters in the Ohio Region.

Impaired Waters

Stream health assessments are complex and time consuming efforts put forth by many individuals. Assessments can include individual studies on the living organisms and habitat within and around the stream, studies on water chemistry, and measurement of physical characteristics. There are also simple visual indicators one can look for to determine a stream's general health. Impaired streams may have eroded or undercut banks, low water clarity, foul odors, large amounts of algae, or have deep deposition of sediments that cover larger rocks on the bottom of the stream. All of these results help determine overall stream health. Restoring impaired streams requires plenty of time and effort combined with the most recent water quality evaluations available.

The Pennsylvania Department of Environmental Protection (DEP), under Section 303(d) of the federal Clean Water Act, implements a program that assesses the water quality of state waters and identifies waterbodies that do not meet the standards

for their designated uses. These designated uses—including aquatic life, recreation, and drinking water—are characterized by the in-stream levels of parameters (e.g., dissolved oxygen, pH, metals, siltation, etc). If a waterbody does not meet the standards for its designated use, it is identified as "impaired" on the Pennsylvania Integrated Water Quality Monitoring and Assessment Report. This report also identifies the cause of the impairment, which may be one or more point sources (like industrial or sewage discharges) or non-point sources (like acid mine discharge or agricultural runoff).

Once impaired waters and their reasons for impairment are established, the state determines what conditions are necessary to return the water

to the quality that meets its designated use. DEP and the United States Environmental Protection Agency (EPA) work in conjunction with other organizations, such as Pennsylvania State University, to develop a Total Maximum Daily Load (TMDL) for each impaired waterbody. A TMDL defines the allowable pollutant loads a waterbody can receive from point and non-point sources and still be able to maintain its designated water quality standards.

The Impaired Waters Map shows the location of impaired streams and waterbodies in the Ohio Region. A majority of these streams are found in the southern two-thirds of the region, particularly around Clarion, and from the Pittsburgh area to Indiana.

Acid Mine Drainage

Drainage from coal mines is often referred to as "acid mine drainage", although a large portion of mine drainage is actually "alkaline". (Acidic water has a pH <5.0 while alkaline water has a pH ≥ 6.0.) Acid mine drainage (AMD) forms from the weathering of pyrite, a mineral containing iron and sulfur. The weathering products are acid, sulfate and iron. Alkaline mine drainage occurs when AMD is neutralized by calcite or dolomite present in surrounding rock or fill materials. If not neutralized, the acid can attack other minerals and leach metals such as manganese, aluminum and zinc.

(BMPs) for cleaning them up. These plans are submitted to the EPA to provide a "road map" for future stream restoration efforts and funding. Currently within the Ohio Region, two Watershed Implementation Plans have been completed for Blacks Creek Watershed and Pine Run Watershed. Specific examples of watershed cleanup projects in the Ohio Region include:

Blacklick Creek and Conemaugh River Watersheds

The Blacklick Creek and Conemaugh River watersheds combined drain approximately a 700-square mile area in Indiana, Cambria and Westmoreland counties. The two watersheds are collectively part of the Lower Allegheny Subbasin.

Efforts to Address Impairment

Many impaired waters exist within the Ohio Region. DEP supports local watershed groups, conservation districts and municipalities in developing Watershed Implementation Plans, which identify pollution sources in these areas and recommend best management practices

Water Resources, continued

The significant abundance of coal and coal mining in the region has negatively affected the Blacklick Creek and Conemaugh River watersheds. Within the subbasin, acid mine drainage (AMD) discharges occur from approximately 300 surface coal mines, 170 coal refuse dumps, and nearly 200 miles of underground mines. Together, they contribute up to 300,000 pounds of contaminants per day. The storage and disposal of brine waste from gas well production has also contributed to the degradation of surface and groundwater resources.

The impacts of AMD have necessitated TMDLs for the metals associated with AMD, in particular aluminum, iron and manganese. The EPA's most recent establishment of TMDLs for the nonpoint sources of pollution in the subbasin occurred in 2005.

In response to the TMDLs and the overall degradation of the streams within the subbasin, several best management practices have been funded and established. Examples include the installation of treatment systems to reduce AMD effects, cleaning and plugging abandoned and orphaned gas wells, and establishing clarification marshes/wetlands to buffer treated wastewaters before they enter other bodies of water.

An aerobic wetland designed to remediate abandoned mine drainage was constructed to restore nearly six miles of Quemahoning Creek in Boswell Borough, Somerset County. The creek, a tributary of Stonycreek River, can now support trout for the first time in nearly 100 years.

Stonycreek River and Little Conemaugh River Watersheds

Stonycreek River and Little Conemaugh River watersheds drain approximately 658 square miles into the Lower Allegheny River Subbasin. Located in Somerset and Cambria counties, the watersheds contain nearly 1,049 streams which flow approximately 1,209 stream miles.

Like the Blacklick Creek and Conemaugh River watersheds, AMD is one of the largest sources of degradation to streams and rivers in the Stonycreek River and Little Conemaugh River watersheds. Surface mining and deep mining both occurred within the subbasin, with some of the deep mines discharging in excess of 2,000 gallons of water a minute and adding to the TMDL of the watersheds. Along with abandoned mines, coal refuse piles also continue to contribute to poor water quality in some streams within the subbasin.

TMDLs were established and approved by the EPA in 2006 for aluminum, iron and manganese—all metals associated with AMD. All contaminants are listed as nonpoint sources of pollution.

In light of the degraded water quality within the subbasin, best management practices have been implemented. Such practices include reclaiming abandoned surface mine sites, treating AMD sites with aerobic wetlands, and plugging abandoned and orphaned gas wells to eliminate further degradation of the surrounding environment.



French Creek Restoration

Running through 117 miles of northwestern Pennsylvania and emptying into the Allegheny River, French Creek has been recognized as one of the most biodiverse environments in eastern North America. The creek supports life to more than 80 species of fish, 10 species of salamanders, 26 species of freshwater mussels and many birds, mammals, insects and plants. Darter fish are also found in French Creek and are recognized for their beautiful colors. French Creek has been able to house so many living organisms, including endangered species, due to its clean waters and unique geological features. Namely, glacial sediment, including limestone, has been helpful to buffer the stream from acidic precipitation.

Over the years, more and more people have settled along the creek, and though the area is not heavily populated, various sources of nonpoint pollution have affected the creek. Nutrients and sediment from fields and lawns have made their way to the creek, interfering with the natural habitat. Restoration efforts are underway to measure and monitor the pollutants in order to administer proper solutions to the various pollution issues. Also, groups like Friends of French Creek are doing work to restore aquatic wildlife and provide educational resources about the creek's ecology in order to keep it healthy and alive. Partnerships with various charities and volunteers have made strides in helping to make the creek a lasting gem of the region.

Stormwater and Flooding

Stormwater as a Resource

Stormwater runoff and flooding are natural events that have helped shape our watersheds and rivers. Human activities on the landscape routinely alter natural drainage patterns. Because of this, stormwater runoff is now being examined as to its effects on water

quality, stream morphology, base flow and recharge. If not managed, these changes may increase localized flooding, stream bank erosion and loss of groundwater recharge. In addition to its physical impact on the environment, stormwater may carry a variety of pollutants.

By managing stormwater runoff as a resource rather than as a waste, a host of opportunities are available to protect the environment and complement water resource management. Since clean and abundant water is a vital resource, effective stormwater management provides for the protection and maintenance of the commonwealth's essential land and water resources. Stormwater management affects and involves all of the possible avenues precipitation might follow after falling to the ground: runoff from the surface of the land; groundwater by infiltrating (or soaking) into the ground; evapotranspiration by evaporating directly into the atmosphere or by transpiring through plant processes and then evaporating; or stored water for various uses.

Human activities that result in land development or changes in land cover, or land use, often affect dramatically the quantity and quality of stormwater runoff from the land surface. These changes can produce potentially harmful impacts on water resources, such as increases in damages from flooding; diminished stream flows and groundwater recharge; degradation of streams and stream channels from scour,

erosion, or deposition; and deterioration of water quality from pollution. These effects can be minimized, or avoided, through the careful preparation and implementation of comprehensive stormwater management plans and other planning or regulatory efforts.

Problems Associated with Stormwater and Flooding

Stormwater can have a detrimental effect on the agricultural lands, developed areas and the water quality of streams and rivers that flow through the 15,600-plus square miles of land that makes up the Ohio Region.

Flooding

Flooding is a localized temporary condition of partial or complete inundation of normally dry land from the overflow of streams or rivers. This potentially hazardous condition is generally the result of excessive precipitation. Generally, floods can be classified into two categories: flash floods, the product of heavy localized precipitation in a short time period over a given location; and general floods, caused by precipitation over a longer time period over the river basin.

Flash floods can occur within a few minutes or several hours of heavy amounts of rainfall, rapid snow melt or from a sudden release of water held back by an ice jam. Flash floods can damage buildings and bridges, uproot trees and scour new drainage channels. Although flash flooding often occurs along small rural streams, it is also common in urban areas where much of the ground is covered by impervious surfaces. The impervious surfaces created by roads and buildings generate greater amounts of runoff than would typically occur over vegetated areas. As land is converted from fields and woodlands to

impervious surfaces, it loses its ability to absorb rainfall. Urbanization greatly increases the quantity and velocity of runoff over what would occur naturally on vegetated and forested terrain. Fixed drainage channels in urban areas may be unable to contain the runoff that is generated by relatively small, but intense, rainfall events.

The severity of a flooding event is determined by a combination of river basin terrain, local thunderstorm movement, past soil moisture conditions and the degree of vegetative clearing. Abnormal weather patterns may also contribute to flooding of a local area.

Urban and Suburban Runoff

As the Ohio Region witnesses an expansion of development in some areas, stormwater runoff is being scrutinized along with its effects on water quality. Stormwater runoff from developed areas in Pennsylvania is the third leading cause of stream impairment. Pollution in the Ohio Region can result from suburban development and impervious surface expansion, resulting in potential runoff of petroleum products, nutrients, etc. The trend of population spreading out from towns and cities into areas that were previously rural is expected to continue into the future.

These population changes can result in development and an increase in impervious surfaces. As impervious surfaces increase so can the amount of pollutant-carrying stormwater from new developed areas. Soils washed away from exposed building sites during construction also contribute to the excess sedimentation of streams.

Pittsburgh, in Allegheny County, is expected to see expanding development continue outward in some

More information can be gathered by visiting the PEMA Web site at www.pema.state.pa.us.

Local Flooding Occurrence

Since flooding is a problem in the Ohio Region, reservoirs and dams have been created to help control floodwaters. Reservoirs and dams in the watershed are managed and maintained by government agencies like the U.S. Army Corps of Engineers. Although reservoirs and dams exist in the watershed, occasionally heavy rains can overwhelm flood controls.

The city of Pittsburgh has dealt with at least four 100-year floods in the last century. One of the worst floods to occur in Pittsburgh happened in 1936 when flood waters exceeded the 500-year floodplain. Although flooding has occurred in Pittsburgh and western Pennsylvania, flood controls reduced the impacts of Tropical Storm Agnes (downgraded from a hurricane) in 1972. While record flooding occurred in the Upper Allegheny Subbasin during Agnes; dams and lock systems reduced the impacts of flood waters downstream. In January 1996, flood controls also reduced the impacts of flood waters in the region.

Flood control utilizing dams and emergency reservoirs is now being augmented by improved stormwater management practices to prevent flooding. Flood mitigation measures are continually being refined by Pennsylvania and have helped reduce the overall impacts of major flood events. Flood hazards are also being addressed in Hazard Mitigation Plans that are being prepared by each county in the state. Also, the Pennsylvania Emergency Management Agency (PEMA) uses the Federal Emergency Management Agency's (FEMA) hazard identification tool, HAZUS, to assist counties and local communities in assessing flood risks and preparing mitigation plans.

Stormwater and Flooding, continued

directions. Stormwater runoff in this area affects water quality in the urban and suburban areas of the three rivers. Future land development can increase stormwater runoff and streambank erosion throughout the watershed. Increased stormwater can cause sewer overflows in older towns that channel stormwater runoff to wastewater treatment facilities, or worse yet, combined stormwater and wastewater can overflow into surface waters. Increased stormwater also destabilizes stream banks, disperses litter and topsoil, distributes unnaturally warm water from developed surfaces into streams, and reduces groundwater recharge.

Agricultural Runoff

Water quality degradation and impairment in the Ohio Region can also be caused by stormwater runoff from agricultural lands. As stormwater flows over agricultural lands, it can wash away excess nutrients like nitrogen and phosphorous from commercial fertilizers and manure. Soils from plowed fields and unstable stream banks, sometimes exposed in part by grazing animals, can also be washed away with stormwater runoff. Excess nutrients, sediments and pollutants in this basin not only impair Pennsylvania's waters but also the Ohio River and ultimately the Mississippi River.

Stream Impairment and Stormwater

In the Ohio Region, water quality degradation of streams, rivers and groundwater has occurred primarily in the lower half of the basin. The region is home to watersheds such as French Creek, Allegheny River, Monongahela River, Raccoon Creek, Shenango River and Youghiogheny River. Several of these watersheds, including Raccoon Creek and French

Creek, contain high amounts of agriculture and development (refer to the Land Cover map on page 69).

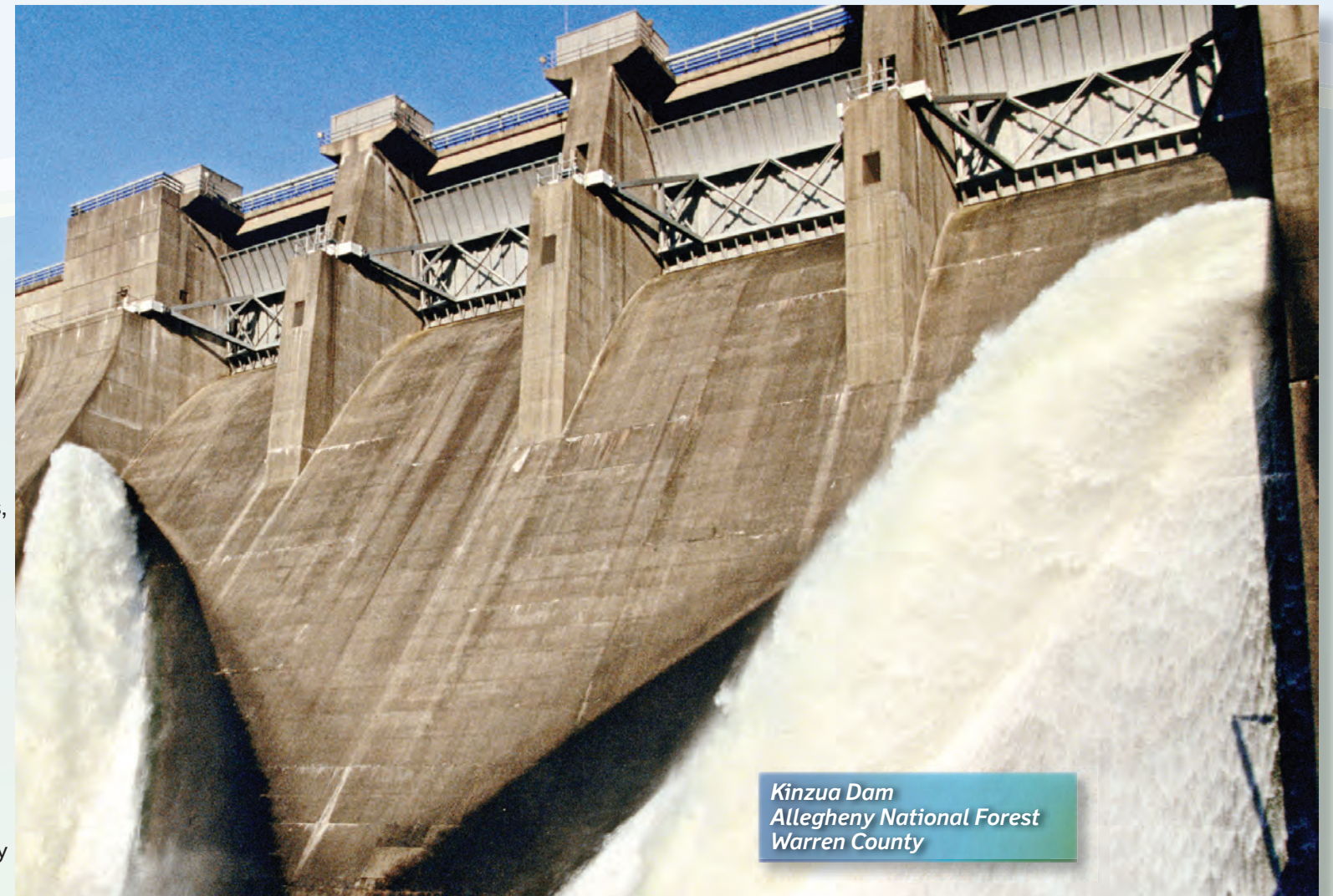
The Monongahela River supplies the city of Pittsburgh and its surrounding communities with drinking water. The river and surrounding watershed possess high potential for contamination from pollutant-carrying stormwater. Stormwater runoff from transportation corridors, residential development, farms, abandoned mines and combined sewer overflows have been identified as some of the highest potential sources for nonpoint pollution.

In the Ohio Region, combined sewer overflow systems are responsible for some water quality degradation. Combined sewer systems channel both stormwater and wastewater to a treatment facility. During heavy rains, stormwater can overwhelm a wastewater treatment facility's ability to disinfect wastewater. In the event combined stormwater and wastewater volume exceed a treatment facility's capacity, the systems are designed to discharge untreated water directly to a stream.

Allegheny County and the city of Pittsburgh are currently working with state and federal agencies to resolve combined sewer overflow issues and update its existing stormwater/wastewater infrastructure. Although combined stormwater overflows can affect Allegheny County's water quality during storm events, overflow systems are not isolated to the city of Pittsburgh. In fact, 152 communities throughout Pennsylvania have been identified as having combined sewer overflows.

Did you know?

Between 1950 and 2000, Allegheny County had the most recorded flood events of any county in the state, ranking number one with 120 floods.



Kinzua Dam
Allegheny National Forest
Warren County

Kinzua Dam and Allegheny Reservoir

The Kinzua Dam and Allegheny Reservoir in Warren County are included within the U.S. Army Corps of Engineers flood control projects in the Pittsburgh District. Completed in 1965, Kinzua Dam has saved an estimated \$1 billion in flood damages. In particular, the dam demonstrated its phenomenal flood control capabilities during Tropical Storm Agnes in which an estimated \$247 million in damages were prevented.

The Kinzua Dam provides the backstop for the Allegheny Reservoir which contributes water releases throughout the year to reduce pollution; support domestic, industrial, and recreational uses; and regulate flow to maintain safe levels for navigation on the Allegheny and Upper Ohio rivers.

The Kinzua Dam itself also benefits the local area by providing hydroelectric power. Operated by First Energy Corp., the dam generates 400,000 kilowatts per hour at peak capacity.

The Johnstown Flood

Known as the “Great Flood” to locals, the Johnstown Flood occurred on May 31, 1889. The South Fork Dam, situated 14 miles north of Johnstown, broke, unleashing 20 million tons of water into the town already inundated by several days of heavy rainfall. The flood was the first major disaster aided by the Red Cross, and approximately 2,200 people lost their lives.

The South Fork Dam was originally state owned, but was sold privately and made into a resort for wealthy residents of Pittsburgh. Unfortunately, when the dam changed ownership, various alterations were made to tailor to recreational activities of the resort, which are believed to have lead to the vulnerability of the dam. Between the club’s opening in 1881 and 1889, leaks formed in the dam and were patched with mud and straw. These cracks combined with Johnstown’s susceptibility to flooding equaled a potential for disaster.

Heavy storm clouds filled the Johnstown area early in the day on May 31, bringing water levels in the city to a significant level. It was only

when the South Fork Dam burst that millions of tons of water washed down to the city at speeds as high as 40 miles per hour, picking up debris including railroad cars and barbed wire from Cambria Iron Works. Forming temporary dams at the canyon walls, the surge of water gained power as it forced its way through to Johnstown. The people of Johnstown found the flood to be a surprise, and were crushed by the debris and water that reached 60 feet in some areas. Those who escaped to their attics or clung to debris above water waited for hours to be rescued, and many did not make it. Conditions worsened when waters reached the Stone Bridge in the city; another temporary dam situation occurred and sent a second surge of water to hit the city. A fire broke out for three days, killing many more people.

Since then, many more floods have hit the city of Johnstown including two more major events in 1936 and 1977, but none have reached the severity of that in 1889. In 1964, the Johnstown Flood National Memorial was built, where remnants of the dam are preserved. Also, a museum in Johnstown is dedicated to the flood.



*Johnstown Flood Museum
Johnstown, Cambria County.*

Nine Mile Run Restoration

Nine Mile Run is a small stream located in the city of Pittsburgh. Its watershed encompasses only 6.5 square miles with 2.2 miles of surface water. It was common practice during the early 20th century to place streams in urban areas underground in pipes or culverts. This was done because streams such as Nine Mile Run, were primarily used to carry offensive smelling wastewater out of a city. Since the stream runs through a local park, a third of the stream was left above ground.

Today Nine Mile Run is still used to transport wastewater and stormwater from the city into the Monongahela River. During storm events, Nine Mile Run is quickly overloaded with water. Stormwater carries pollutants from impervious surfaces and causes combined sewer and stormwater systems to overflow into the stream.

Nine Mile Run and its watershed have been the focus of aquatic ecosystem restoration efforts by the city of Pittsburgh, the U.S. Army Corps of Engineers, the Nine Mile Run Watershed Association and the Three Rivers Wet Weather Demonstration Program. These groups worked together on stream channel modifications and improvement, replanting native vegetation, and creating sequences of deep and shallow water in the stream which improve aquatic life. Since these improvements were made, the Nine Mile Run Watershed Association continues to educate watershed communities about the restoration project.

For information on drought monitoring and flood protection, visit the Pennsylvania Department of Environmental Protection’s Web site at:

Drought Monitoring –
www.depweb.state.pa.us, keyword:____
“DEP Programs – Drought Monitoring”

Flood Information –
www.depweb.state.pa.us, keyword:____
“DEP Programs – Flood Protection”

Geology and Groundwater

The Ohio Region is the only regional basin that is contained within one physiographic province, the Appalachian Plateaus Province. Although found in only one province, the Ohio Region has varying geology and groundwater characteristics.

A significant variable in the Ohio Region's geology and groundwater was the presence of glaciers approximately 20,000 years ago in the northern areas of the region. Also, the mining of coal and drilling for natural gas in the region has impacted and diverted groundwater supplies.

Bedrock Geology

The sandstone, shale and other sedimentary bedrock formations in the Ohio Region, as illustrated in the Bedrock Geology Map on page 61 are consolidated rocks that comprise the majority of aquifers in the region. Groundwater is contained within and moves through fractures, spaces and partings in the consolidated rock. Aquifers exist here under two different conditions. Where water only partly fills the aquifer and is free to rise and fall, it is referred to as an unconfined aquifer or water table aquifer. Where water completely fills a rock unit and the aquifer is under a low-permeable feature or confining layer, this aquifer is said to be confined. This confining layer helps protect this kind of aquifer from contaminated water migrating from above. Another key difference between the two is the varying pressure regimes. The unconfined aquifers are under atmospheric pressure while confined aquifers are at a greater pressure due to the confining layer overhead.

The connection between surface water and the aquifers that store and discharge groundwater is often misunderstood. The water table, which is the boundary below which all the spaces and cracks in the soil and bedrock are completely saturated, is often times a reflection of the surface topography. As the topography changes due to hills, mountains or valleys, the water table will often times change depth with the changing surface elevation.

However, streams, wetlands, springs or rivers will often form in areas where the water table intersects the land surface. These areas occur

where the groundwater discharges from groundwater storage and becomes surface water. This discharge of groundwater into surface water is also known as base flow. Base flow can be thought of as the sustained low flow of a stream because it is supplied by the groundwater that is discharging from the underground storage. Dry streambeds or springs that no longer supply water are a result of the water table being lower than the land surface.

Appalachian Plateaus Province

Across the entire Ohio Region, bedrock formations were largely created from sedimentation that occurred nearly 400 million years ago. The sedimentation occurred while the province was covered by saltwater and freshwater seas that once occupied the area. Bogs and

Did you know?

The Allegheny River used to flow north toward Lake Erie through the channel of today's French Creek. The direction of flow was reversed when continental ice masses blocked the water's northern escape.

swamps developed when the area was not submerged which resulted in large beds of peat, an accumulation of decaying organic matter. Sedimentation occurred again during the area's history, covering the peat beds. The weight and pressure caused by the new sediment increased over thousands of years and eventually caused the peat beds to metamorphose into coal.

Within the entire region as well, topography generally reflects the underlying bedrock. The gently folded and warped bedrock was modified by streams that scoured valleys into the surface. Abrupt changes in elevation and topography often occur where provinces transition and encounter different bedrock. Typically, these transitions are along areas of bedrock that are more erosion-resistant and form a distinct change in elevation, or an escarpment.

Glaciated Areas

The northwestern areas of the Ohio Region were glaciated several times in their past. Counties in the region that experienced the most recent glaciation include Erie, Crawford, Warren, Mercer, Venango and Lawrence.

The glaciers deposited large amounts of unconsolidated material, or till, as they receded. Wetland areas are likely to form in the valley floors that contain large amounts of glacial till. Also, a fragipan layer can develop in the glacial till, which retains water on the surface as it slowly infiltrates into the groundwater supplies. A fragipan layer is a very dense layer of soil forming beneath the surface that inhibits infiltration of water.

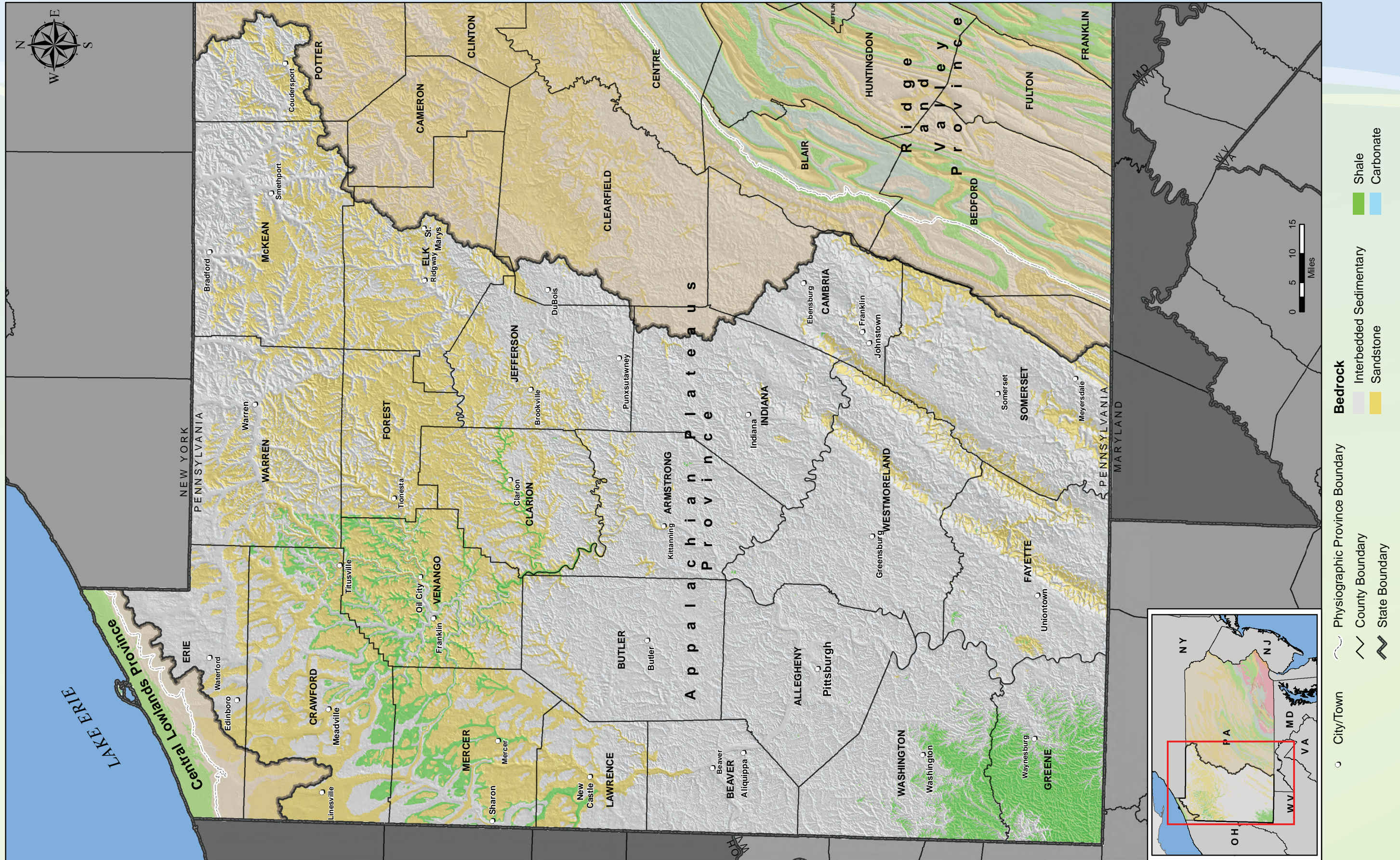
The sandstones and more resistant bedrock types typically form the highland areas across the entire Ohio Region. Valley areas are common in the less-resistant shale and sedimentary rock found in the lowland areas. Like nearly all areas that have a hilly landscape, the highlands receive a majority of the aquifer recharge and discharge in the valley areas. This downward flow of water through the ground caused by gravity and the pressure from the water above cause water to discharge into streams and creeks or as springs in the valley and low lying areas.

Thick areas of glacial till also aid in groundwater recharge if permeability is sufficient. Till can act as a sponge absorbing precipitation and slowly releasing it into the aquifers, increasing groundwater supplies. However, areas with a fragipan layer are less likely to receive large amounts of infiltrated precipitation.

Non-Glaciated Areas

The largest land area of the Ohio Region remained untouched by glaciers of the past. These areas contain the large bituminous coal fields and natural gas fields. The area is generally flat-lying although definitive highlands exist in the vicinity between Uniontown and Johnstown. Hilly regions also exist in the southwestern sections of the region including Washington, Greene and Fayette counties.

Bedrock Geology



Geology and Groundwater, continued

Groundwater supplies are affected by the local geology in several ways throughout the non-glaciated areas of the region. In general, areas that have a high concentration of fractures and cracks in the bedrock accept the most water for aquifer recharge. However, the Ohio Region never experienced the intense folding and fracturing like the Ridge and Valley Province did during the formation of the Appalachian Mountains. This resulted in overall fewer fractures in underlying bedrock, which inhibit infiltration of water into groundwater aquifers and inhibit groundwater flow within the aquifer itself.

The abundant formations of coal fields in the Ohio Region have important effects on groundwater supplies. Coal beds in the region are typically cracked and fractured allowing for better transportation of groundwater through its conduits. However, intense past and present mining practices have impacted and diverted groundwater supplies. These impacts are described in more detail in the following sections.

One benefit to the Ohio Region's groundwater supply is the existence of sand

and gravel aquifers in the Allegheny and Ohio river valleys. These aquifers benefit from large amounts of recharge because of their high permeability and porosity. This results in large amounts of discharge to those having wells withdrawing from the aquifer. An exceptional example of groundwater supplied from the sand and gravel aquifers within the river valleys is the fountain at Point State Park in Pittsburgh.

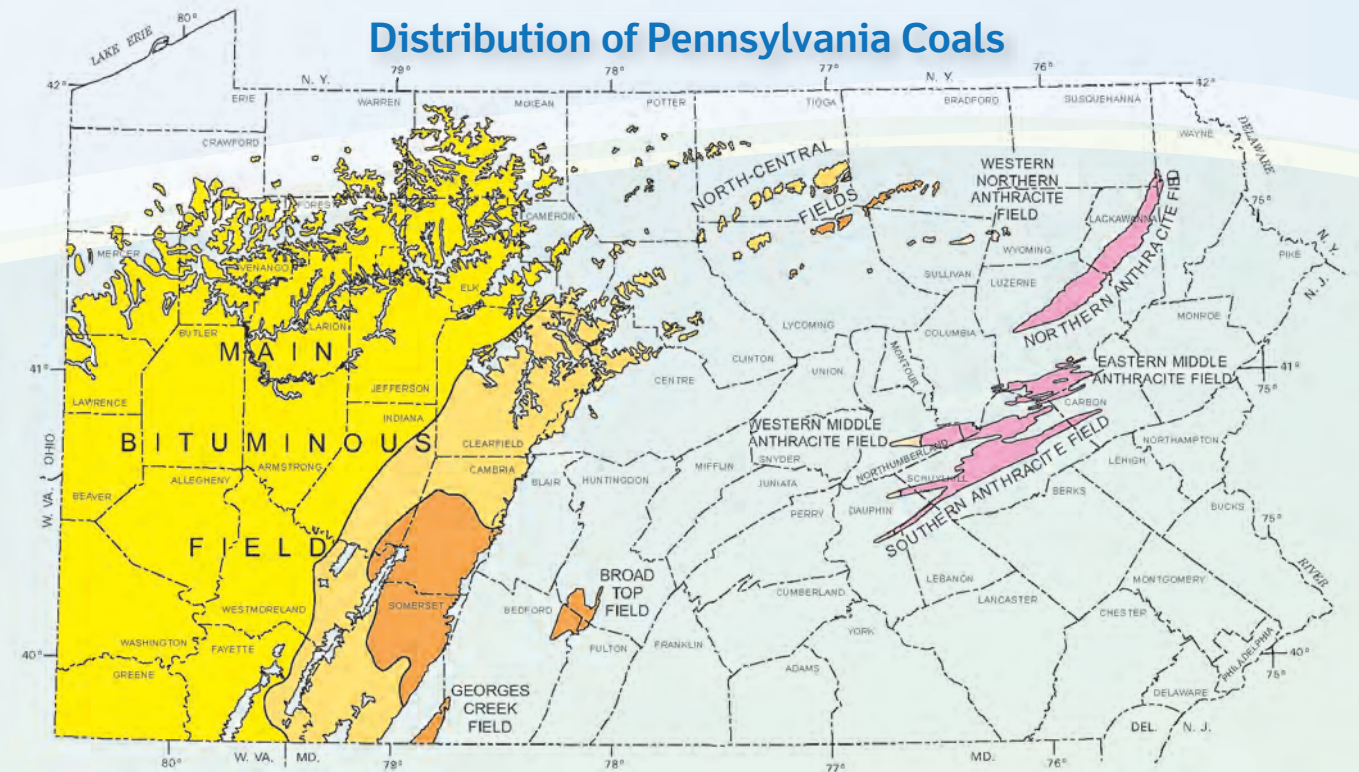
Coal Resources

Bituminous coal mining in Pennsylvania began its storied history in the "Coal Hill" region near Pittsburgh, now known as Mount Washington. Production of mined coal has been fueled by industrial, commercial and domestic use since the

mid-1700s. Coal was initially mined to support the steel mills that have a permanent place in history in the Pittsburgh region. It is now used for producing electricity as well as supporting the steel industry.

Bituminous coal has been extracted in Pennsylvania almost exclusively using the room and pillar method. This method involves mining large open areas into the coal seam (rooms) while leaving large columns (pillars) to support the overburden above. The use of retreat mining is also used to complete the coal mining process. Also known as "second mining," the supporting pillars are systematically removed to recover up to 70 percent of the target coal seam. As the pillars are removed, the mine roof, or overburden, usually quickly collapses into the unsupported mine shaft resulting in mine subsidence.

Another method of coal mining is long-wall mining. This method removes coal that is found in large blocks or panels that can be anywhere from 800 to 1,500 feet



Source: Pennsylvania Department of Conservation and Natural Resources



wide. Special roof supports using hydraulics are set up to allow a machine to remove the coal. The machine moves across the face of the coal, removing it, and then sends it to the mine entrance via a chain conveyor that travels along the entire length of the coal face. As the machine progresses along the coal face, the roofing equipment advances as well. This method has some controversy associated with it because it often results in surface subsidence because nearly 100 percent of the coal is removed. Mining companies are therefore required by law to repair, replace or compensate for any structural damage from subsidence from deep mining.

Pennsylvania bituminous coal mining, using both surface and subsurface mining, produced more than 68 million tons in 2005. Along with coal production, nearly 4.6 million tons of coal refuse was reprocessed as well. Nearly 75 percent of this current production comes from only five bituminous coal beds in the region, which include the Pittsburgh Coal Seam, the Upper and Lower Freeport Coal Seam, and the Upper and Lower Kittanning Coal Seam.



Point State Park, Pittsburgh.

Coal - Environmental Concerns

Both surface and subsurface coal mining can create problems for local water supplies. The open pit mines and large refuse piles of surface mine waste as well as the large underground chambers of subsurface mining contributes to acid mine drainage (AMD).

The formation of AMD is primarily a function of the geology, hydrology and mining technology employed for the mine site. AMD is formed by a series of complex geochemical and microbial reactions that occur when water comes in contact with pyrite (iron disulfide minerals) in coal, refuse or the overburden of a mine operation. The resulting water is usually high in acidity and dissolved metals. The metals stay dissolved in solution until the pH raises to a level where precipitation occurs. Solubility charts for the various metals show the pH at which precipitation begins and the pH at which maximum insolubility occurs. Neutralization with limestone addition and bioremediation are some solutions to alleviate these symptoms but the problem still persists.

Room and pillar mining that occurs in the region has the ability to greatly alter groundwater flow. If mining occurs below the water table, the low pressure area created by the mine encourages groundwater to move downward, away from the surface. Draining of overhead aquifers in this case is also referred to as “dewatering.” This change in flow can alter surface water baseflows by decreasing discharge rates or eliminating streamflow all together.

Natural Gas and Oil Resources

Natural gas, aptly named, is a natural byproduct from the formation of oil and coal. Like bituminous coal, natural gas in Pennsylvania has its beginning in the Ohio Region. With the first oil well drilled by Col. Edwin Drake in Titusville in 1859, natural gas was also accidentally found.

Natural gas production in Pennsylvania and the Ohio Region has a very prominent place in history. Several firsts for the industry occurred within the region, including the first natural gas compressor station built at Rixford in McKean County and the first supply of bottled liquid propane (LP) in 1912 by Dr. Walter Snelling in Waterford, Erie County.

Sugar Creek Mine Reclamation Project

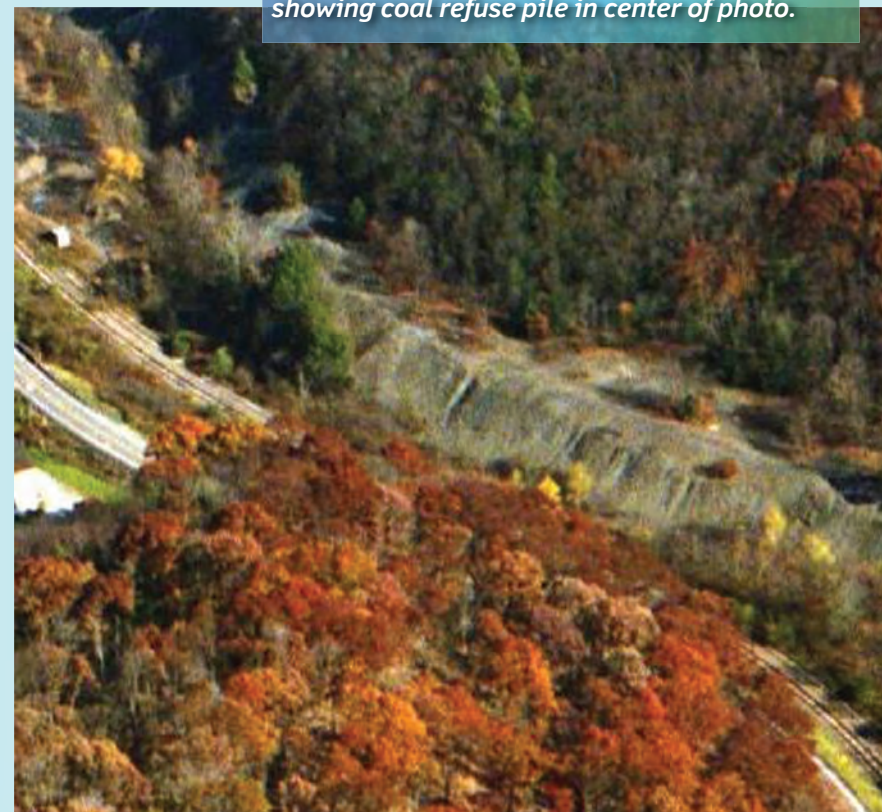
The Sugar Creek abandoned mine reclamation project is a modern success story that continues to improve the waters of Sugar Creek. Located in Bradys Bend Township, Armstrong County, the project included the reclamation of a 15-acre coal refuse pile and the construction of a passive mine drainage treatment system.

The project was designed to eliminate the safety hazards surrounding the mine, including the steep, unstable coal refuse pile estimated to contain approximately 340,000 tons of refuse, and to remediate the degraded mine drainage entering Sugar Creek. The refuse pile was re-contoured after being graded back away from the stream. Erosion control was then installed in the form of rip-rap, which further increased the stability of the refuse pile. The final step was applying a protective cover of soil to allow cultivation of vegetation to further stabilize the pile.

The implementation of the passive mine drainage treatment system involved the relocation of a small tributary to Sugar Creek, construction of a retention pond, and construction of a multi-chambered aerobic wetland. The aerobic wetland was further enhanced by the addition of limestone diversions that increased alkalinity and distributed water more evenly through the wetland before entering Sugar Creek.

Continued monitoring of the reclamation project and passive treatment system has shown dramatic improvements to Sugar Creek. Within six months, in-stream iron concentrations decreased to less than 0.5 mg/l from 20-75 mg/l prior to reclamation. Since then, constant monitoring has shown that water chemistry continues to improve and exceeds water quality standards.

Sugar Creek project prior to reclamation, showing coal refuse pile in center of photo.

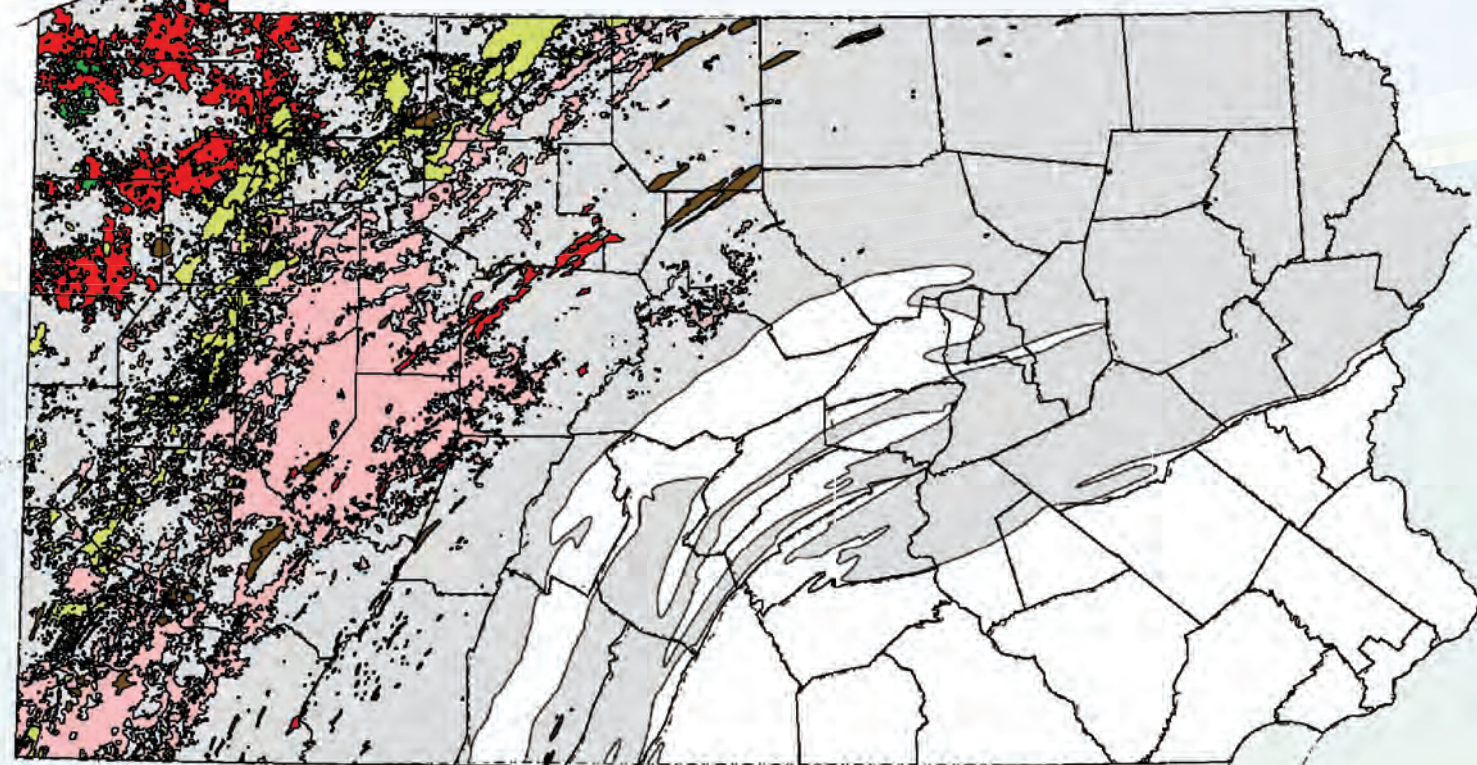


Completed project showing reclaimed, revegetated refuse pile.



Geology and Groundwater, continued

Distribution of Pennsylvania Oil and Gas



■ Gas Storage
■ Deep Oil
■ Shallow Oil
■ Deep Gas
■ Shallow gas

MARCELLUS OCCURS IN
 SUBSURFACE OR OUTCROP

Source: Pennsylvania Department of Conservation and Natural Resources

Underground natural gas storage is a practice that occurs in the Ohio Region. For the most part, natural gas demand is determined by fluctuations in the weather. Weather can be difficult to predict, making gas demand difficult to predict as well. The utilization of underground storage provides reservoirs within a relatively close distance to consumers instead of having to transport the gas for hundreds or thousands of miles across other states.

Several large underground storage areas in the Ohio Region exist in Westmoreland, Green, Washington and Fayette counties. The gas is pumped into depleted natural gas reservoirs from past operations. Since they originally contained natural gas, operators have little concern about the gas escaping because of the presence of natural confining layers surrounding the reservoir. Pennsylvania contains more underground storage facilities (49) than any other state in the U.S.

Oil is also an important natural resource extracted within the Ohio Region. Presently, approximately 3.6 million barrels of crude oil are produced and approximately 168 billion cubic feet of natural gas is produced per year.

Natural Gas and Oil - Environmental Concerns

As with any resource extraction that occurs, effects to the environment and corresponding protection strategies are developed. The same applies with natural gas and oil extraction and the waste that is produced.

A common waste product that is associated with the extraction of natural gas is brine. Brine is a saline solution that accompanies the oil and gas in the bedrock. As the gas or oil is extracted, various amounts of brine are also brought to the surface where it is separated from the gas or oil and stored in large lined pits or storage tanks. If storage areas fail, surface water and groundwater sources can become contaminated by the salty, degraded brine solution.

Environmental issues also arise as natural gas wells no longer provide an economic gain to the owner or client and are abandoned. Plugging these abandoned wells is necessary to eliminate any threat to water supplies and the surrounding environment. Act 78 of 1992, which amended Pennsylvania's Oil and Gas Act, helps fund money for "orphan wells" to be plugged to reduce harmful environmental impacts. Wells are designated as orphan wells if they were abandoned prior to April 18, 1985.

Far Left: Loaded coal barges and steamers on Monongahela River, Pittsburgh, 1907.

Left: Transportation of coal by railway, 1907.

Mineral Resources

The Ohio Region contains a notable amount of large, non-fuel mineral producers. Crushed stone producers occur in Butler, Lawrence, Westmoreland, Fayette and Somerset counties. Construction sand and gravel producers are located in the areas that were glaciated in the past with major producers found in Mercer, Warren and Crawford counties.

Road Application of Brine

The large amounts of brine produced as a byproduct in oil and natural gas extraction requires diligent efforts to contain, treat and dispose of the waste product. New uses for brine now include application to roadways for dust control and road stabilization.

DEP has published guidelines outlining a general system on the use of brine for dust control and road stabilization. The guidelines, administered under the authority of the Clean Streams Law and the Solid Waste Management Act, direct the development of site specific brine spreading programs that specify the amounts and frequency of brine being spread and establish monthly reporting.

Another use for brine is as an ice melting agent. The brine is used in combination with anti-skid material to treat snow or ice covered roads.

Additional information on the uses of brine can be found at DEP's Bureau of Oil and Gas Management Web site, located at: www.depweb.state.pa.us, keyword:oil and gas.

Laurel Caverns

Privately owned near Uniontown, Penna., Laurel Caverns is the largest cave in the state. Sitting on Chestnut Ridge, the cave was once known as Dunlaney's Cave and Laurel Hill Cave, and currently is a show cave with hour-long guided tours.

Unlike many other caves in Pennsylvania, Laurel Caverns is not made of limestone, and is instead comprised of sandstone and calcium carbonate. The rough walls and sandy floor are a result of the calcium carbonate being washed down millions of years ago, allowing the silica to dissolve away. Laurel Caverns is tilted 15 degrees due to its formation from folded and fractured rock, resulting in long and steep passageways. In these passageways, the optical illusion of a gravity hill can be observed, where a ball appears to defy gravity and roll uphill.

In addition to tours, many activities are available at Laurel Caverns. Visitors over the age of 12 can enjoy caving, where undeveloped and unlighted portions of the cave can be explored. Also, there is a mini golf course, Kavernputt, in a simulated cave arena designed to educate players about unique aspects of caves. Various girl scout and boy scout packages are also available on site.



Laurel Caverns, Uniontown, Fayette County.

Land Use: Past and Present



*Farmland in the Ohio Region.
Photo courtesy of Joe West.*

approaching maturity. The great oak-chestnut forests of the mid-Atlantic have been replaced by other forest types.

History of the Ohio Region

Studying the change in land use over time can offer insight into the development patterns that may influence the future landscape of an area.

Pennsylvania's Forests

Pennsylvania's water resources are closely tied to its forests. The vast forests of Penn's Woods provided clean, pure water not only for Native Americans, but also for the state's founder, by acting as a natural filter. However, William Penn might not recognize his property today.

When colonists first arrived in the mid-Atlantic, more than 90 percent of the landscape was forested. By the mid-1800s, most of the region's trees had been cut down to clear land for cities, towns and farms or to provide lumber. Once dominated by virgin white pine, hemlock and chestnut forests, the forests regenerated into current day second-growth mixed deciduous and evergreen forests.

The post-colonial changes to the forest were significant. At one time, the predominant tree species in the mid-Atlantic deciduous forest was the American chestnut. Unfortunately, with the accidental introduction of a fungus (*Endothia parasitica*) to the area in 1904, most American chestnut fell to this disease. The fungus survives in stumps and saplings affecting any trees

Early Settlement

During the 1700s, both Virginia and Pennsylvania claimed the area that is now southwestern Pennsylvania. The boundary dispute was resolved only when the Mason and Dixon Line (which defined the southern boundary of Pennsylvania) was extended west into what is now West Virginia in 1786.

The French and Indian war began in what is now Fayette County in 1754 when Virginia sent George Washington, then a young officer, to warn the French that they were on land claimed by Virginia. After a failed attempt to hold Fort Duquesne (now Pittsburgh) and defeat at Fort Necessity in present-day Fayette County, the British troops under Washington retreated back to Virginia.

In 1755, the British government sent General Edward Braddock and 1,500 regular troops to Fort Duquesne. Braddock built a road beginning in Virginia, crossing Maryland, and into southern Pennsylvania. He was surprised and defeated by the smaller force of French and Native Americans at Turtle Creek on the Monongahela River on July 9, 1755. General Braddock died on the retreat back to Virginia. For the rest of the decade, the French and their native allies controlled the region, keeping any European settlers away. Fort Duquesne remained in French hands until General John Forbes marched 7,000 troops into western Pennsylvania in 1758. He began in Carlisle, Penna., cutting a new road through the Allegheny Mountains.

Did you know?

One of the first flatboats, a rectangular boat with flat bottom and square ends used to transport freight on inland waterways, was built and launched from Brownsville, Fayette County into the Monongahela River in 1782.

Following the defeat of the French at Montreal in 1760, pioneers used the Forbes Road to settle in the lush valleys and timber-rich mountains of the Ohio Region. Many of the early settlers in the region were Scots-Irish and Scottish immigrants. Other prominent groups included the English and Germans.

After the American Revolution, in 1791, Congress approved a national excise tax that included whiskey. Two of the nation's major distilling regions, western Pennsylvania and Kentucky, regarded it as an unfair burden. Political leaders John Smilie, William Findley and Albert Gallatin agreed with their constituents and when the federal government refused to repeal the measure, they refused to pay the tax and threatened the tax collectors. On October 4, 1794, Washington joined troops from Pennsylvania, Maryland and Virginia near Carlisle, Penna., and marched them out to Bedford County. The presence of the army scared off the "Whiskey Boys," and they agreed to pay the tax. Federal troops arrested 150 rebels and sent 20 of the ringleaders to Philadelphia to stand trial. The Federal District Court of Philadelphia found most of the rebels not guilty, but in July, 1795, sentenced two of the men to death for treason. Washington later pardoned both men.

Industry

Pittsburgh's unparalleled strategic location at the confluence of the Ohio, Monongahela and Allegheny rivers was key to its success in industry. The rivers, once improved for navigation, became a source of transportation for

nearly all goods coming in and out of the region. Industry success was also boosted by the expanding railroad and canal systems, which granted businesses access to once-remote western Pennsylvania.

The Ohio Basin was a major source of bituminous, or soft coal, and iron ore. The Cambria Iron Works at Johnstown was established in 1854 and, by the end of the Civil War, it was one of the largest iron mills in the country. Pittsburgh's industry and commerce flourished throughout the nineteenth century. Gristmills, printing shops, manufacturing establishments, shipbuilders, glassworks and the iron industry grew vigorously in the Pittsburgh area. At one time, Pittsburgh produced more than one quarter of all the steel made in the entire world.

The manufacture of steel and iron products was the largest single industry in the Ohio Region. Pennsylvania's steel industry furnished the rails for the nation's railways, the steel for its modern cities, and arms for national defense. The success of the region's steel industry was supported in part by a strip of land, 50 miles long and no more than three miles wide, in Westmoreland and Fayette counties. This area provided a seven foot thick seam of high-quality coal that could be baked into coke, a valuable industrial fuel used in blast furnaces to smelt iron ore into molten pig iron, the raw material used in steel production. In the early 1900s, 38,000 Connellsville-area ovens provided nearly half of the entire nation's supply of metallurgical coke.

After World War II, the aluminum industry also grew in western Pennsylvania with the emergence of the giant Alcoa Corp. George Westinghouse's air brake, patented in 1869, revolutionized railroading and was followed by many other inventions including signals, switches, and other safety features for trains. His Union Switch and Signal Co. was formed in Pittsburgh in 1882. The Pennsylvania steel industry declined in the 1960s as smaller mills in southern states, the Great Lakes region, and the Midwest emerged. In 1995 Pennsylvania still produced more than 9 million short tons of raw steel, which was 8.66 percent of the nation's total production.

Although never a large part of the economy of the region, agriculture was still important. Early settlers farmed out of necessity for their own subsistence. They grew corn, wheat, oats, barley, rye, buckwheat, flax and hemp. Fruit trees, including apple, cherry and peach were also common. Livestock was equally important, and most farmers had pigs, cattle and horses, while some raised sheep for their wool. Early farmers who had surplus products to sell usually found it easiest to send them down the Ohio River for sale in major cities

Allegheny National Forest

Covering nearly 500,000 acres of land in northwestern Pennsylvania, the Allegheny National Forest has a rich history and has provided various resources over the years. The forest headquarters is located in Warren, Pennsylvania with ranger stations located in Marienville and Bradford. The Allegheny National Forest was established in 1923.

A significant feature of the forest is its location in the state's oil and gas region. Oil from Pennsylvania is sought after for its lubricating traits, which can be attributed to its paraffin content. Historically, 17 percent of the Pennsylvania's total crude oil was produced within the forest's boundaries.

Timbering in the region proved to be a great asset to the state in the early years of industry. While the wood from the forests was first used for cabins and barns, it was quickly desired for various commercial uses as well. Large saw mills were built in the forest and by the 1930s, nearly every tree in the forest was removed. Soon thereafter, the U.S. Forest Service began replanting and

managing the forest to ensure its preservation.

Recreational activities including hunting and fishing are large attractions in the forest. The Allegheny Reservoir and Kinzua Dam were completed in 1965, allowing for an increase in water activities. The growth of interest in the forest allowed for the development of campgrounds, hiking trails, beaches, ATV trails and various other attractions.



Allegheny National Forest, Warren County.

Land Use: Past and Present, continued

like New Orleans. By the mid-nineteenth century, industrial development became the dominant force in the economy of the region and the majority of agriculture in the region began to focus on livestock and dairying with few exportable vegetable crops.

Land Use in the Ohio Region Today

As the pie chart below indicates, 63 percent of the land area consists of forestlands. Deciduous species make up the majority of the forest types throughout the region. Pasture and hay are a substantial part of the agricultural sector. Developed areas are concentrated around Pittsburgh and its surrounding communities.

The Land Cover Map on page 69 shows the various land uses and vegetative cover across the Ohio Region. Definitions for the land use categories used in the Land Cover Map are as follows:

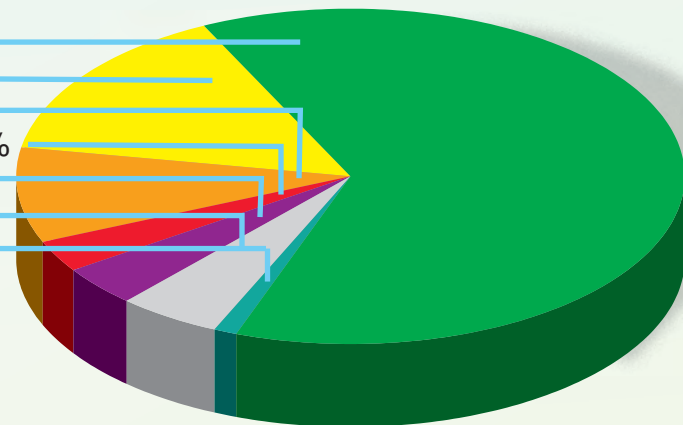
Development

Approximately 7 percent of the land in the Ohio Region is developed for residential, commercial and industrial use. Developed areas are categorized by the amount of land area covered by impervious surfaces:

- Developed, Open Space – less than 20 percent of the area is covered by impervious surfaces, mostly vegetation in the form of lawn grasses (e.g., golf courses, parks, single-family housing units and vegetation planted in developed settings for recreation, erosion control or aesthetic purposes)
- Developed, Low Intensity - 20 to 49 percent of the area is covered by impervious surfaces (e.g., single-family housing units)
- Developed, Medium Intensity – 50 to 79 percent of the area is covered by impervious surfaces (e.g., single-family housing units)
- Developed, High Intensity – 80 to 100 percent of the area is covered by impervious surfaces, where people live and work in high numbers (e.g., apartment complexes, row houses and commercial/industrial areas)

Ohio Region Land Use

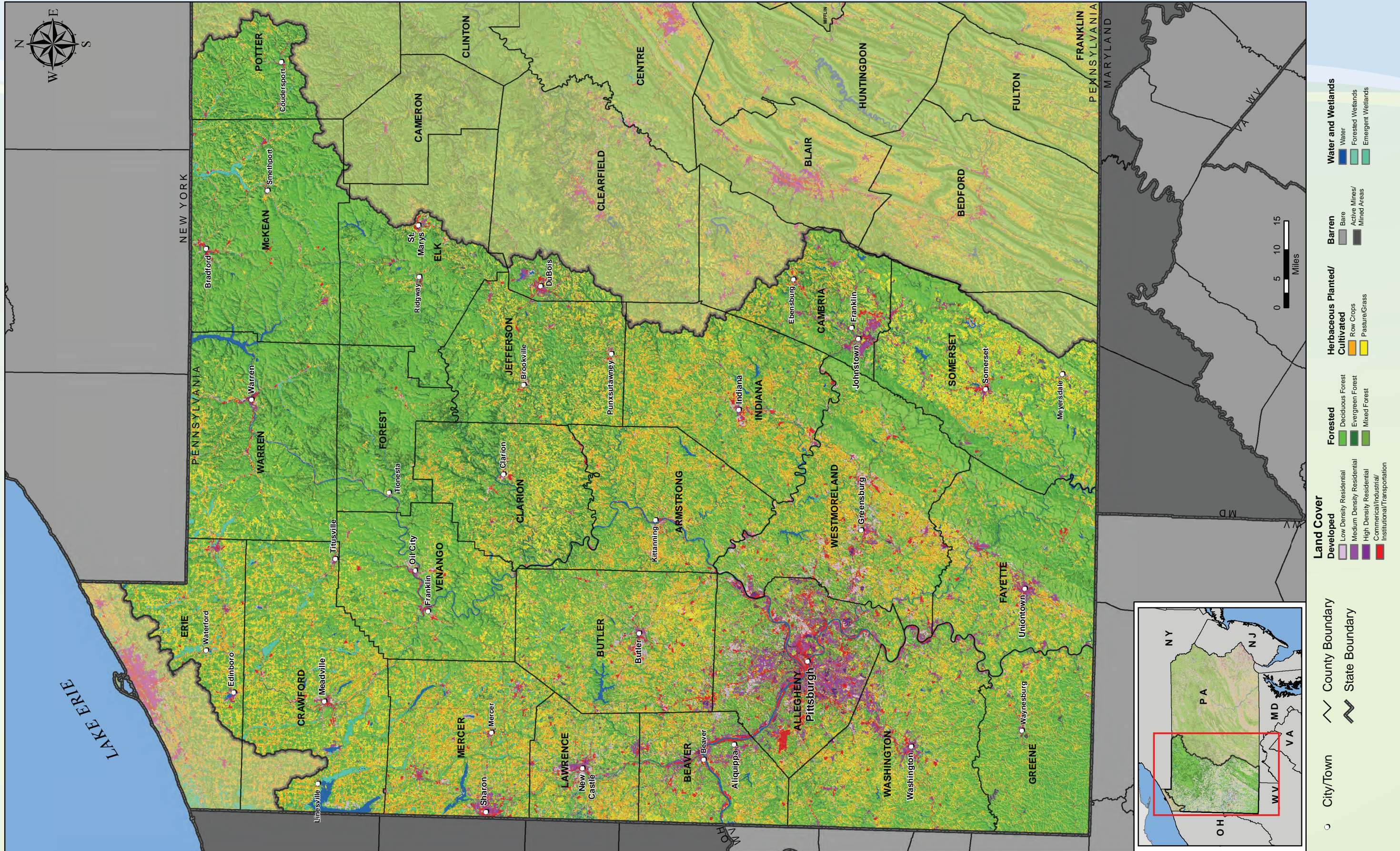
- Forest 63%
- Pasture/Grass 14%
- Row Crops 9%
- Institutional/Industrial/Commercial/Transportation 3%
- Residential 4%
- Bare 5%
- Wetlands 1%
- Water <1%
- Active Mines/Mined Areas <1%



Ohiopyle State Park, Ohiopyle, Fayette County.



Land Cover



Land Use: Past and Present, continued

Forest

A majority of the land in the Ohio Region, 63 percent, is covered by forests. Forest lands are categorized by the type of trees that dominate the area:

- Deciduous Forest – greater than 48 percent of the area is dominated by trees that are taller than 5 meters and shed leaves in the autumn
- Evergreen Forest – greater than 8 percent of the area is dominated by trees taller than 5 meters and maintain their leaves all year round
- Mixed Forest – greater than 7 percent of the area is dominated by trees taller than 5 meters but are not dominated by deciduous or evergreen species

Agriculture

Approximately 23 percent of the land in the Ohio Region is used for farming. Agricultural lands are categorized by the type of crop that is cultivated:

- Pasture/Hay – 14 percent of the agricultural area is covered by grasses and legumes planted for livestock grazing or hay production
- Cultivated Crops – 9 percent of the area is covered by annual crops (e.g., soybeans, vegetables, tobacco, cotton), orchards and vineyards and/or all land that is actively being tilled

Other

Less than seven percent of the land in the Ohio Region is covered by barren lands, open water and wetlands. These areas are categorized by the amount of land covered by vegetation (other than trees) and/or by water:

- Barren Land (Rock/Sand/Clay) – Areas of accumulated earthen material (e.g., bedrock, sand, glacial debris, strip mines, gravel pits) with less than 15 percent vegetation cover
- Open Water – all areas of open water with less than 25 percent of the area covered by vegetation or soil
- Wetlands – areas where the soil is periodically saturated or covered with water and greater than 20 percent of the area is covered with vegetation

Pittsburgh's industrial history undoubtedly affected land development throughout the entire region. Within the city itself, mills and warehouses were constructed on thousands of acres of prime riverfront property while railroad tracks



*Clear Creek State Park in Winter, Jefferson County.
Photo courtesy of DCNR.*

traversed the region as means of transporting the goods produced at these industrial sites. When Pittsburgh's steel industry began to decline in the 1970s and 1980s, the numerous mills, warehouses and railroads were abandoned. In an effort to minimize the amount of open space

converted to developed lands, the Ohio Region has become a model for reusing developed land through brownfield development and rails-to-trails programs.

Miles of railroads that once connected cities and towns of the coal, coke and steel industries became idle after the decline of these industries. Hundreds of these miles in the Ohio Region have been converted to recreational trails used by bikers, hikers and outdoor enthusiasts. The rails-to-trails program not only reuses already developed lands for free recreational activities, but also encourages economic development and environmental improvement efforts in the communities along these trails. New restaurants, retail shops and lodging that cater to tourists visiting these trails help revitalize the economy of communities that suffered when the steel industry declined. Similarly, communities initiate projects involving river restoration, habitat improvement and coal waste and dump site clean-up in order to attract tourists. When completed in its entirety, the Great Allegheny Passage will be a 150-mile hiking and biking trail that connects Pittsburgh to Cumberland, Md. The trail will connect to the C&O Canal Towpath in Cumberland, creating a 316-mile continuous non-

From Brownfield to Technology Center

A brownfield is an industrial or commercial property, abandoned or underused, that is considered for potential redevelopment. Often, these properties are contaminated and require remediation before redevelopment can occur. Brownfield development takes a site viewed as a wasteland and turns it into a viable economic contributor without destroying open space. A prominent brownfield site in the Ohio Region is the Pittsburgh Technology Center along the Monongahela River. Originally the location of a 48-acre mill including coke ovens, blast furnaces, two blooming mills, two billet mills, a strip mill and tar storage tanks, the facilities were abandoned and demolished leaving behind tar pits, 2,000 gallons of waste oil, 420,000 gallons of oily water and soils laden with ferrous iron cyanide. The Urban Redevelopment Authority of Pittsburgh bought the property in 1983 and worked at remediating the contamination as well as excavating the tar pits and tunnels to provide support for the construction of the center. Today, the Pittsburgh Technology Center is a hub of academic and corporate technology research and provides 1,000 jobs and more than \$1 million in tax revenues.

groundwater, and forested areas are often good locations for municipalities to drill high-yield water wells.

Some forests are particularly effective at delivering water quality benefits. Wooded buffers along streams trap sediment and transform nutrients and other pollutants into less harmful forms. For example, properly managed woodlands can remove 90 percent of the nitrates in stormwater runoff given the right soil conditions.

With regard to drinking water, intact forests within wellhead protection areas play a vital role in protecting the amount and quality of water reaching public wells. In developed areas, urban forests are critical to reducing stormwater runoff from small storms.

Forests also protect local waterways by retaining nitrogen in air deposition. An oak/hickory forest retains an average of 90 percent of atmospheric deposition, while a spruce/fir forest retains 78 percent. In general, coniferous forests use less nitrogen than deciduous forests (a factor more of the soils than the tree itself). The exception is the Eastern hemlock forest, which is highly efficient at retaining nitrogen. Forests also sequester, or remove, carbon from the air helping to reduce the impact of carbon dioxide on global warming.

motorized corridor from Pittsburgh to Washington, DC.

How Land Use Affects Water Resources

The various uses of land affect water in different ways, some better than others.

Importance of Forested Areas to Water Supplies

Forested areas are critical to the supply and quality of water resources. Tree canopies and the rich organic matter found in forest floors store, clean and slowly release the majority of water that replenishes groundwater and maintains streamflow. Areas of forested lands are reserves of clean



Cucumber Falls in Ohio State Park. Photo courtesy of Ryan Hale.

Land Use: Past and Present, continued

Allegheny National Forest, Warren County.

Some of the most important forests for water resource protection are the most threatened. Forests are vulnerable to development and other land uses that can fragment high quality forests and expose woodlands to invasive species. Parcelization is another threat – more people own forests than ever before but many own less than 10 acres. As larger tracts of forest land are subdivided, it is important that woodlot owners be educated about sustainable forest management practices.

In addition, efforts to protect woodlands can be misguided and serve to diminish forest health. Under the Municipalities Planning Code, forestry, which includes timber harvesting, is a permitted use by right in all zoning districts. Concerns over forest regeneration and wildlife habitat have led to the adoption of local timber harvesting ordinances that, in some cases, are overly restrictive in prescribing timber harvesting practices. Local governments can benefit from knowledge of state regulations protecting against poor timber harvesting practices and advice from a professional forester when planning and adopting local ordinances.

Agriculture

Farmers usually rely on groundwater wells or springs to provide drinking water for both their families and livestock. Because groundwater is buried beneath the earth's surface, it is sometimes thought

that groundwater is protected from contamination. That is not the case. Activities on the land surface, including improper agricultural practices, can harm groundwater quality. Pollution by nitrate (a form of nitrogen), bacteria and pesticides can cause health problems for human beings and livestock when these contaminants pollute a water supply.

Animal manure, commercial fertilizers and pesticides can also pollute surface waters if they are misused or applied in excess of crop needs. Much of the sediment pollution in streams comes from eroding and unprotected stream banks. Fencing stream banks and limiting livestock access with crossings promotes the establishment of a healthy vegetative cover. Forested vegetation along streams, called riparian forest buffers, helps stabilize stream banks in reducing erosion and collapse. These buffers can also help trap soils and pollutants that may otherwise run off of adjacent fields into the waterways.

Forestland and Farmland Conversion to Developed Land

A map showing future population projections is presented earlier in the Ohio Region

Introduction pages of this atlas. Many older towns and cities throughout Pennsylvania are currently losing population as people continue to settle in suburban and rural housing in areas that were once forest or farmland. During the 1990s, the total number of acres developed in Pennsylvania increased by 53.6 percent, while Pennsylvania's population grew by only 3.4 percent. The aerial photographs on page 73 illustrate the landscape changes that have occurred in the Ohio Region over time. Both photographs were taken west of Pittsburgh, where US-22 and PA-60 intersect. The sparse houses among farm fields and wooded areas



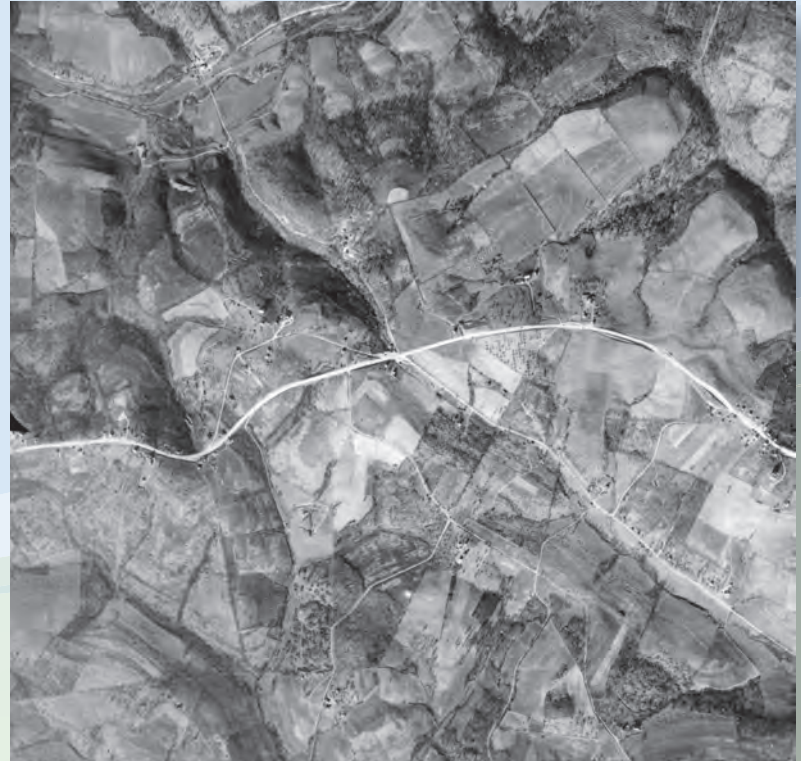
Winter in Seven Springs Resort, Somerset County.

Did you know?

Kane, in McKean County, is nicknamed the Black Cherry Timber Capital of the World.

Autumn in Jefferson County.





Pittsburgh, Intersection of US-22 and PA-60. Right: 1938, Far right: 2006.

of the 1938 photograph have been replaced with malls, restaurants and other commercial properties at the intersection of two multilane highways in the 2006 photograph.

The relationship between development patterns and water resources is complex. Since Pennsylvania recommends a watershed approach to managing water resources, it's critical that the local decision-making framework consider water resources and land uses within the entire watershed area when planning for growth and development.

A watershed approach broadens the geographic planning area beyond political boundaries and extends it to the hydrological boundaries of the watershed. Protecting and managing water resources at the broader watershed scale are likely to require inter-municipal cooperation.

Evaluating the percent of impervious cover in a watershed can be a useful indicator in planning future growth and development. Impervious surfaces, which prevent water from flowing through them and into the groundwater system, include roads, parking lots, rooftops, driveways and sidewalks. The Impervious Cover Map on page 75 shows impervious surfaces based on land use/land cover in the Ohio Region. Areas of impervious cover are centered around cities and towns as well as corridors connecting these locations. Developed lands are more prominent in the western half of the Ohio

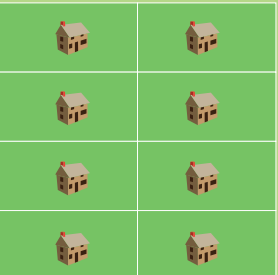

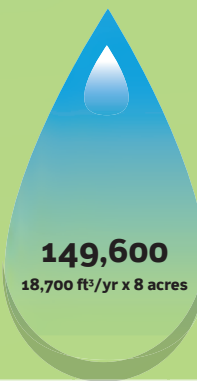


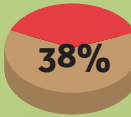



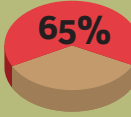


Region, especially in and around Pittsburgh. Of particular interest is the medium density development along the Ohio, Allegheny and Monongahela rivers within Allegheny and Beaver counties.

Research has shown a strong inverse relationship between the percent impervious cover and water quality and stream health. However, the location of impervious cover within a watershed is another variable that needs careful consideration. For example, in an attempt to protect water quality by limiting impervious cover, many local governments have mistakenly applied impervious cover thresholds to individual sites within a watershed by adopting low density zoning districts, thereby encouraging scattered low density development.

Used alone, low density development consumes more land and generates more stormwater runoff than the same number of homes accommodated under a higher density scenario in a given watershed. (See illustration right.) In other words, when measured by the house, higher densities produce less stormwater runoff.

When runoff is measured by the acre, limiting density does minimize water quality impacts compared to higher-density scenarios. However, when measured by the house, higher densities produce less stormwater runoff. (Source: Protecting Water Resources with Higher-Density Development, EPA, 2006)

Average Annual Runoff - Lot Level Comparisons

Density of Houses/Acre	Impervious Cover percent of total area	Total Runoff ft ³ per year	Runoff per House ft ³ per year
 8 houses on 8 acres	 20%	 149,600 <small>18,700 ft³/yr x 8 acres</small>	 18,700
 8 houses on 2 acres	 38%	 49,600 <small>24,800 ft³/yr x 2 acres</small>	 6,200
 8 houses on 1 acre	 65%	 39,600 <small>18,700 ft³/yr x 8 acres</small>	 4,950

Land Use: Past and Present, continued

Higher density development—more people on less land—can effectively protect water resources if it occurs within the framework of a more encompassing watershed strategy that considers other factors, such as the location of old and new development, preservation of critical natural lands, and the use of site-specific stormwater management practices.

In some situations, low density development can be a tool to preserve agricultural and forest lands if it too reflects a watershed strategy and includes such elements as the protection of water supply protection areas, streamside buffers and floodplains, or critical ecological habitats.

When planning for future growth that will be protective of water resources, it's important that local governments use a wide range of land use strategies, based on a sound understanding of local watershed hydrology, assessment of undeveloped lands and local housing and infrastructure needs.

Land Use Planning for Water Resources

Planning for adequate supplies of clean water is just as important as planning for roads, businesses and schools. In recognition of this fact, the Municipalities Planning Code (MPC), the enabling state legislation that empowers local governments to plan and regulate land use, was amended in 2000 to require the inclusion of a plan for the reliable supply of water in the preparation of local comprehensive plans.

Nearly 1,200 municipalities have adopted comprehensive plans to guide future land uses. More importantly, the number of municipalities engaged in cooperative, multi-municipal planning (permitted under the MPC since 2000) is growing – 760 municipalities and counties were involved in 207 multi-municipal comprehensive plans in 2005.

Collaborative planning is essential to sound water use planning since water almost always crosses political boundaries. By planning at a watershed scale, local government leaders can take advantage of the many land use tools that are particularly useful in protecting the long term supply and quality of water.

For example, a multi-municipal approach provides for joint zoning ordinances. Instead of each municipal government providing for every land use, joint zoning allows neighboring governments an opportunity to integrate land uses. A joint overlay zone may protect a wellhead protection area that crosses municipal lines. An agricultural district may make more sense in one municipality where prime farmland dominates, while higher density development can be better accommodated in another municipality where the soils are less productive.

Many more land use planning tools, adopted jointly or individually, are at the disposal of local government officials who recognize the need to protect water resource lands and allow for growth and development. Examples include:

- Effective agricultural zoning
- Transfer of development rights
- Conservation easements on agricultural or forested land (purchased or donated)
- Overlay zones to protect wellhead protection areas, streamside buffers
- Green infrastructure planning
- Conservation subdivision or open space design
- Traditional neighborhood development
- Infill and redevelopment incentives
- Site-level development regulations that reduce impervious cover and infiltrate and/or treat stormwater runoff

All of these land use planning tools are most effective when applied within the framework of local watersheds. It is up to municipal governments to integrate watershed strategies in their comprehensive plans and development regulations in order to truly protect our most precious natural resource – water.

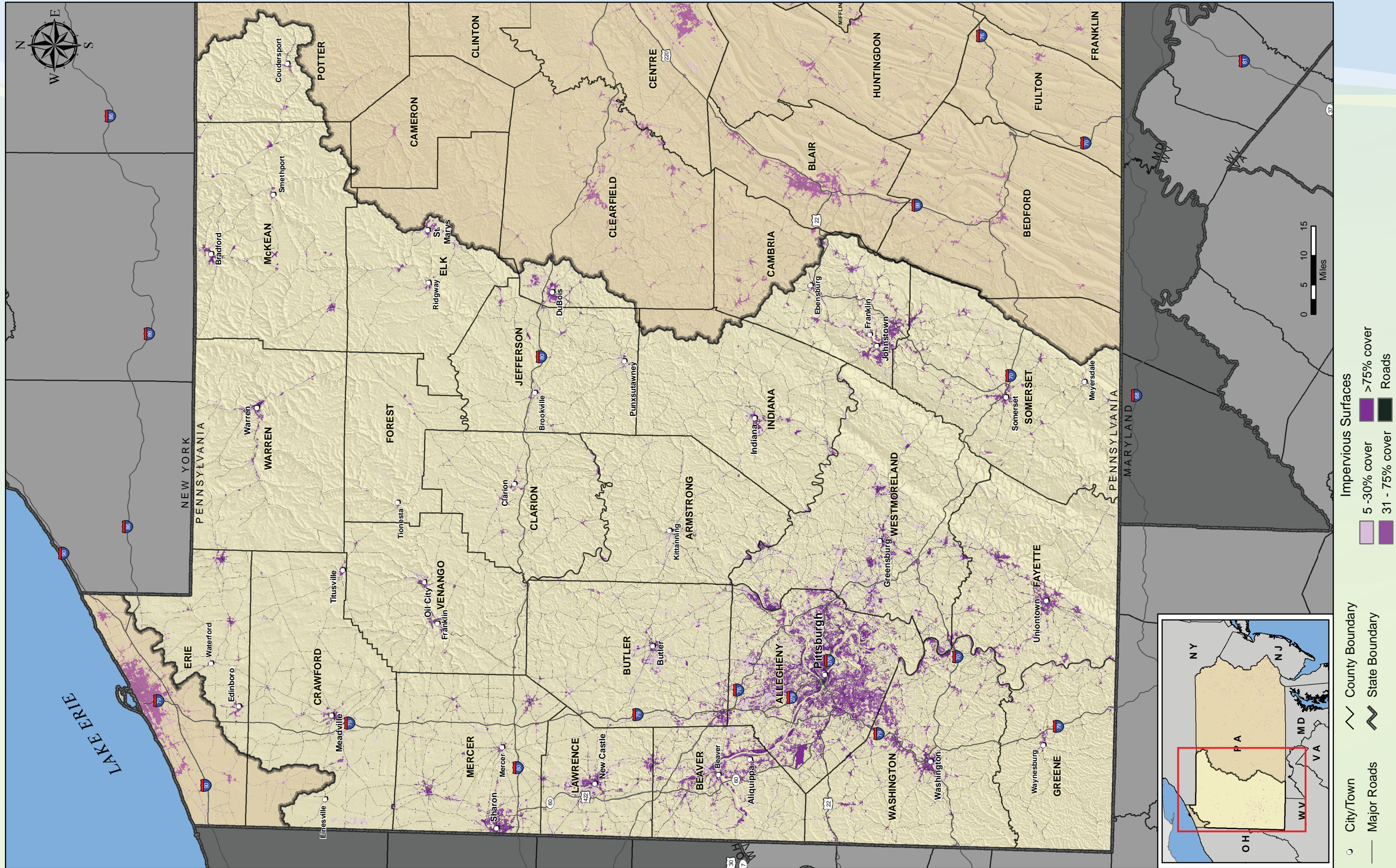
For more information on smart growth techniques, EPA's Protecting Water Resources with Smart Growth provides an excellent overview of how communities have minimized the impacts of new development on water resources through effective planning policies and site-level practices. Visit www.epa.gov/smartgrowth.

Snowmobiling, Warren County Winterfest
Chapman State Park, Clarendon, Warren County.



Point State Park, Pittsburgh.

Impervious Cover



Water Supply and Wastewater Treatment

History of Water Supply and Wastewater Treatment in the Ohio Region

Early settlers found the confluence of the Monongahela and Allegheny rivers a prime area for settlement in the Ohio Region. Settlement in the region was framed by several rivers like the Beaver, Kiskiminetas and Youghiogheny. The area offered abundant freshwater resources, navigable waterways and pristine lands. In 1794, Pittsburgh was organized into a borough and then in 1816 incorporated as a city. Eight years after Pittsburgh's formation as a borough, the first efforts to establish a public water system occurred. The borough's organized effort led to the creation of a 47-foot-deep public well.

Historically, much of the development in the Ohio Region occurred in or around the city of Pittsburgh. The region required new sources of fresh drinking water to supply the growing population. In 1828, the city's waterworks began using a stream pump to distribute water from the Allegheny River and delivered 40,000 gallons per day. The system was small and was eventually replaced in 1844 with an expanded system that was capable of pumping up to 9 million gallons a day.

Over the course of the 19th century several more reservoirs and pumping stations were created

to meet the needs of Pittsburgh and its surrounding communities. By 1878, Pittsburgh's population had grown to 106,000 people and the water supply systems were now pumping more than 15 million gallons per day.



*Ambridge Reservoir, Beaver County.
Photo courtesy of Joe West.*

During the 19th century, river water was pumped to communities without purification. At this time, the only water treatment available was the use of settling reservoirs where solids in the water were allowed to sink to the bottom. Water purification was needed considering the

city and its communities had no wastewater treatment facilities for much of the 19th century. Wastewater was commonly placed in local cesspools or privy vaults with underground containers.

By 1875, Pittsburgh had built about 25 miles of sewer systems that helped direct stormwater but did little to remove wastewater. The Allegheny River by 1900 was heavily polluted with wastewater. Wastewater contaminating the river came from municipal sewers upstream of Pittsburgh, where about 350,000 people resided, as well as from the city itself. Although the Allegheny River received large amounts of untreated

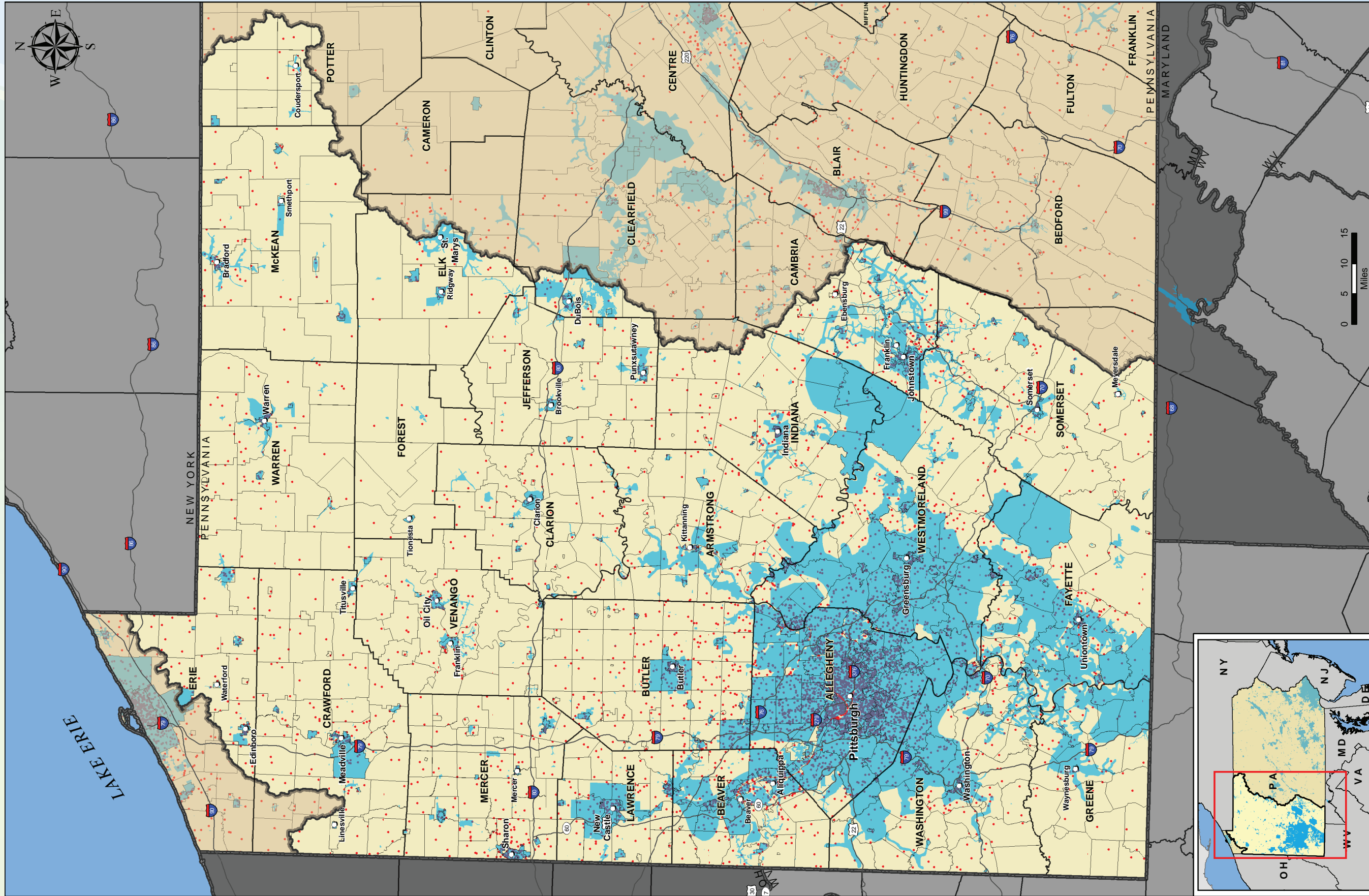
wastewater so too did the Monongahela River which had 47 public sewer outlets along its banks.

In the late 19th and early 20th centuries, Pittsburgh had the highest rate of typhoid fever mortality of any U.S. city. Typhoid fever is a waterborne disease that is commonly the result of poor sanitary conditions. Cholera outbreaks in Pittsburgh were also frequent throughout much of the 19th century. In 1907 Pittsburgh began operating slow sand filtration plants to combat the pollution and outbreaks in the city. Five years later the city began disinfecting its water supply with chlorine. The combination of filtration and disinfection resulted in Pittsburgh's typhoid fever mortality rate dropping to the national large city average.

Pittsburgh was not the only city dealing with typhoid fever outbreaks; the city of Butler also suffered from a severe outbreak. In response to the epidemic in Butler, the Pennsylvania state legislature approved a law that prohibited the discharge of untreated sewage into state streams from new municipal sewer systems.

It would take a half century for Pittsburgh and communities in the region to develop wastewater treatment facilities. The construction of wastewater treatment facilities in the region was a result of changing views about the environment in Pennsylvania. As citizens, conservation groups and government agencies obtained new technology and scientific information, wastewater treatment became part of the solution to restoring water quality in the region.

Public Water Service Areas



- City/Town
- Major Roads
- ▬ Public Water Service Area
- Municipality Boundary
- ▬ County Boundary
- ▬ State Boundary
- Population density for 2000 by municipality
- 1 Dot = 500 People

Water Supply and Wastewater Treatment, continued

Ohio Region Today

It was because of past problems that Pennsylvania has worked hard to help restore the Ohio Region's watersheds to health. Today the Ohio Basin is responsible for supplying more than three million people throughout Pennsylvania with water for drinking, industrial use (such as mining) and commercial use (such as car washes). Pennsylvania alone accounts for 15,614 square miles of the Ohio Region's 203,940 square miles. The commonwealth is home to the confluence of the Monongahela and Allegheny rivers which forms the Ohio River. Along with headwaters to the Ohio River, Pennsylvania's portion of the Ohio Region also contains many groundwater resources, lakes, reservoirs, streams and rivers.

The Public Water Service Areas Map on the previous page depicts population density throughout the Ohio Region in relation to areas served by public water suppliers. Each dot on the map represents 500 people living in the municipality (2000 Census). The dots are randomly placed within the municipality boundaries and do not represent the exact location of people living in a township, town or city. As the map shows, densely populated areas, represented by dots so close together that they form a solid color block, are generally served by public water supplies. In addition to Pittsburgh and surrounding communities, New Castle, Washington, Butler, Johnstown and Meadville also have concentrated service areas. The sources of public water supplies are groundwater, lakes, reservoirs, rivers and streams. Sparsely populated areas, where the dots are farther apart, are not included in the public supply service areas and residents must find private sources of water, such as residential wells that tap into groundwater, to meet their water needs.

For more information on private well water management and protection, visit Penn State's Master Well Owner Network located at mwon.cas.psu.edu/.



Monaca Water-Works, Beaver County. Photo courtesy of Joe West.

Public Water Resources

Groundwater

In the Ohio Region, groundwater is used to supply boroughs and municipalities including Fairchance Borough in Fayette County or Derry Borough in Westmoreland County. Groundwater use for public water supplies can be found elsewhere in the Ohio Region and is largely used in rural areas. Groundwater is particularly abundant in the Allegheny and Ohio river valleys where large sand-and-gravel aquifers exist.

Lakes and Reservoirs

The Ohio Region has lakes and reservoirs that provide drinking water, flood control and recreational use. Lakes throughout the watershed are maintained by state agencies like the Pennsylvania Department of Conservation and Natural Resources (DCNR)

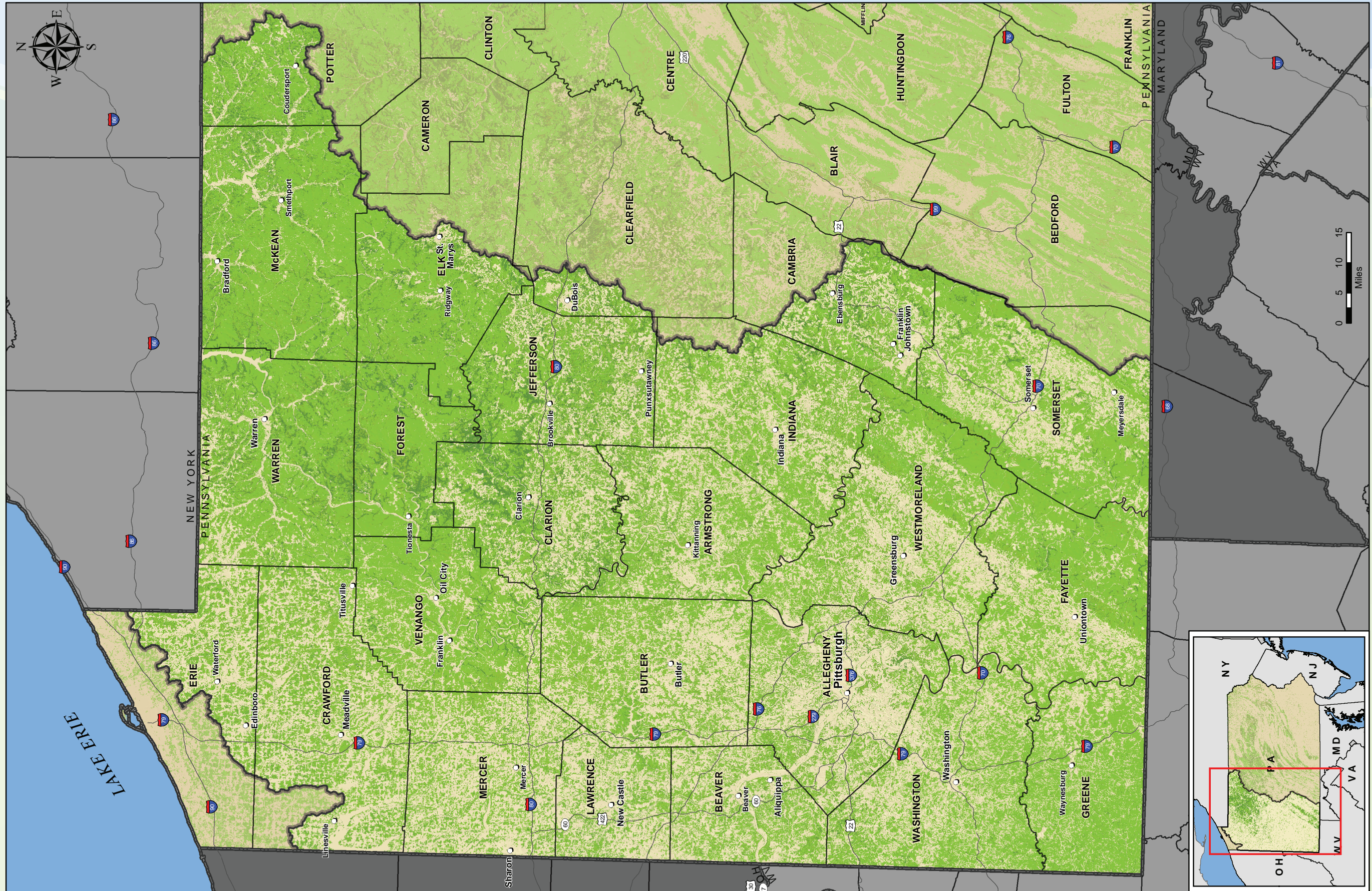
and the Pennsylvania Fish and Boat Commission (FBC), and federal agencies like the Army Corps of Engineers. Lakes such as the 1,860-acre Lake Wilhelm in Mercer County and 562-acre Tamarack Lake in Crawford County are maintained by DCNR and FBC, respectively.

Rivers and Streams

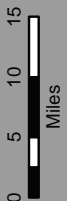
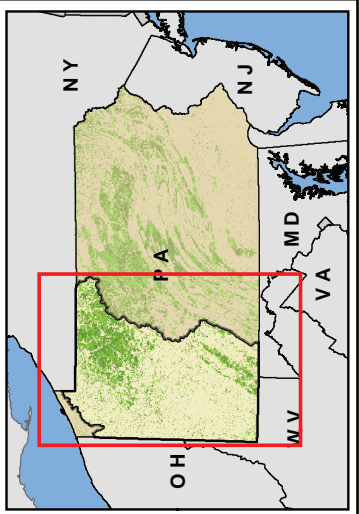
The 15,614 square miles of the Ohio Region contains many streams and rivers that are utilized for water supply and recreation. For example, Shenango River in Mercer County and the Allegheny River in Armstrong County are equipped with public water intakes that supply the city of Sharon and suburbs of Kittanning, respectively. The Monongahela River and Becks Run are used to supply the city of Pittsburgh in Allegheny County.

The Ohio River Valley Sanitation Committee (ORSANCO) is a multi-state commission that works to control and remediate pollution in the Ohio River Basin. For more information on ORSANCO, refer to "Pennsylvania Regulations, Laws, and Public Policy" in the Statewide section of this atlas.

Forested Areas



- City/Town
- Major Roads
- ~ County Boundary
- ~ State Boundary
- Forested Lands**
 - Light Green: Deciduous Forest
 - Medium Green: Mixed Forest
 - Dark Green: Evergreen Forest



Water Supply and Wastewater Treatment, continued

Drinking Water

Like all living organisms, humans need water to survive. Whether a person lives in a single family home in the country or a large metropolitan city, water supplies support daily life. Public drinking water may be supplied by a publicly-owned or privately-owned company while private drinking water is usually supplied by an on-site well. Depending on its source, water supplies may require purification before human consumption. This purification is done to ensure that all harmful materials are extracted or minimized so not to adversely affect human beings.

Public Water Treatment

Water treatment for most urban and suburban centers involves a process of filtration, disinfection and distribution of purified water. The first process in filtration, coagulation, involves adding selected chemicals that stick to

particles in the water and make them heavy. As the particles become heavy they drop to the bottom which is known as precipitation.

Water is then filtered to remove the precipitate. During the filtering process, the water passes through layers of sand, gravel and charcoal that remove even smaller particles. Next, disinfection is accomplished by injecting chlorine or ozone into the filtered water. Chlorine is the most common form of disinfection because it has a residual effect, meaning it will remain in the water through the distribution system. Depending on where the source water to the aquifer comes from, groundwater resources may also require treatment for removal of organics and metals. The final aspect of water treatment is distribution in

For more information on mining BMPs and passive treatment of AMD, see EPA's Coal Remining Best Management Practices Guidance Manual at www.epa.gov/waterscience/guide/coal/manual.

which the treated water is sent through piping systems to homes, businesses and industries or to a storage facility for later use.

Pennsylvania American Water Company disinfects and purifies water from the Monongahela River, Becks Run and Aldrich intakes located south of the city, and supplies drinking water to parts of Allegheny, Washington and Beaver counties, including parts of Pittsburgh. The Pittsburgh Water and Sewer Authority services approximately 83,000 customers throughout the city of Pittsburgh and strives to become a regional water supplier to the greater Pittsburgh area.

Private Well Water Treatment

Rural areas, more common in the northern section of the Ohio Region, extract water from private wells. Homeowners with private wells have a variety of options for filtration and water softening systems that remove mineral particles from well water. The system selected usually depends on the amount of water a private residence uses per day as well as the most common types of contaminants necessary to filter from the water source. Fortunately for most private well users, little treatment is usually needed as a large portion of groundwater is unaffected by contaminants that typically affect surface water. Information on home water systems and contaminants can be obtained from the DEP, EPA, Center for Disease Control, or the National Sanitation Foundation International.

Importance of Forested Areas to Water Supplies

Forested areas are critical to the water supply. Wetlands, vegetated areas and forests along streams act as natural filters of soils and pollutants. The importance of these vegetated areas along streams, known as riparian buffers, is largely overlooked. These areas, along with natural filtration, provide protection from erosion, allow excess water to be reabsorbed, and provide unique habitat to many plants and animals. Forests sequester carbon, helping to reduce the amount of carbon dioxide in the atmosphere. The forested areas that surround many streams and rivers also provide benefits to the waterways. Specifically, hemlocks are common residents of riparian areas that are beneficial by providing habitat and beneficial shade. Their dense canopies provide shade to streams which regulates stream temperatures providing an

Did you know?

Potter County is the home of the God's Country Marathon, beginning in Galeton and finishing in Coudersport. The marathon has been an annual event occurring on the first Saturday in June since 1974.



Seven Springs Resort, Somerset County.

ideal ecosystem for many coldwater inhabitants, including brook trout. The loss of these hemlocks would be detrimental to many aquatic species as well as the species that live in and among the trees. The map on page 79 shows the region's forested areas. The Ohio Region supports hardwood forests, including oak-hickory forests, as well as coniferous (that is, trees that produce cones and have needles such as pine trees) forests, including Eastern hemlock. The Ohio Region is mainly comprised of deciduous (that is, trees with leaves that fall when autumn arrives) forest type, with 49 percent of the regional land cover comprised of deciduous forests and 14 percent comprised of mixed and coniferous forests.

Importance of Abandoned Mines to Water Supplies

Abandoned mines may affect the amount and quality of drinking water available to municipalities. After a mine is abandoned, the shafts and workings may fill up with water, lowering the water table and causing nearby wells to go dry. Acid mine drainage (AMD) is responsible for contaminating 2,500 miles of streams in the commonwealth, rendering them uninhabitable by aquatic wildlife and unable to be used as a drinking water supply. For example, in 1996, there were 14 identified acid mine drainage sites on Quemahoning Creek, degrading its quality for fishing, recreational and public water uses. AMD in the creek forced the village of Jenners in Jenner Township to buy water from another company and increased the costs the city of Johnstown spent on water treatment for the Quemahoning Reservoir, its source of drinking water. Since then, several clean-up projects along Quemahoning Creek, including AMD wetlands, have restored fishing on part of the creek—which had not been fished for almost 100 years—and has improved the quality of the reservoir, enhancing its uses for recreation and as a public water supply.

AMD is a major environmental concern of the mining industry. AMD is formed from a reaction between a sulfide mineral—such as pyrite found in mine spoils—oxygen and water. The reaction causes metal ions to be released into water, which increases its acidity. Best management practices (BMPs) to address acid mine drainage usually consist of abatement, remediation and/or preventive procedures established during active mining operations. The main goal of a BMP for mining is to limit one of the three factors that cause AMD, either through hydrologic and sediment controls, geochemical practices or operational guidelines. Example BMPs for controlling acid mine drainage include:

- Capping mines with a low-permeability material to prevent surface water from coming into contact with sulfide-containing materials.
- Installing diversion ditches to divert runoff away from disturbed areas.
- Revegetating refuse piles and backfilled mines. The plant roots will hold water and prevent infiltration of surface water, which in turn will limit the amount of water that reacts with sulfide containing material.
- Neutralizing acidic drainage by adding carbonate material in mine backfill.
- Rapid mining and concurrent reclamation to limit the time and surface area that sulfide material is exposed to oxygen.
- Coal refuse reprocessing to glean out remaining coal from old refuse piles. Large refuse piles still exist at historic mining sites which contain coal that could not be extracted using older mining practices. These piles are still producing AMD and because of the high coal content, cannot be revegetated. By utilizing the latest technology to extract remnant coal from these refuse piles, the amount of sulfide material available to produce AMD is decreased and the area can then be regraded and revegetated.

In addition to BMPs, there are passive treatment techniques that can be installed after reclamation to treat acid mine drainage. Passive treatment techniques include constructed wetlands to decrease iron content and acidity of wastewater while increasing pH and open limestone channels and alkalinity-producing diversion wells to neutralize acidic wastewater.

Source Water Protection

Pennsylvania, like all other states in the U.S., is required to ensure that healthy drinking water is available for its citizens through compliance with the Safe Drinking Water Act (for more information visit: www.epa.gov). Other federal and state laws, including the Water Resources Planning Act which prompted the creation of this atlas, lay the groundwork for water planning and protection. (Water laws and regulations are discussed in the Statewide Overview Section of this atlas.)

Since the Ohio Region supplies people with drinking water, protecting these resources has become paramount for the commonwealth. Groundwater, rivers and lakes in the region face potential contamination from a number of sources, such as development, agriculture, malfunctioning septic systems, waste disposal sites and abandoned mines. Pennsylvania state agencies are working with

Ohio Region Public Education Programs

Municipality and community based organizations have become more involved with increasing public awareness on Ohio watershed issues. More information can be found through the DEP or through the Water Resource Education Network.

- The Greene County Watershed Alliance partnered with several organizations including the Wheeling Creek Watershed Conservancy to create and distribute education materials, including a Web site, on the Ohio River Basin.
- Chartiers Creek Watershed Association in Washington County worked with other organizations to develop educational materials on the Upper Chartiers Creek Watershed. The educational materials created were based on their River Conservation Plan.
- Shenango River Watchers Inc., located in Mercer County, partnered with several organizations and universities to create and distribute material on nonpoint source pollution. The partnership distributed door hangers and placemats and also stenciled storm drains in the city of Sharon. This was done to help educate citizens on preventing nonpoint source pollution.
- The Monaca Borough Water Department in Beaver County worked with the Monaca Jr./Sr. High School, St John's the Baptist School and Penn State Cooperative Extension-Beaver County to develop teacher guides on water resource education and water resource protection. The cooperative effort also purchased equipment for classrooms that aid in water resource education.
- The Mountain Watershed Association Inc. in Westmoreland and Fayette counties work with several groups to educate children about protecting the Indian Creek Watershed and their drinking water sources. The partnership looks to actively involve children by mountain biking through the watershed while at the same time educating them.
- The Venango County Conservation District partnered with the Venango County Commissioners, Venango Campus of Clarion University and Oil Creek Chapter of Trout Unlimited to create a conference on the French Creek, Oil Creek and Sandy Creek watersheds. The purpose of the conference was to highlight watershed improvement projects and create educational display materials to raise awareness on nonpoint source pollution.

Water Supply and Wastewater Treatment, continued

organizations in the Ohio Region to help assess the health of surface water and groundwater, identify point and nonpoint sources of pollution, prevent contamination, restore degraded waters, preserve pristine waters, increase public awareness of existing problems, and help the public utilize best management practices.

Although federal and state level agencies are creating new policies, source water protection must literally begin at the source. Local governments – counties and municipalities – have the greatest opportunity to influence the future of Pennsylvania’s water supply. By studying their water sources, identifying areas of concern or hazards that threaten those sources, developing water protection and conservation regulations, and implementing those regulations, local governments can protect water supplies for future generations. Many Pennsylvania counties in the Ohio Region are rising to this challenge.

- The Greene County Conservation District through the DEP’s Growing Greener Grant helped form the Greene County Watershed Alliance. This alliance works to increase public awareness on watershed issues in the county, promote sustainable water and land use, and help develop grassroots watershed organizations.
- The Beaver County Conservation District owns and maintains an environmental center along with an 18-acre mitigated wetlands site. The mitigated wetlands are comprised of two ponds connected by a channel and are open to the public. The environmental center offers student programs that explore stream ecology, watersheds, aquatic habitats and more.
- The Lawrence County Conservation District has created a watershed management plan. The watershed management plan focuses on providing and assisting organizations with information on watersheds as well as improving surface and groundwater resources. Some areas of focus in the watershed management program are riparian buffers, structural and nonstructural best management practices, and land use connections to point and nonpoint source pollution.
- The McKean County Conservation District has developed a strategic plan that focuses on maintaining and improving water resources. The

conservation district’s strategic plan also focuses on maintaining and improving county soil resources. The McKean County Conservation District’s plan utilizes resources in the erosion and sediment control programs as well as nutrient management programs.

- The Venango County Conservation District recently sponsored a Pennsylvania Growing Greener Grant for the Cooperstown Borough Council. The grant went toward a stream bank stabilization project in which 450 feet of stream bank along Lake Creek was stabilized and planted with a vegetative buffer. The project was completed by the Borough of Cooperstown along with several local organizations.

Wastewater Treatment

Long before mankind appeared on the earth, natural biological processes had already found a means to deal with waste in streams. Once human beings began to evolve, they created small communities, towns and cities. As these population centers grew larger so did the amount of wastewater being generated by mankind. Natural biological processes were easily overwhelmed by humankind’s high outputs of wastewater.

It was not uncommon for older cities to fall victim to outbreaks of disease caused by pathogenic viral, bacterial or protozoan organisms from untreated wastewater contaminating drinking water supplies. This was exemplified in 19th century London England’s outbreaks of cholera that contaminated drinking water supplies and resulted in many deaths. It was because of harmful outbreaks like that in 19th century London that biologists, scientists and engineers developed methods for the treatment of wastewater.

When water leaves a private residence or business through a drain or toilet it travels to a septic tank or wastewater treatment facility. Wastewater treatment facilities follow a series of processes that screen, aerate and disinfect water before discharging it back into a stream or river or back into the groundwater supplies. The treatment process starts by screening any large debris from wastewater. The screened water is then aerated, which allows for natural biological processes to decay organic matter. Any material

left in the tanks is then extracted and disposed of appropriately. The water is then disinfected, usually with chlorine, to kill any microorganisms that may be harmful to streams and rivers.

Public Wastewater Treatment

Pennsylvania has learned from history that discharging untreated sewage or industrial waste into the rivers and streams can have devastating results for its inhabitants and the natural environment. Just as high volume water purification facilities are needed to service urban centers and cities, so too are wastewater treatment facilities needed.

In the Ohio Region, for example, the Allegheny County Sanitation Authority collects, treats and disposes of wastewater for 320,000 residential, commercial and industrial locations in the city of Pittsburgh and 82 neighboring municipalities in Allegheny, Washington and Westmoreland counties.

Private Wastewater Treatment

Private residences in some suburban and most rural areas of the Ohio Region commonly use private septic systems. Typical private septic systems allow for wastewater to flow to an underground tank. Once in the tank, heavy particles fall to the bottom while water can flow out of the top of a tank and into a drain field pipe. Once in the drain field pipe the remaining wastewater is dispersed into a drain field where it slowly permeates down through the soil. Unfortunately, malfunctioning on-lot septic systems can be a significant source of groundwater pollution in these rural communities. DEP is continually researching innovative technology that aids in the most effective way to reduce pollution from private septic systems.

For more information on the latest technology, see www.depweb.state.pa.us under “DEP Programs-Wastewater Information.”

Water-Based Economy

Pittsburgh was once the center of the American steel industry. Although it is still called “The Steel City,” steel mills have been replaced with the medical, education and tourism sectors. Regional manufactured products include: metal (fabricated products and primary), glass products, machinery, food, medical equipment, chemicals, plastics, electronics,

software and robotics. The Ohio, Allegheny and Monongahela rivers and their tributaries are important to the economic vitality of the region for their support of transportation, power generation, agriculture and recreation. In addition, a clean, abundant water supply encourages new industries to establish themselves in the region, thereby boosting the economy.

Transportation

The Port of Pittsburgh is the second busiest inland port in the U.S. Approximately 44 million tons of coal, sand, gravel, iron ore, manufactured goods, petroleum products and chemicals pass through the port every year, contributing more than \$873 million in revenue

for the region. The Pittsburgh Port District includes 200 miles of commercially navigable waterways, 10 western Pennsylvania counties, and more than 200 river terminals. The port serves as a gateway to 24 states along 8,000 miles of navigable waters and fosters foreign trade through international sister port agreements with the cities of Duisburg, Germany and Monterrey, Mexico.



Fall Foliage, Cooksburg, Clarion County.

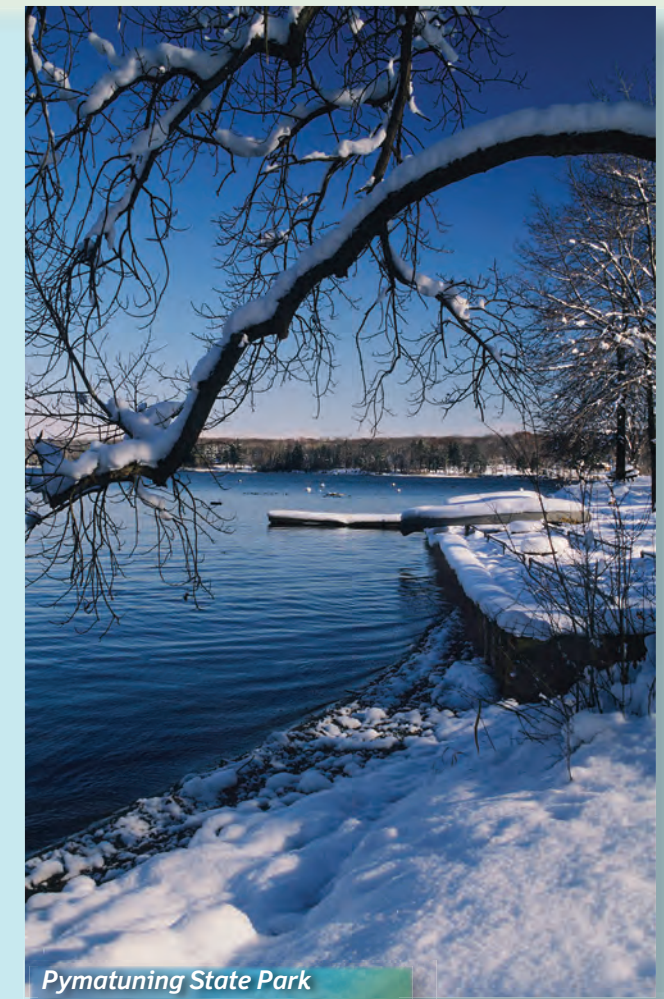
Pymatuning Lake

Located on the border of Pennsylvania and Ohio, Pymatuning Lake is a huge attraction for fishing and other outdoor pursuits. Pymatuning, a term meaning “the crooked-mouthed man’s dwelling place” in the Native American language surrounding the lake, was manmade and was once an area rich in wetland habitats. In 1933 a dam was created to regulate the flow of the Shenango and Beaver rivers, impounding Pymatuning Reservoir. The lake is enclosed in Pymatuning State Park, which is the largest in the state.

Anglers are attracted to Pymatuning Lake for its fantastic walleye fishing. Walleye can be found in the lake year round, and ice fishing is particularly popular in the winter months.

A fish hatchery run by the Pennsylvania Fish and Boat Commission is on-site in the park.

In addition to fishing and other water sports, camping is a popular attraction around the lake and with its three campgrounds, Pymatuning State Park has the most camping facilities in the Pennsylvania state park system. Also, cold weather activities including cross country skiing, ice skating and snowmobiling can be enjoyed in winter.



*Pymatuning State Park
Jamestown, Crawford County.*

Water-Based Economy, continued

Barge transporting coal, Pittsburgh.

Electricity Generation

Power generating facilities of all types—hydroelectric dams, nuclear power plants and coal-fired steam generation facilities—are important contributors to the economy of the Ohio Region. In 2007, the U.S. Department of Energy released a list of the 100 largest electricity plants, based on generation amounts, in the country. Ten nuclear and coal-fired Pennsylvania plants ranked on this list, half of which are located in the Ohio Region.

Beaver Valley, located in Beaver County, is the only nuclear power plant in the Ohio Region. The facility consists of two light water reactors that generate almost 14 million megawatt-hours of electricity, or 18 percent of the state's nuclear generation. Owned and operated by First Energy Nuclear Operating Corp., the first reactor was constructed in 1976 and the second reactor was constructed in 1987.

Energy Sources of the Ohio Region

The power and energy industry in western Pennsylvania is dominated by Allegheny Energy and Duquesne Light Holdings. The two companies compete for users in the Pittsburgh area: Duquesne Light is more concentrated to southwestern Pennsylvania, and Allegheny Energy provides service all throughout western Pennsylvania, along with sectors of Maryland, West Virginia, and Virginia.

Allegheny Energy is based in Greensburg and is the region's biggest energy supplier, providing power to more than 1.5 million customers. The company has a generating capacity of 9,670 megawatts of power, most of which is produced from burning coal. Allegheny Energy is investor-owned

and yields more than \$3 billion in annual revenues.

Based in Pittsburgh, Duquesne Light Holdings is comprised of an array of subsidiaries, with its primary company being Duquesne Light. Duquesne Light provides energy to about a half million customers in Pennsylvania and has been innovative in the power industry. Namely, Duquesne Light was the first to install a plant-wide scrubber system to improve environmental air quality. Also, it was the first plant in the nation to operate a nuclear power station. Like Allegheny Energy, Duquesne Light produces the majority of its power via coal plants, but is considering expanding its energy portfolio.

The Ohio Region contains several coal-fired power plants, most of which are located in the southern half of the basin—including Beaver, Indiana, Armstrong and Fayette counties.

- The Bruce Mansfield Plant is the largest coal-fired plant in Pennsylvania, based on electricity generation. Located along the Ohio River in Beaver County, the facility consists of three units built between 1976 and 1980, and generates more than 18 million megawatt-hours of electricity.
- The Homer City Generating Station in Indiana County consists of three units built between 1969 and



- 1977. The 13.5 million megawatt-hours of electricity the plant generates supports the needs of 2 million households in the Pennsylvania, New Jersey and Maryland Power Pool and can provide power to the New York Power Pool.
- The Keystone Steam Electric Station in Armstrong and Indiana counties consists of two coal-fired, steam-electric generation units that were built between 1967 and 1968 and produce a combined 13.5 million megawatt-hours of electricity.
- The Conemaugh Generating Station is located along the Conemaugh River in Indiana County. The facility's two steam turbines built between 1970 and 1971 generate almost 13 million megawatt-hours—enough electricity to light 17 million 100-watt bulbs. Multiple hydroelectric dams are located on waterways in the region, including the Allegheny River, Beaver River, Conemaugh River and Youghiogheny River. Two of the larger facilities are Kinzua Dam and Youghiogheny River Lake.
- The construction of the Kinzua Dam (Warren County) on the Allegheny River in the 1960s created one of the largest dams in the U.S. east of the Mississippi River and the deepest lake, the Allegheny Reservoir, in Pennsylvania. The hydroelectric plant associated with the dam is operated by First Energy Corp. and has a peak capacity of 400 megawatt-hours.

Port of Pittsburgh Commission

The Port of Pittsburgh Commission was created in 1992 to support the current industry and future growth of Pittsburgh and southwestern Pennsylvania. The commission's dedication to the Pittsburgh area, as stated in their mission statement, is to ensure the "...intermodal future of the residents and industries of southwestern Pennsylvania."

Currently, the Port of Pittsburgh Commission supports eight regional barge carriers and seven long-haul barge carriers. They also support a number of marine maintenance operations that offer a wide variety of services including welding repair and tug boat services.

The commission also integrates other modes of transportation to support water-based transportation including 15 rail service providers.

Along with industrial services, the commission also supports an extensive range of recreational opportunities for local citizens and weekend warriors. Opportunities include river cruises and excursions onboard The Gateway Clipper Fleet and exploring the Great Allegheny Passage.

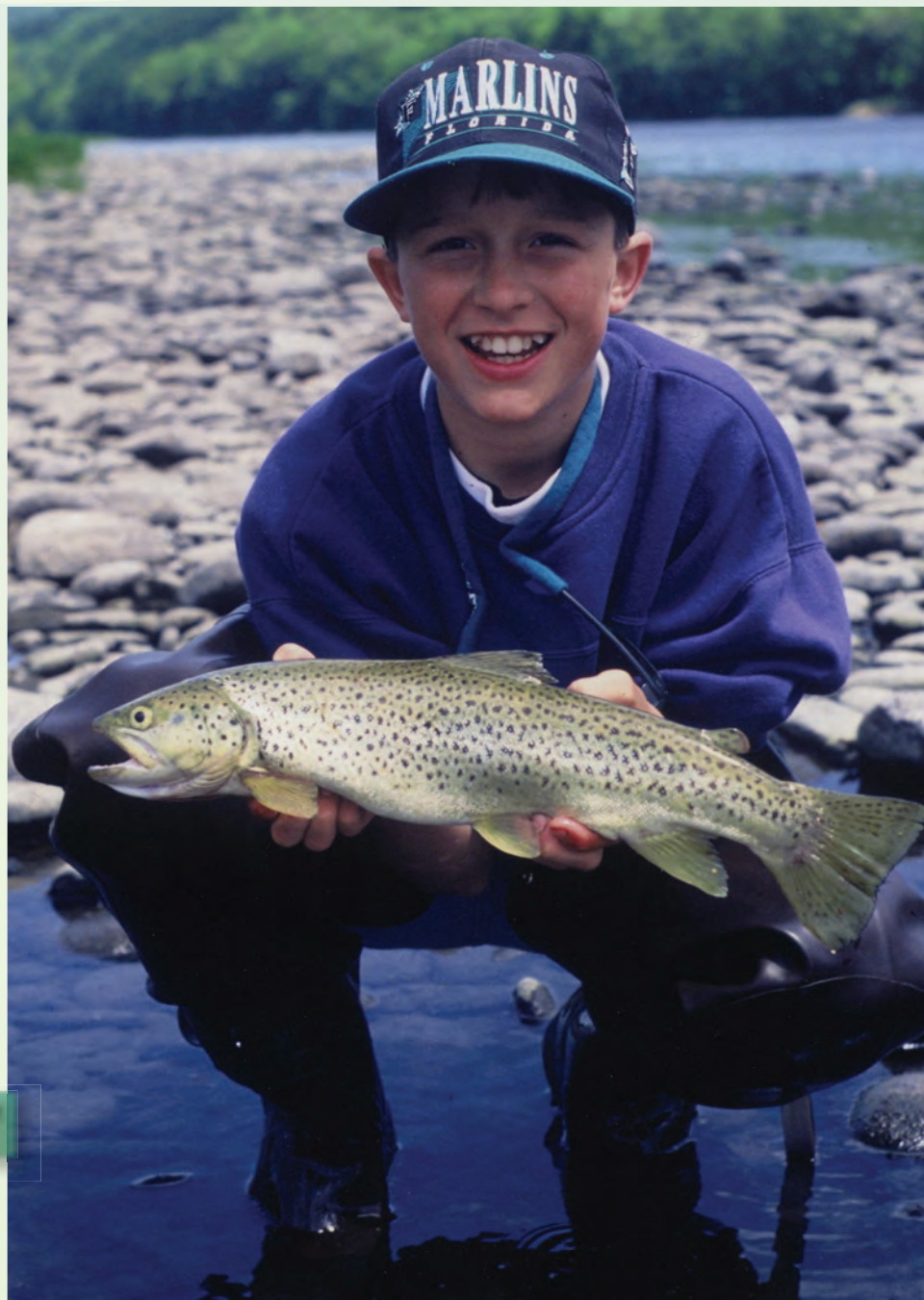


- A dam constructed in 1943 along the Youghiogheny River (Somerset County) created the Youghiogheny River Lake which spans the Pennsylvania-Maryland border. The D/R Hydro Co. has operated and maintained the hydroelectric plant since 1989. The dam's electricity capacity is 12 megawatt-hours.

Manufacturing

Manufacturing of steel and other iron ore products are commonly the first to come to mind when discussing the Ohio Region. Steel manufacturing is still a profitable business today in the region. The bulk production of steel and specialty steel products are easily shipped and transported from the region via the Ohio River. The river provides an attractive offer for businesses to locate and manufacture their product near or on the river ports. Some specialty steel products that are produced include numerous alloy products, stainless steel products, and titanium and nickel alloy products.

Other manufacturing enterprises that are located within the Ohio Region are chemical companies. These companies are capable of producing petroleum-based resins for use in rubber goods, plastics, paints and numerous coatings for different products. These companies are constantly monitored by numerous organizations and committees to ensure their compliance with environmental standards. With their close proximity to the Ohio River and smaller tributaries, it is imperative that they follow the proper procedures to prevent contaminating the water resources in and around the region.



Fishing on the Youghiogheny River. Photo courtesy of Brian Hudock.

Agriculture

The Ohio Region produces a wide variety of agricultural products. Some areas, such as Somerset County, are large producers of grain crops. Somerset County, over a two year period between 2005 and 2006, produced the most oats in the state, averaging nearly 550,000 bushels per year. Further north, the Appalachian Plateaus areas of the region are heavily forested, producing the most Christmas trees in the state as well as the country. Indiana County, informally dubbed the Christmas Tree Capital of the World, produces thousands of trees each year. Current statistics show that the county produces nearly 150,000 cut trees a year.

The region also contributes to the overall production of livestock. Currently, Washington County has nearly 9,500 head of sheep, the most in the state. They can be sheered to provide wool for local and non-local textile manufacturers. Although the region as a whole isn't a large producer of dairy products, several counties continually produce milk in excess of 250 million pounds per year.

One woodland agricultural product that many times gets overlooked is maple syrup. Produced from the sap of sugar maples and black maples, pure Pennsylvania maple syrup is an often sought after product valued for its outstanding taste and flavor. Somerset County is currently the largest producer of maple syrup in the state, manufacturing more than 18,000 gallons a year as reported in the 2002 USDA Census of Agriculture.

Fisheries and Hatcheries

Fishing is a major recreational pastime in the commonwealth. In order to maintain a thriving recreational fishing industry, the Pennsylvania Fish and Boat Commission operates 15 state fish hatcheries used to stock Pennsylvania waters. There are four state fish hatcheries in the Ohio Region: Union City, Erie County; Corry, Erie County; Linesville, Crawford County; and Tionesta, Forest County. These hatcheries boost the state's economy by \$61.5 million annually. A few of the species stocked or produced by these hatcheries include: various trout species, fathead minnow, tiger and purebred muskellunge, walleye, saugeye, white and black crappie, channel catfish, small- and large-mouth bass and paddlefish.

Water-Based Economy, continued

Recreational Areas

The Ohio Region is rich in water-based recreational activities that cover the gamut from historical/cultural to outdoor adventure to environmental conservation to just plain fun. Highlights of some of the recreational opportunities within the watershed include:

- The preserved Pennsylvania Canal System presents a window into the economic history of the watershed. Canals were built along waterways that could not be navigated—such as the Conemaugh, Shenango and Monongahela rivers—as a means of delivering goods to inland areas. The canals were used to transport commodities important to the region’s economy at the time, such as coal, coke, iron ore and stone. Today, portions of the canal system have been preserved or restored where visitors can enjoy museums, parks and canal tunnels at various locations along the canals. For instance, Saltsburg Canal Park, located where Loyalhanna Creek joins the Conemaugh River to form the Kiskiminetas River, honors the 105-mile canal system that ran between Johnstown and Pittsburgh and contributed to the development of the Saltsburg area, a leading salt-producer in the U.S. between 1829 and 1863.

Skiing in the Ohio Region

While many people may associate Pennsylvania’s ski resorts with the Poconos of northeastern Pennsylvania, many premier resorts reside in the western half of the state. Within 100 miles of Pittsburgh, there are eight ski resorts, ranging from Boyce Park, where a lift ticket is around \$10 to Seven Springs, a top-rated ski destination on the east coast.

Skiers in the Pittsburgh area looking for a quick day getaway have to look no further than Boyce Park, a county park in Monroeville, Allegheny County. For a very affordable price, winter enthusiasts can enjoy downhill and cross-country skiing, snowtubing and snowboarding. As the only place in the county to offer downhill skiing, its nine ski runs include moguls, halfpipe, Nastar timing runs with gates, jumps and night skiing. A snowboard park offers two quarter pipes, three table top jumps and one of the longest half pipes in Pennsylvania. To warm up from the chilly temperatures, skiers can enjoy a roaring fire and hot refreshments at the Four Seasons Lodge.

Seven Springs is a very popular tourist attraction and was named from the property deed that described it as “a piece of land with seven springs on it.” Today,

Ice Fishing (right), and Ice Golfing, (below) at the Warren County Winterfest Champmans State Park. Clarendon, Warren County.



Skiing at Seven Springs Resort, Champion, Somerset County.



Ohiopyle State Park

Located mainly in Fayette County, Ohiopyle State Park is a shrine of natural beauty, including more than 14 miles of the Youghiogheny River Gorge that flows through the heart of the park. Nature enthusiasts are drawn to the park for its unparalleled whitewaters and rugged trails. Several waterfalls reside in the park and are the focal point for many of Ohiopyle's visitors.

Ohiopyle is derived from the Native American word "ohiophehla" meaning "white, frothy water" and dates back to the days before European settlers populated the area. In the 1800s, the area that is now Ohiopyle State Park was primarily used for lumbering, and many railroads were built around the region to transport the wood. Eventually, the railroads began transporting people to the Ohiopyle area, as word got out to surrounding towns about the park's natural beauty. Tourism flourished in the area, with resorts, hotels, boardwalks and other attractions popping up around the park area. Unfortunately, with the invention of the automobile, many of the visitors opted to explore other places. In the mid-1960s, the area was purchased by the state, the resort attractions were torn down, and the natural beauty was conserved in what is the Ohiopyle State Park today.

Around the park are various observation decks to overlook the gorgeous waterfalls.

Cucumber Falls, Jonathan Run Falls and Ohiopyle Falls are all different in terms of their unique geological formation, and are fascinating to view. Anglers enjoy the Cascades, a waterfall in Meadow Run that has cool, lean waters that are perfect for fishing. Whitewater athletes enjoy the Lower Yough, which begins after the Ohiopyle Falls, and is the busiest whitewater in the eastern United States. The challenging waters continue for a seven mile stretch of the river, and are great for rafters.



*Whitewater rafting
Ohiopyle State Park, Fayette County.*

- The Ohio Region contains numerous state parks that draw visitors looking to enjoy the recreational activities offered: fishing, swimming, kayaking, canoeing, boating, skiing and ice skating to name a few. Among these destinations, the Ohio Region boasts the highest number — eight — of parks designated by DCNR as "20 Must See Pennsylvania State Parks." These must see parks' attractions include the largest state park in the commonwealth (Pymatuning State Park), excellent white water opportunities (Ohiopyle State Park), old growth and mature forests (Cook Forest State Park and Pymatuning State Park), and a National Engineering Landmark (Kinzua Bridge State Park).
- The Allegheny National Forest spans Warren, McKean, Forest and Elk counties and includes 90 miles of shoreline around the Allegheny Reservoir, more than 138 miles of national wild and scenic rivers, and two nationally designated wildernesses. As the only national forest in Pennsylvania, the 513,325 acres are managed for multiple uses such as timber, clean water, wildlife habitat and recreation. Recreational enthusiasts travel to the Allegheny National Forest to take advantage of its 20 campgrounds, six boat launches, seven canoe access sites, four beaches and miles of hiking, cross-country skiing and snowmobiling trails.
- The Erie National Wildlife Refuge in Crawford County offers 8,800 acres of protected land between two sites for recreational enjoyment. Walking trails lead to prime spots for wildlife observation while other activities include fishing, cross-country skiing and snowshoeing.
- The Three Rivers Heritage Trail is a greenway trail around Pittsburgh stretching for 37 miles on both sides of the Allegheny, Monongahela and Ohio rivers. Cyclists, walkers, runners, cross-country skiers and the like enjoy the scenic trails along the waterways. On-going construction intends to incorporate the Three Rivers Heritage Trail with the Great Allegheny Passage, a 150-mile continuous biking and walking trail connecting Pittsburgh to Cumberland, Md. In Cumberland, the Great Allegheny Passage connects to the CandO Towpath which continues to Washington, DC.

Did you know?

The Youghiogheny River is the most floated river in the country.

Water-Based Economy, continued

- The Gateway Clipper Fleet operates five boats offering dinner, entertainment and sightseeing cruises along the three rivers for 2,500 passengers daily.
- Pittsburgh holds the annual Three Rivers Regatta every 4th of July at Point State Park. Land and water activities such as boat races, a bass fishing tournament, dragon boat exhibition, concerts and fireworks bring in visitors that contribute \$69 million to local, county and state economies.
- Stoneycreek Whitewater Park at Greenhouse Park, Somerset County is the first park in a natural river channel east of the Mississippi River. The 300 yards of in-stream whitewater offer two deep areas and both a free-style and slalom course.

For more information on Pennsylvania's Water Trails, see the Pennsylvania Fish and Boat Commission's "Water Trails" Web site: www.fish.state.pa.us/watertrails

Erie National Wildlife Refuge

The Erie National Wildlife Refuge serves as a resting habitat where waterfowl and other migratory birds can nest, feed and reproduce. Additionally, the refuge supports a diverse array of wildlife species in a protected habitat and works to educate the public on wildlife and environmental issues. It is located in Crawford County, Pennsylvania and is broken down into two separate land units. The Sugar Lake Division contains 5,206 acres and is near Guys Mills, Pennsylvania and the Seneca Division contains 3,594 acres and borders French Creek.

A great variety of wild species flock to the various habitats in the Erie National Wildlife Refuge, including 237 species of birds, 47 species of mammals, and 37 species of amphibians and reptiles. White tailed deer, red fox, woodchuck, great blue heron and cuckoo are among the varied animals that frequent the refuge. Migratory waterfowl generally can be found in the refuge from March to April and again from September to November.

The Erie National Wildlife Refuge was established in 1959, and since then has been dedicated an "Important Bird Area" by the National Audubon Society for the diverse habitats that attract so many different birds.



Water Trails

Water trails are recreational corridors suitable for canoes, kayaks and small motorized watercraft. These trails are comprised of access points, boat launches, day use sites and in some cases overnight camping areas. Each water trail is designated by the Pennsylvania Fish and Boat Commission as a unique reflection of the state's diverse geology, ecology and communities.

The Ohio Region includes six water trails:

- Middle Allegheny River Water Trail – 85 miles from Kinzua Dam to Emlenton
- Three Rivers Water Trail (Lower Allegheny River) – 30 miles from Freeport to Pittsburgh
- Youghiogheny River Water Trail – 45 miles from Connellsville to McKeesport
- Upper Monongahela River Trail – 60 miles from Fairmont, WV to Rice's Landing, PA
- Clarion River Water Trail – 100 miles from confluence of East and West Branch Clarion rivers to Parker Bridge
- Kiski-Conemaugh River Water Trail – 50 miles from Johnstown to Freeport

Three Rivers Regatta, Pittsburgh.

