

RARITAN BASIN

Portrait of a Watershed



*Raritan Basin
Watershed Management Project
"Central to New Jersey"*

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- Rutgers Center for Environmental Communication
- South Branch Watershed Association
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- United States Department of Agriculture – Natural Resources Conservation Service
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- Upper Raritan Watershed Association

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Raritan Basin Watershed Management Project

New Jersey Water Supply Authority

Watershed Protection Programs

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A LETTER OF INTRODUCTION

Welcome to the Raritan Basin Watershed Management Project. The Raritan Project officially began in 1999 when the New Jersey Department of Environmental Protection (NJDEP) funded a partnership of government, regional nonprofit groups, academia, and watershed associations to coordinate watershed activities and develop a watershed management plan for the Raritan Basin. The New Jersey Water Supply Authority leads this partnership, which is open to anyone interested in participating. The primary objectives of the project and partnership are to build on past and current successes, to identify ways to improve watershed protection, and to develop a watershed management plan that NJDEP and others can adopt and endorse, with a commitment to effective implementation.

The first priority of the Raritan Project was to characterize and assess the watersheds within the Basin to determine the current status of the environment, and how that status compares to community goals and to adopted standards in New Jersey. The characterization and assessment process determines a baseline condition for the Raritan Basin against which future degradation or improvement can be compared. This document summarizes the seven characterization and assessment technical reports and two background reports and serves as a foundation for public education, issue identification and management plan development. Some of the issues examined by the technical reports include population growth, land use, riparian areas, aquatic habitat, water supply, ground water, surface water quality and pollutant loadings.

Water resources and our understanding of them change -- it will be important for various agencies and organizations to improve upon the Raritan Project characterization and assessment. Even more important, though, is solving existing problems and protecting key resources of the Raritan River Basin. Regardless of the method used, watershed management is our best hope for water resources protection. The Raritan Project has been developing watershed protection goals, objectives, implementation strategies and commitments. Stakeholders are identifying implementation projects that can be put in place immediately. For information about participating in watershed management, please visit our web site at www.raritanbasin.org or NJDEP's watershed planning web site at www.dep.state.nj.us/watershedmgt.

For additional information about the topics covered in this summary report, the technical reports are posted on the project web site. If you have further questions, please call the Watershed Protection Unit of the New Jersey Water Supply Authority at (732) 356-9344 or NJDEP's Watershed Planning Program-Raritan Region Bureau at (609) 633-7020.

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SUMMARY

The Raritan River Basin has many streams that are considered unimpaired and many subwatersheds with a great deal of natural forest cover. Threatened and endangered species find homes in the Basin and regulatory actions over the last thirty years have stayed or reversed some of the worst surface water and ground water pollution problems. New management practices are being adopted by local, County and State government, and implemented voluntarily by some interests, such as farmers. The Raritan Basin faces both challenges and opportunities and its residents and decision-makers must act quickly if the Basin's resources are to be protected. This report was written to help people understand these issues.

The Raritan River Basin includes 1,100 square miles of land that ultimately drain to the Raritan Bay through the Raritan River. The Basin includes large areas of urban, agricultural and forested land, along with significant areas of wetlands. Historic and recent land uses have resulted in the loss or degradation of significant watershed resources, including wetlands, riparian areas (stream corridors), and ecosystems in urban and agricultural areas. Ground water recharge is decreasing due to increased impervious cover such as roads, parking lots and buildings, which in turn reduces the flow in small streams during dry periods. New residential and commercial development in unsewered areas, if poorly planned, can exceed the carrying capacity of watersheds for septic systems and subsurface water supply for domestic wells. Development of septic systems in suburban and rural areas is increasing. Flood damage has occurred through the urbanization of flood plains in areas such as Bound Brook, Manville and South River and may have been exacerbated by poor stormwater management practices over recent decades.



The North and South Branches of the Raritan River join to form the Raritan River

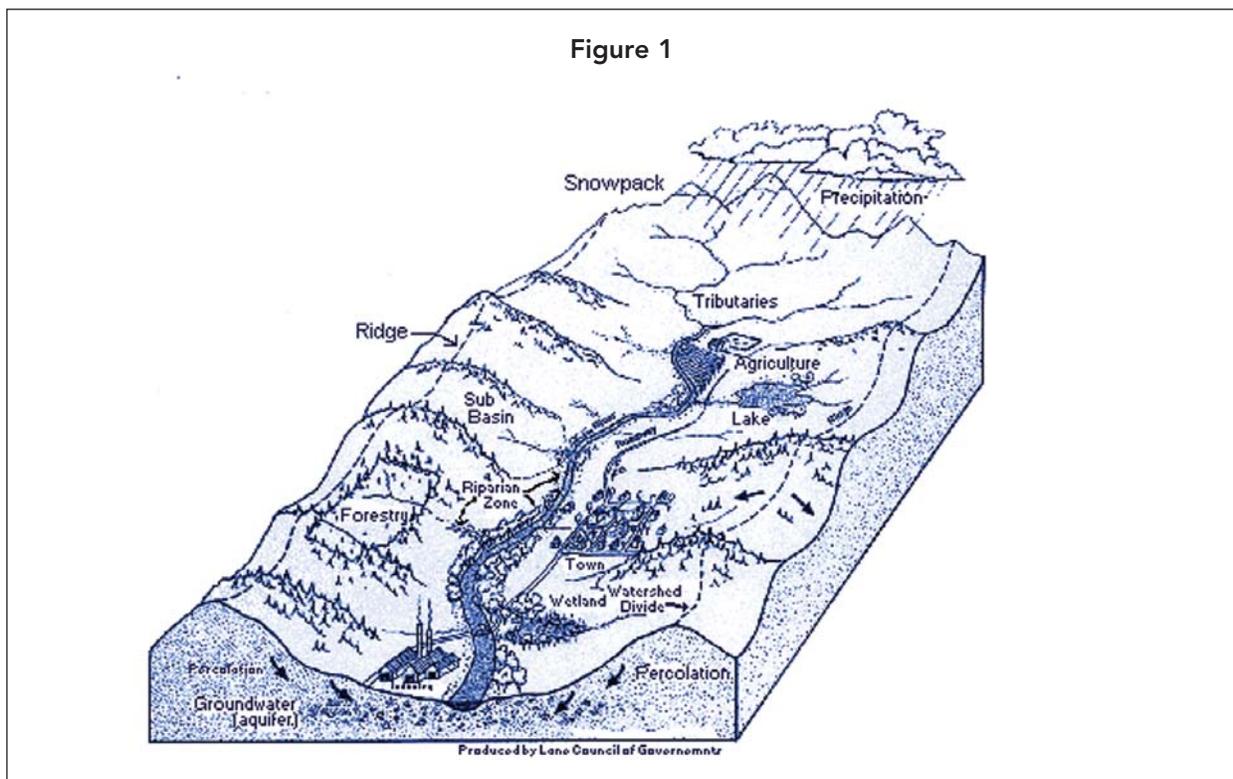
INTRODUCTION

The Raritan Basin Watershed Management Project has produced seven technical and two background reports, written to characterize and assess the condition of the Raritan River Basin. This document summarizes these reports and is formatted as “questions and answers” based on common inquiries from the public. As a summary of the characterization and assessment of the Raritan Basin, this report does not offer solutions to issues, but rather is a collection of findings about the Basin and a foundation for the development of the watershed management plan.

What is a watershed?

A watershed is the land area that drains into a body of water, such as a river, stream, lake or bay. Watersheds for large rivers are called drainage basins and encompass many smaller watersheds. Smaller watersheds are sometimes called catchments or sub-watersheds. Topography (the shape of the land surface) defines the boundaries of a watershed: high points,

such as hills, mountains and slopes, separate different watersheds. Political boundaries, such as city, county and state lines, usually do not coincide with the boundaries of a watershed. Thus, watershed protection activities often require collaboration among jurisdictions. Figure 1 presents a schematic.



A watershed contains all the land area that drains to a single body of water.

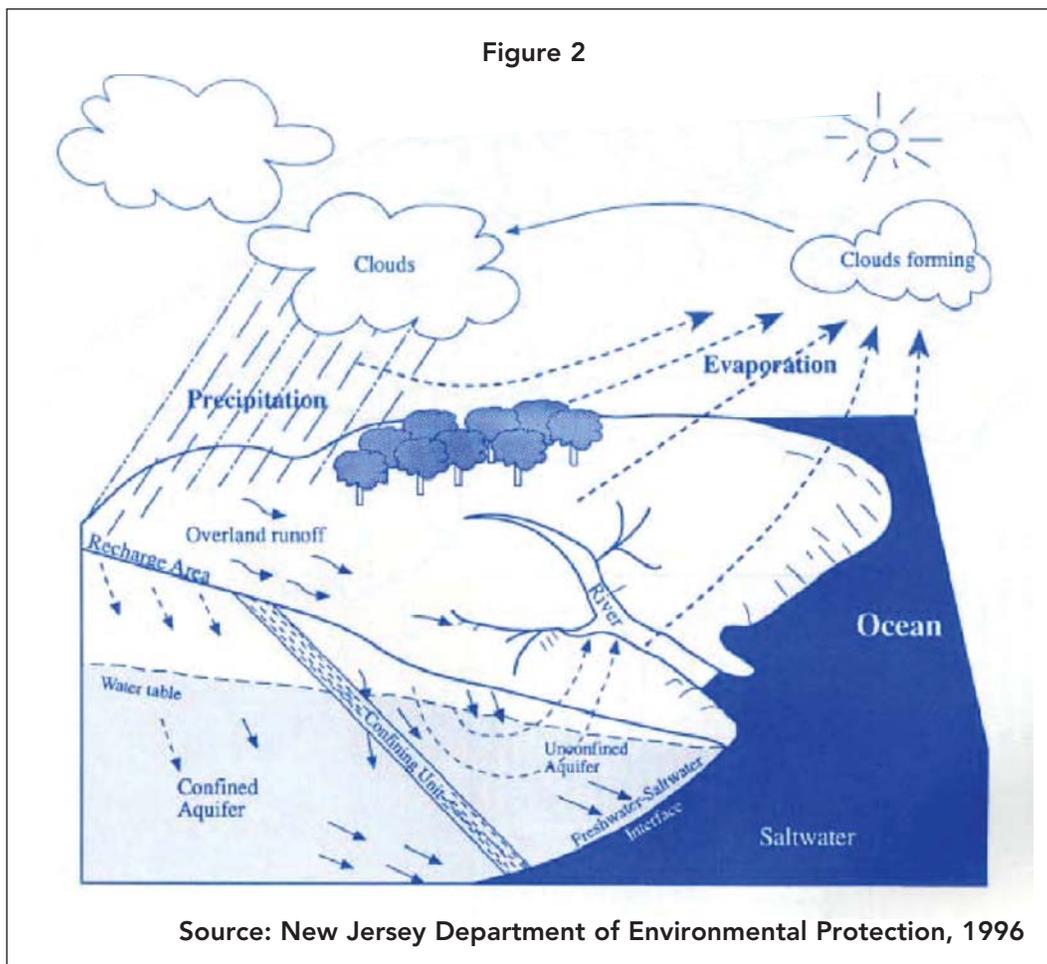
How do watersheds function?

The hydrologic cycle describes how water moves through a watershed. Figure 2 shows a conceptual diagram of the hydrologic cycle. The balance between incoming, outgoing, and stored water remains constant over time. Precipitation is the primary source of incoming water. During and after a rainfall event, the water does one of the following:

- Evapotranspirates (evaporates or is absorbed by vegetation and then released as water vapor);

- Infiltrates (soaks into the ground, becoming ground water); or
- Flows overland into ditches, channels and streams (a process called runoff).

Water that evapotranspirates rises into the atmosphere where it becomes incorporated into the clouds and precipitates. Water that infiltrates soaks into the ground and re-supplies stored ground water. Water that neither evapotranspirates nor infiltrates becomes runoff and flows over land into streams and through the watershed to its exit into another watershed or the ocean.



The hydrologic cycle represents water movement through a watershed and the environment

Raritan Basin: Portrait of a Watershed

Where and what is the Raritan Basin?

The Raritan Basin is the largest river basin located entirely within the State of New Jersey and is the watershed for the Raritan River and its many tributaries. Centrally located in New Jersey, the Raritan Basin is bounded by the Passaic River Basin to the north, by the Delaware River Basin to the west, by the Atlantic Coastal Basin to the South, and by the Hudson River Estuary (including the Arthur Kill area—the Metropolitan Watershed Management Area) to the northeast. The Raritan Basin encompasses 1,100 square miles of land drained by the Raritan River into the Raritan Bay and is just about the size of Rhode Island. Portions of seven counties and 100 municipalities are contained within the Basin. Counties partially or wholly within the Raritan Basin include Hunterdon, Mercer, Middlesex, Monmouth, Morris, Somerset and Union. Figure 3 presents the Raritan Basin with political (municipal and county) boundaries and major roadways.

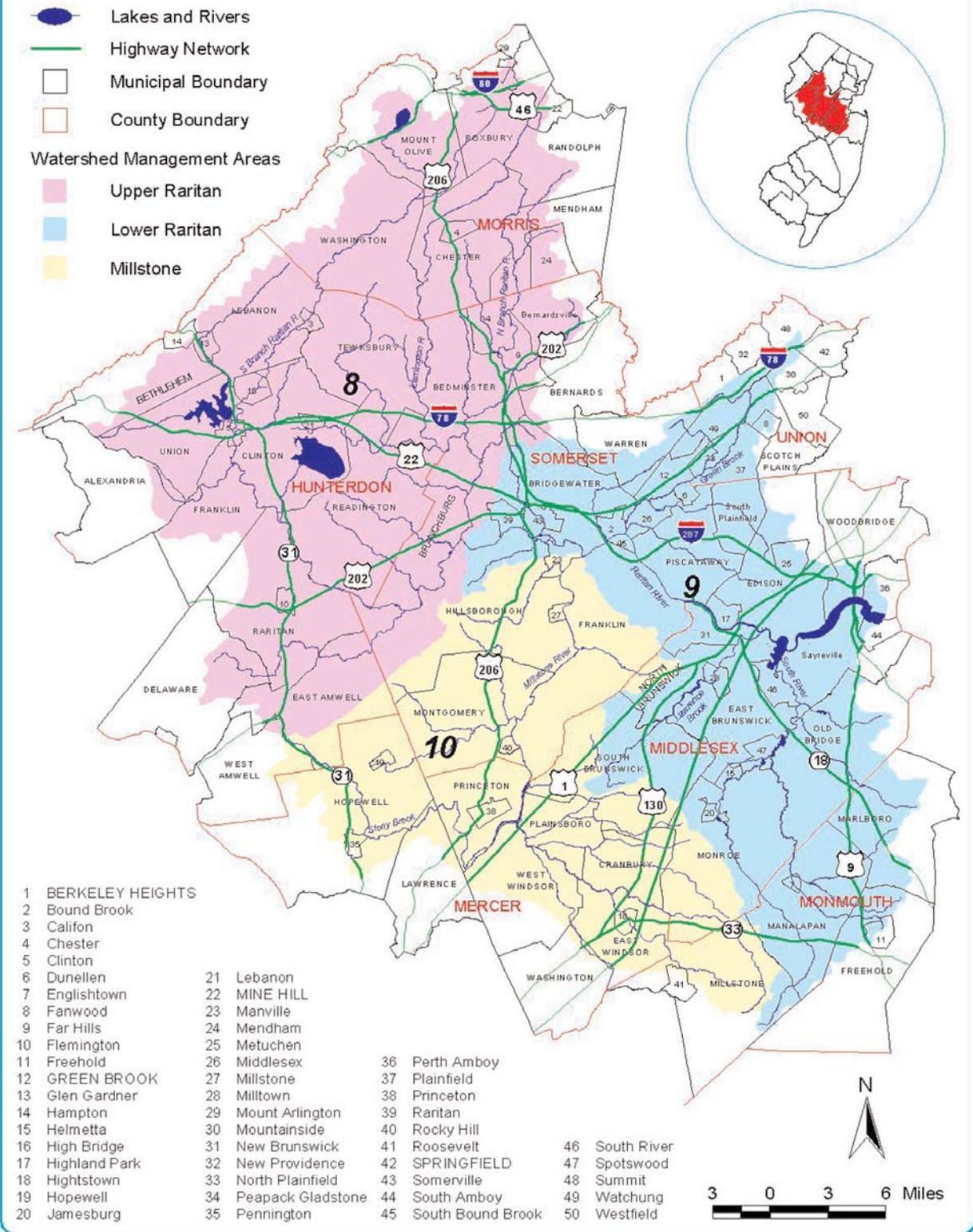
Major waterways within the Raritan Basin include the North and South Branches of the Raritan River, the Millstone River, the Stony Brook, the main Raritan River, Bound Brook, Green Brook, the South River, Lawrence Brook and all of their tributary streams. For planning purposes, New Jersey Department of Environmental Protection (NJDEP) divided the State into five watershed planning regions and twenty watershed management areas. The Raritan Basin contains three Watershed Management Areas (WMAs): the Upper Raritan, containing the North and South Branches of the Raritan River above their confluence; the Lower Raritan, containing the Raritan River, Bound Brook, South

River and Lawrence Brook; and the Millstone, containing the Millstone River and Stony Brook. Figure 3 indicates the three watershed management areas within the Raritan Basin.

The Raritan Basin ranges in elevation from sea level near the Raritan Bay to over 1,400 feet near Budd Lake in Morris County. In the northern portion of the Basin, the topography is steeply sloped with incised stream valleys. In the southern portion of the Basin, the topography is more gently sloped. The difference in topography of the Basin is related to the underlying geology. The surface and bedrock materials of the Raritan Basin reflect three distinct types of geology of the State of New Jersey: the Highlands, Piedmont and Coastal Plain Provinces. The geologic composition of the soil and bedrock materials influences the rate of erosion, soil drainage capabilities, surface water runoff and ground water recharge potential.

The Highlands province in the northwestern portion of the Basin contains soils weathered from eroding bedrock and glacial deposits that are generally shallow and stony with frequent rock outcrops. Highland soils are generally well drained, but some poorly draining soils are found in depressions and along streams. The Piedmont province in the central portion of the Basin contains sedimentary rock and is characterized by gently rolling terrain, dissected by broad winding river valleys. Piedmont soils are known as well drained silty soils formed in weathered red shale; however, areas of shallow, poorly drained soils are found in upland areas. The Coastal Plain province consists of sandy aggregates with a wide variety of

Figure 3



The Raritan River Basin contains part or all of 100 municipalities.

Raritan Basin: Portrait of a Watershed

drainage conditions in the southeastern portion of the Basin. Coastal Plain soils are described as moderately to well drained fine textured sediments with low-lying areas of poor drainage. Figure 4 presents the topography and major landforms of the Raritan Basin.

The geology of the Basin controls the movement and storage of ground water under the land surface. Ground water movement under the Highlands province occurs primarily through the joints, fractures, and bedding planes of the sedimentary rock formations, resulting in poor-yield aquifers. However, some areas of the Highlands are underlain by

limestone formations, which generally are high-yield aquifers due to the holes and channels dissolved by water flowing in the formation. The ground water movement under the Piedmont province flows primarily through the cracks, joints, fractures and bedding planes of the sedimentary rock formations. Thus, aquifers associated with the Piedmont province tend to have limited water movement and relatively poor to moderate yields. The Coastal Plain province contains layers of silt and clay that act to confine the sand units. The sand units allow large storage and the rapid movement of water through the subsurface and create high-yield aquifers.

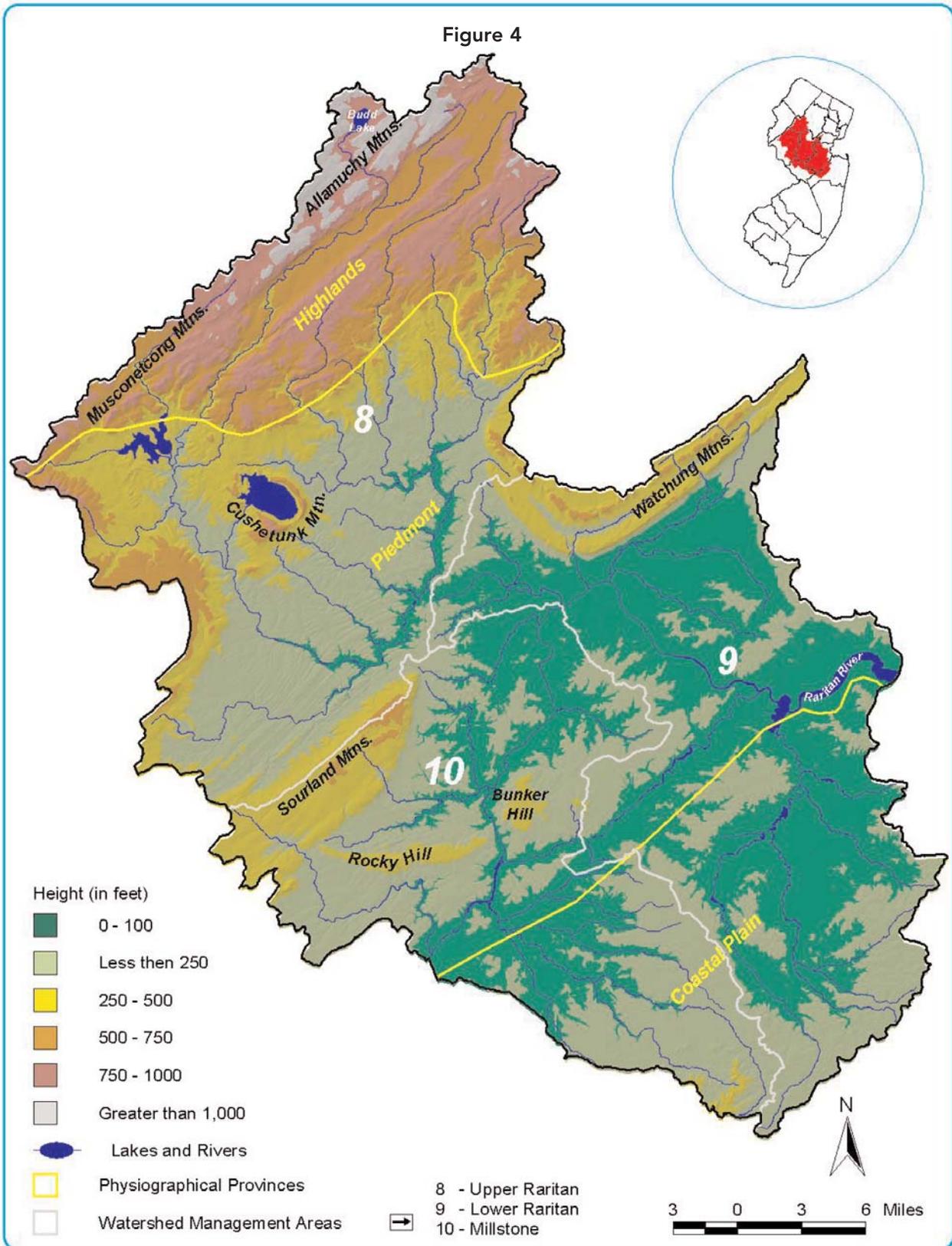
What is important about the Raritan Basin?

The Raritan Basin is where 1.2 million residents of New Jersey live. Not only is the Basin home to people but also is home to thousands of species of plants and animals. The Raritan Basin contains critical wildlife habitat, including grasslands, forests and wetlands. Water provided by the Basin is treated for drinking and used for agriculture and industrial processes. Based on 1995 data, jobs for 600,000 people existed within the seven Counties that comprise the Raritan Basin. In the 1980s, more square footage of office space was built along 13 square miles of the U.S.

“Water provided by the Basin is treated for drinking and used for agriculture and industrial processes.”

Route 1 corridor in the Basin than exists in Indianapolis, the thirteenth largest city in the Country. Considering only locations with water-based recreation, over 200 recreation sites and protected areas have been identified in the Raritan Basin, totaling over 50,000 acres. The Raritan Basin is rich in the history of the nation with early American architecture, Revolutionary War Battlefields in Princeton and Monmouth, preserved Victorian Era homes, Princeton and Rutgers Universities, and the recently restored Flemington Courthouse.

Figure 4



The Raritan Basin ranges in elevation from near sea level to over 1400 feet above sea level

Raritan Basin: Portrait of a Watershed

How have people affected the Raritan Basin?

People have affected the Raritan Basin throughout time by their activities in the watershed, particularly those that disturb the natural landscape. Much of the Raritan Basin remained rural until the 1980s, except for some post World War II suburban development (Old Bridge, Piscataway, Woodbridge) in the Lower Raritan Watershed Management Area.

Early Native American settlers (The Lenni-Lenape Nation) practiced agriculture, but gardening is considered a more accurate term since the plots were small and tilled by hand. The gardens most often were located near villages and on floodplains. Although fields abandoned due to unproductive harvests quickly reverted to their former state, by clearing land, disturbing the soil, and altering the natural vegetation in the floodplains—all activities that make soil more susceptible to erosion—Native Americans were the first to affect the Raritan Basin.

With the introduction of European settlers, much of the forested land was cleared and converted to agricultural production, furthering the effects people had on the Basin by exposing soils to erosion and altering vegetation and habitats. Wheat, rye, potatoes, garden vegetables and fruits gave New Jersey the reputation as a “bread” colony and later the Garden State, further encouraging agricultural development. Agricultural and other products from the Basin required a transportation network for the movement of goods out of the region, allowing farmers to enjoy the close proximity of the large urban markets of Philadelphia and New York.

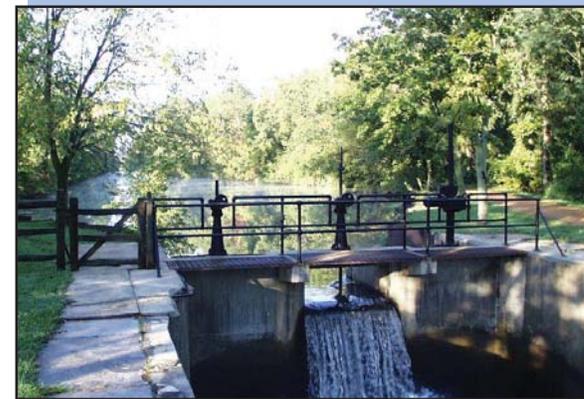
The river, streams and Native American trails that provided the basis of the transportation network in the Basin gradually improved over time. In the early 1800s, the Delaware and Raritan Canal and railroads were built to facilitate such transportation. Later, highways and interstate roadways completed the transportation network. As in areas surrounding most major rivers, industries evolved along the Raritan River, where water provided the power to run grist, saw, paper and textile mills. In addition, iron forging, copper mining, brick and clay production, and whiskey distilling were developed as industries in the Basin. Waste products from these industries were often stored in the flood plain or discharged directly into waterways with no understanding of the environmental consequences.

Many municipalities within the Basin experienced the majority of their housing development after 1980. Between 1986 and 1995 almost 57 square miles of land coverage was converted to urban land use. Almost 42 square miles of agricultural land were lost, as well as over 8 square miles of forested land and 6.6 square miles of wetlands between 1986 and 1995.

“Between 1986 and 1995 almost 57 square miles of land coverage were converted to urban land use.”

Urbanization, the conversion of other land uses to urban land use, results in more impervious surface (roofs, sidewalks, parking lots, roads) in the watershed. Increasing the amount of impervious surface increases the volume of runoff from storm events, speeds the delivery of runoff to a waterway and increases the peak flow, and reduces infiltration to ground water. Figure 5 presents examples of how people have affected the Raritan Basin.

Figure 5



People affect the water resources of the Raritan Basin by adding impervious surfaces, practicing agriculture, and changing the natural course of water (hydromodification and interbasin transfers).

What sources of pollution affect the Raritan Basin?

Water pollution sources generally are classified into two categories: point and non-point sources. Point sources are discharges from a specific location or facility, such as treated wastewater effluent from municipal sewage treatment plants, non-contact cooling water from industrial facilities, and treated process wastewater from manufacturing plants. The New Jersey Pollution Discharge Elimination System (NJPDES) permitting program regulates these discharges and requires that effluent concentrations be below certain

values to maintain water quality in streams. Non-point source pollution is from sources not readily attributable to a specific location or “point”, such as soil erosion, fertilizer runoff, road spills and others. Non-point source pollutants are deposited on the land surface and are washed off by stormwater or moved by ground water, which carries the pollutants into streams, lakes, estuaries and other waterways. Land management, prevention and “good housekeeping” activities are the only means to control non-point source pollution.



Runoff from streets and parking lots affects water quality

WATER BUDGET AND SUPPLY

A water budget is an accounting of the water flowing through the basin and is used to determine the amount of water available for people to use. Precipitation provides the majority of incoming water to the Raritan Basin, over 900 billion gallons per year during an average year of rainfall. This amount of water would fill Round Valley Reservoir (New Jersey's largest) over 16 times. Not all precipitation runs off and becomes stream flow. Generally, over half becomes evapotranspiration. Over one quarter of the water becomes runoff and exits the Basin via streams and rivers into the Raritan Bay. The remaining water infiltrates into the soil, becoming ground water.

People can alter the water budget by moving water from one watershed into another or by pumping ground water to the surface for use as water supply. This process, moving water from one watershed into another, is called an inter-basin transfer. In the Raritan Basin, two major inter-basin transfers of water occur. Water from the Delaware River is brought to the Raritan Basin via the Delaware & Raritan Canal. Water is removed from the Raritan Basin via water supply pipelines to urban areas north of the Basin, and the discharge of treated wastewater from the Middlesex County Utilities Authority into the Raritan Bay.

Water supplies in the Basin are from both ground and surface water sources. Some water is obtained from intakes in the Raritan River and the Delaware & Raritan Canal and then treated for drinking water. Some water is drawn (pumped) from ground water supplies contained in aquifers and then treated for drinking. Wells that collect drinking water for an entire community are called public community water supply wells. In addition, in many suburban and rural areas, people obtain their drinking water from private domestic wells (also known as individual homeowner wells).



Water from the Delaware Basin is brought to the Raritan Basin via the Delaware and Raritan Canal

Raritan Basin: Portrait of a Watershed

What water supplies are available in the Raritan Basin?

The New Jersey Water Supply Authority (NJWSA) operates three facilities in the Raritan Basin: Spruce Run Reservoir, Round Valley Reservoir and the Delaware & Raritan Canal. The NJWSA manages these water resources for the State, providing untreated bulk water to water purveyors who withdraw, treat and sell the finished water either wholesale or retail. Spruce Run and Round Valley Reservoirs store water in

the Basin for periods when stream flows are lower than normal. Water is then released from the reservoirs to augment both stream flow and water supply. In addition to these sources, surface water also is obtained from the Lawrence Brook Chain of Lakes and the South River watershed. Ground water from aquifers around the Basin completes the water supply picture for the Raritan Basin.



The Spruce Run Reservoir releases water during periods when stream flows are lower than normal.

Who uses the water from the Raritan Basin?

Eleven major water purveyors, listed in Table 1, treat and distribute the water from the Raritan Basin to people within and outside the Basin. Besides municipal water supply systems, about 18 percent of the Basin residents get their water from domestic ground water wells. Most industries use water purchased from municipal water supply systems, but some withdraw water directly from the Raritan River or from ground water for their own use. Water from within the Basin also is

used for the irrigation of golf courses and agricultural fields. Most irrigation water is self-supplied from either ground water wells or on-site ponds. Some golf courses have experimented with the use of treated wastewater effluent for irrigation, but this is not a common practice in the Raritan Basin. Based on data from 1995, about 12 million gallons per day is used for irrigation (other than residential lawns) in the Raritan Basin, about 5 percent of the current total water demand.

Table 1. Major Water Purveyors in the Raritan Basin

- Elizabethtown Water Company (SW & GW)
 - Middlesex Water Company (SW & GW)
 - Borough of Sayreville Water Department (SW)
 - City of Perth Amboy (GW)
 - City of New Brunswick (SW)
 - Morris County Municipal Utilities Authority (GW)
 - Township of East Windsor Municipal Utilities Authority (GW)
 - Township of Old Bridge Municipal Utilities Authority (GW)
 - Township of North Brunswick (GW)
 - Township of South Brunswick (GW)
 - United Water – Matchaponix (SW)
- SW=Surface Water Sources; GW=Ground Water Sources
(suppliers of more than one million gallons per day)



How is water availability determined?

Water supply availability represents the usable water that can be taken from a water source without harm to the system. The availability of surface water is dependent upon rainfall patterns and the storage capacity and operations of the reservoir and canal systems. The availability of ground water is determined by the storage capability of the aquifer and the rate of aquifer recharge. The availability of surface water (from a lake, reservoir, stream or river) is determined by simulating the water system over a long period of time, varying the demand for water and the amount of precipitation supplying the water. The result is the “safe yield,” which is the amount of water that can be supplied continuously without shortages during a repeat of the drought of record. The availability of ground water (from aquifers

and wells) is called the “dependable” or “firm” yield. The dependable yield is the amount of water that can be pumped from an aquifer without the occurrence of salt-water intrusion or severe lowering of the water table. The dependable yield and safe yield of all sources of water in the Raritan Basin determine the availability of water. Contaminated water sources are not considered when calculating water availability.

The Raritan Basin can supply between 305 and 360 million gallons of water a day. That is roughly enough water to cover one square mile of land with 21 inches of water or enough water for 2.5 million people to use on an average day for drinking, bathing, and cleaning (based on a generous per capita water use of 145 gallons per day).

Of the 360 million gallons per day, 225 million gallons comes from surface water and 135 million gallons comes from ground water, based on an analysis performed for the Statewide Water Supply Plan (1996). However, an earlier evaluation, performed for the Eastern

Raritan Water Supply Feasibility Study (1990), indicated a lower ground water dependable yield of just 79 million gallons per day. Ground water estimates range widely because less is known about aquifer capacity and recharge than reservoir capacity and stream flow.

Are our regional and local water supplies sufficient now?

Provided that we do not experience a drought much worse than the drought of record (the one of the 1960s), our regional surface water supplies are sufficient to supply the existing demand. During drought conditions, water consumption by individuals and industry can be reduced to alleviate some of the demand for water. Extended, widespread droughts are infrequent in New Jersey; however, short-term local droughts can be severe. The drought of 1961-66 was the most severe in New Jersey's history, affecting the entire State for 5 years. Rainfall totals for 1965 were the smallest since statewide record keeping began in 1883. Records also indicated that stream flows were at a 100-year low in the State. The 2001-2002 drought, while severe, may not reach the same length or impacts.

For the most part, ground water supplies also are adequate. One local exception to the adequacy of the Raritan Basin water supplies is in the South River Watershed, where over-pumping of confined aquifers led to a decline in water levels and salt water intrusion from the Raritan Bay. In 1985, NJDEP declared the South River Watershed Aquifers a critical water supply and by 1990 required a 50 percent reduction in ground water withdrawals. Water levels have risen and salt-water intrusion has receded, but pumping

restrictions still remain in effect. NJDEP currently is evaluating both the recovery and the area as a critical water supply to avoid future problems. More localized constraints on ground water supplies also exist in the poorer aquifers in the western part of the Raritan Basin.

Another concern for the future of our water supply is the decrease in ground water recharge in 130 of the 136 sub-watersheds of the Raritan Basin from 1986 compared to 1995, in places as much as 20 percent. Increased impervious surfaces from development are directly responsible. As the amount of impervious surface increases in a watershed, the available surface area for infiltration of rainfall into the ground is diminished. Water falling on impervious surfaces becomes runoff, which is usually channeled directly to streams, severely limiting the chance for aquifer recharge.



Low water levels at Spruce Run during recent drought in 2002

Do we have enough water for future water supply demands?

The water supply for the Raritan Basin is provided by both surface and ground water sources. Surface water supplies are centralized and primarily benefit urban and suburban areas where infrastructure, such as water treatment plants and water distribution systems (water mains), exists. Ground water use for water supply purposes is spread non-uniformly throughout the Basin and is in the form of municipal wells or domestic wells for individual houses.

“The Basin can yield up to 360 million gallons per day from both surface and ground water sources.”

Based on earlier population and water use forecasts, the Raritan Basin should have an adequate water supply until about the year 2040. The projected demand for water in 2040 is 350 million gallons per day. The Basin can yield up to 360 million gallons

per day from both surface and ground water sources. Comparison of the 2000 Census data with Year 2000 population predictions from earlier plans indicates that the Basin population is growing faster than expected and the demand for water may increase more rapidly than originally predicted. In addition, the estimated available supply assumes the continued availability of water resources from various different sources, including ground water and the Delaware River. These water resources may not always be available at their current levels. Finally, localized demands on ground water from domestic and municipal wells may eventually overwhelm the available supply.

What plans exist to address future water supply needs?

The people in the Basin must address the potential need for new water supplies in the coming decades. This need could be hastened by increased population growth, loss of supply due to contamination, changes in the water budget resulting in decreased aquifer recharge, heavier reliance on surface water supplies, diversions to other watersheds for water supply, and other changes. The need to develop new supplies can be delayed by improved water conservation practices, reduced population growth (slower than predicted), reduced non-residential demand, protection of water supplies, and other preservation, conservation and demand reduction practices. However, two surface

“The people in the Basin must address the potential need for new water supplies in the coming decades..”

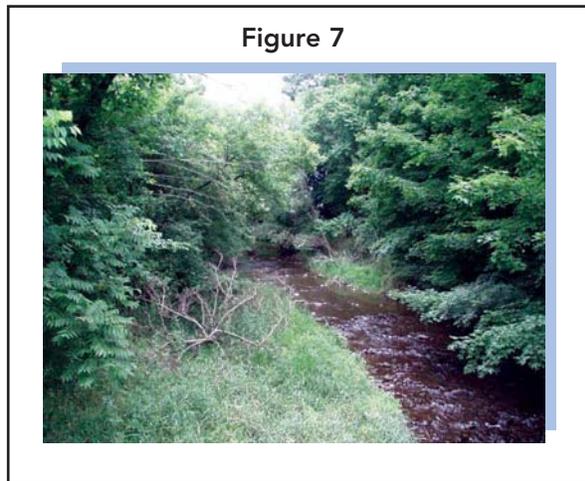
water supply projects, the Kingston Quarry Reservoir and the Confluence Pumping Station, have been identified as cost-effective projects that can provide an additional 65 MGD and 53 MGD, respectively, with relatively limited environmental impacts. The Statewide Water Supply Plan anticipates that one of these projects will be built after 2030 to supply future needs of the more urbanized areas, assuming population and water demand projections remain as predicted. No plans currently exist that would increase ground water dependable yields, which raises a possible constraint on demand in many rural and suburban areas.

RIPARIAN AREAS, WETLANDS AND FLOODING

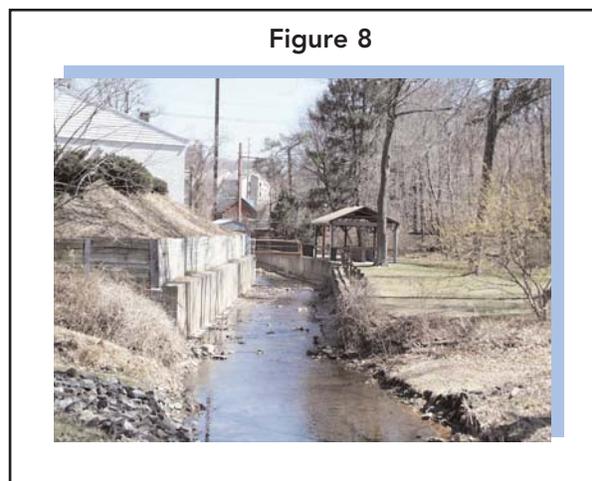
What are riparian areas and why are they important?

Riparian areas are transitional land areas between uplands and streams that support surface water ecosystems and protect streams from degradation. Figure 6 presents a diagram of a riparian area. These areas are comprised of grasses, shrubs, trees and other vegetation, vary in shape and character, and are not uniform in width on either side or along the length of the water body. Riparian areas provide habitat for aquatic and terrestrial organisms by

providing shade, food, shelter and movement corridors. Vegetation in riparian areas stabilizes stream banks and removes sediment and other contamination from water entering the stream. Riparian areas also store and absorb energy from floodwaters and improve the aesthetics of stream corridors. Figure 7 presents a sample of a stream with a good riparian area, while Figure 8 presents a stream with a poor riparian area.



Thick vegetation indicates a good riparian area



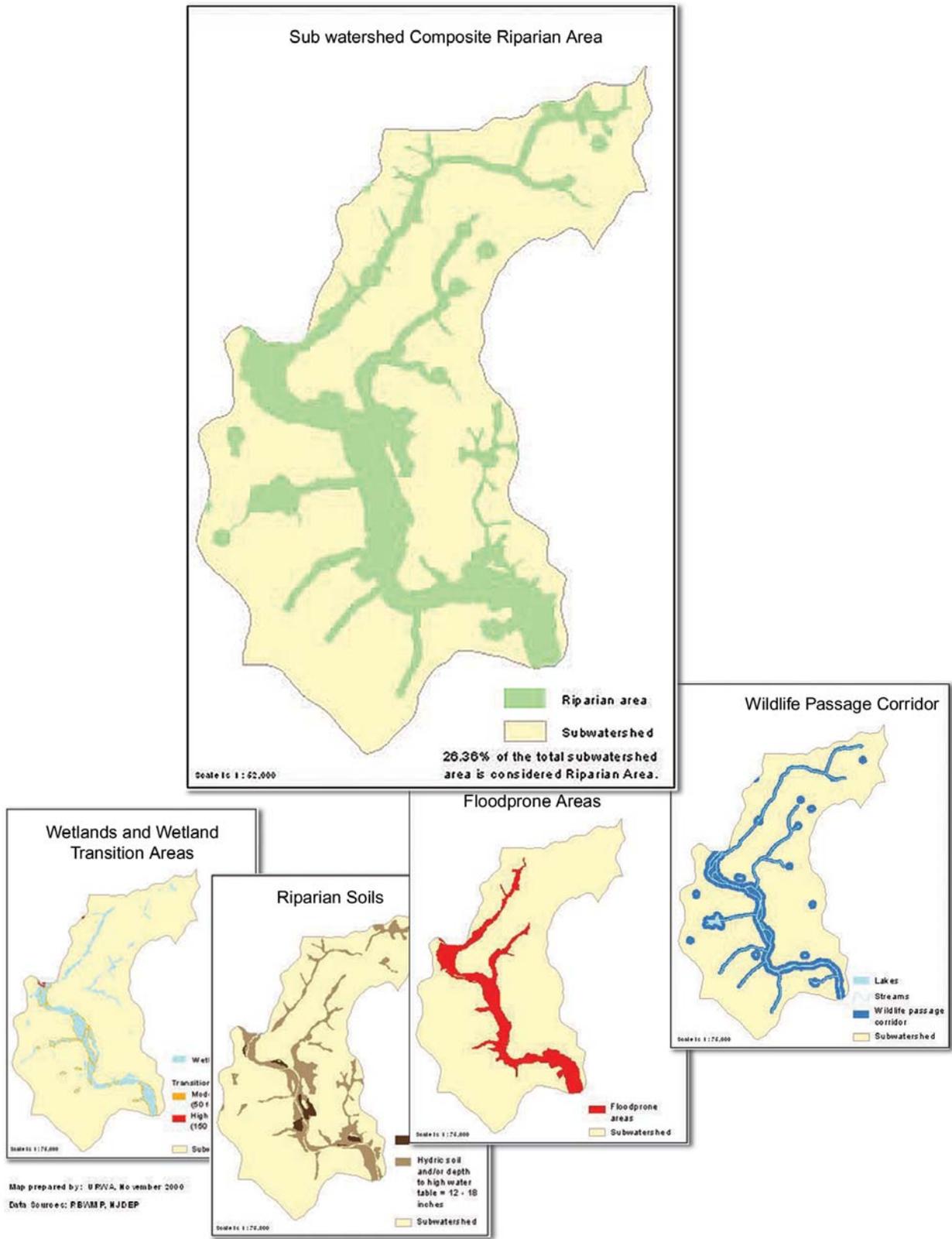
Channelization and lack of vegetation indicate a poor riparian area

What is the status of the riparian areas within the Raritan Basin?

For the characterization and assessment of the Raritan Basin, historical riparian areas were defined based on the width of the 100-year flood plain, the extent of streamside wetlands and associated transition areas, hydric soils, and a wildlife passage corridor of a width based on stream size. Of the historic riparian area of the Basin, about one-third was converted to agricultural and urban land uses by 1995. The fragmentation and alteration of streams has dramatic

effects on ecosystem integrity and biological diversity. Barriers including dams, bridges, locks and culverts divide aquatic ecosystems by blocking the access of migratory fish and other species to upstream spawning areas and limiting downstream movement of insects and other small aquatic organisms. A recent inventory of dams in New Jersey indicated that 253 dams are located in the Raritan Basin and affect nearly all major streams.

Figure 6



Four features are combined to describe riparian areas of subwatersheds

Raritan Basin: Portrait of a Watershed

Road crossings also damage riparian corridors, because vegetative cover is interrupted and the stormwater drainage usually is channeled directly into the stream, untreated and without energy dissipation. Also, automobiles kill wildlife attempting to cross roads, a major source of mortality for many species. For the Raritan Basin, the number of stream

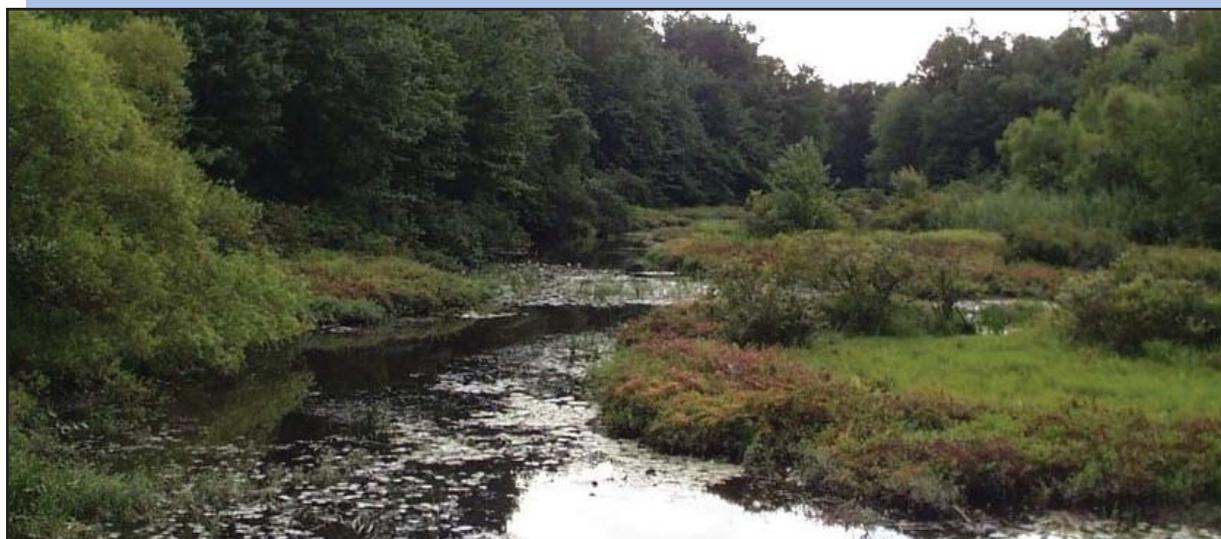
crossings per kilometer was calculated for the sub-watersheds in each of the three WMAs. On average, the Millstone WMA has the fewest stream crossings per kilometer, followed by the Upper Raritan WMA. The Lower Raritan WMA had the most crossings per kilometer on average, but also had the sub-watersheds with both the lowest and the highest values.

What are wetlands and why are they important?

A wetland is an area of land commonly inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation adapted to life in saturated soils. Generally, wetlands are considered swamps, marshes, bogs or similar areas found in flat vegetated areas or depressions along streams, rivers, lakes and coastal areas.

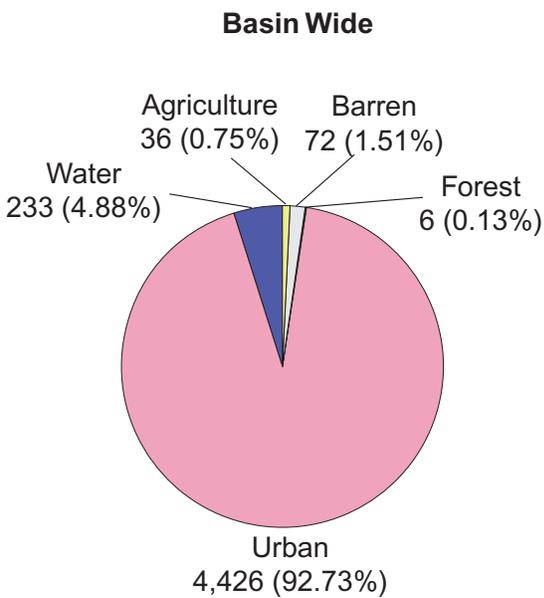
Wetlands are important because they provide habitat for plants, aquatic organisms, fish and wildlife. Also, wetlands are natural flood control systems because they store and later release

stormwater runoff. Studies have shown that wetlands control erosion and remove pollutants through settling and adsorption by plant life. Loss of wetlands can be devastating to an area. Not only is habitat lost, but also natural flood control and water treatment mechanisms. In the Raritan Basin, almost 4,800 acres of wetlands were converted to other land uses between 1986 and 1995 based upon a comparison of the land use/land cover data. Much of the conversion has occurred around the fringes of larger wetland systems. Table 2 presents the amount of wetland area lost in each watershed management area.



Wetland areas grow along Lawrence Brook

Table 2. Acres of Wetlands Converted to Other Land Uses from 1986 to 1995



By WMA (# of Acres)

	Upper Raritan	Lower Raritan	Millstone
Agriculture	6	20	8
Barren	8	56	10
Forest	0	4	2
Urban	394	2,982	1,056
Water	23	133	77
TOTAL	431	3,195	1,154

What is a flood plain?

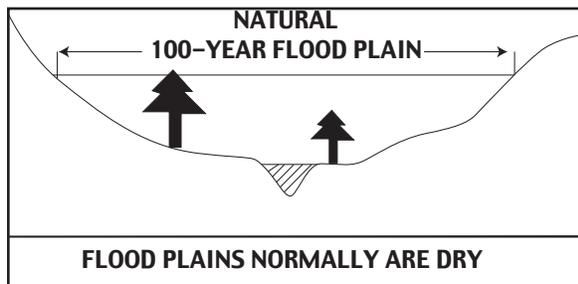
A flood plain is an area of land adjacent to a stream, lake or pond that may become covered by floodwaters during heavy rains. This area may vary in size depending on the elevation of the landscape and the amount of rainfall. The flood plain is comprised of two parts known as the floodway and the flood fringe. The floodway contains the bed and banks of a stream where water normally flows. The flood fringe extends from the top of the stream bank outward and holds water when the stream overflows its banks. Flood plains are defined by the area inundated by water caused by a storm of a given frequency, from frequent (2-year) to very rare (such as Hurricane Floyd, greater than the 100-year). In general, the regulated flood plain is the area that would be covered by water

during the “100-year storm” (a storm which has a 1 in 100 chance of occurring in any given year).

Flood plains provide storage for floodwaters and reduce the depth and velocity of flow downstream, then slowly release stored water back into the stream. Vegetated flood plains reduce the potential for erosion of stream banks and adjoining land areas, preventing sedimentation of the stream. Vegetated flood plains also provide a number of ecological benefits including habitat for aquatic and terrestrial wildlife, maintenance of cooler instream temperatures by providing shade over the stream, and aesthetic values. Development in the flood plain impedes flow and reduces flood storage to the detriment of surrounding and downstream areas.

Why are some areas more prone to flooding than others?

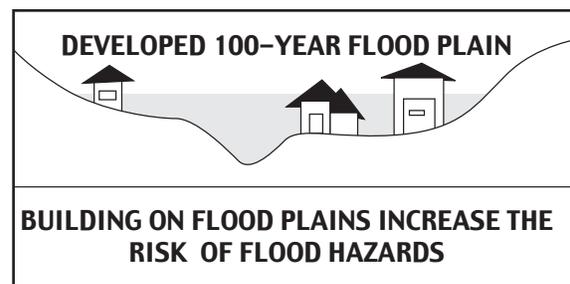
Floods occur due to different reasons and areas may be prone to different types of flooding. In general, flooding is natural and occurs because the stream or river does not have sufficient capacity to carry the volume of stormwater downstream from large storms. Flooding can be exacerbated behind culverts or bridges where the stream's capacity has been



reduced and often is blocked by debris. Flash floods occur during and after very intense rainfalls when precipitation falls faster than can be absorbed by the ground. Small watersheds with steep slopes and watersheds with soils of limited infiltration capacity, such as Stony Brook, are susceptible to flash flooding. Flash floods also occur during winter rain events, when the ground is frozen and

water cannot infiltrate. Another type of flooding occurs after prolonged periods of precipitation. The ground becomes saturated and can no longer absorb water.

Urbanization of an area exacerbates flood damages by placing buildings in the natural flood plain. Also, when the natural landscape is developed and covered with impervious surfaces, the land area available to absorb water is reduced, increasing the volume of stormwater runoff entering a stream during and after a rainfall event. This increased volume of water is delivered to the stream more quickly through curbs, gutters, drains and storm sewers. Because flow arrives more quickly at the stream, the flood peak is larger than what would have been observed before development. Small watersheds are known to suffer these effects.



Where are the major flooding problems in the Raritan Basin?

Major flooding areas in the Raritan Basin occur in the Millstone and Lower Raritan Watershed Management Areas, particularly within historic riparian area boundaries. About 13 percent of the Basin, including water designated land coverage areas, are within the 100-year flood plain or the flood prone area. About half of the Basin area located within the flood prone area is classified as wetlands. Some

wetlands are sponges for flood flows, providing temporary storage and gradual release of stormwater, and should be preserved in flood prone areas. Key urban areas most prone to flood damages in the Basin are located in the flood plain. Areas in the lower reaches of the Basin in the Millstone and Lower Raritan WMAs prone to flooding include Plainsboro, South Brunswick and Monroe Township.

Significant areas prone to flooding occur along the main stem of the Raritan River around Bound Brook, Manville and Bridgewater. The tidal portion of the Raritan River and its tributaries, such as South River, experiences flooding as well.



Blackwells Mills Road in Franklin Township flooded from the Millstone River on December 18, 2000

LAND USES

Land uses, the amount of impervious cover on land parcels, and the activities occurring on different land uses greatly affect the quantity and quality of water within and coming from a watershed. Forested land tends to absorb water; wetlands tend to absorb or treat water; urban areas tend to increase runoff volume and degrade water quality. Watershed management attempts to manage human needs and their impacts on water resources.

What is land used for in the Raritan Basin?

Based on NJDEP 1995/97 Land Use/ Land Cover data, the most recent data available, land use in the Basin is primarily urban, forest and agriculture. Urban land uses, the largest percentage of land use coverage in the Basin, include residential, commercial and industrial uses. Table 3 presents the land use breakdown for the Raritan Basin and each of the watershed management areas. The Lower Raritan WMA has the most developed area with over half of its land use classified as urban.

This development is concentrated in Union, northern Middlesex and central Somerset counties. The Upper Raritan and Millstone WMAs are less than one-third urban. Well over half of the Upper Raritan WMA is forest and agriculture, while the Millstone WMA is slightly less than half forest and agriculture. Other land use types in the Basin include water, wetlands and barren land. Figure 9 presents the general land uses of the Basin in 1995.

Table 3. Percentage Land Use Breakdown in the Raritan Basin (NJDEP 1995/97)

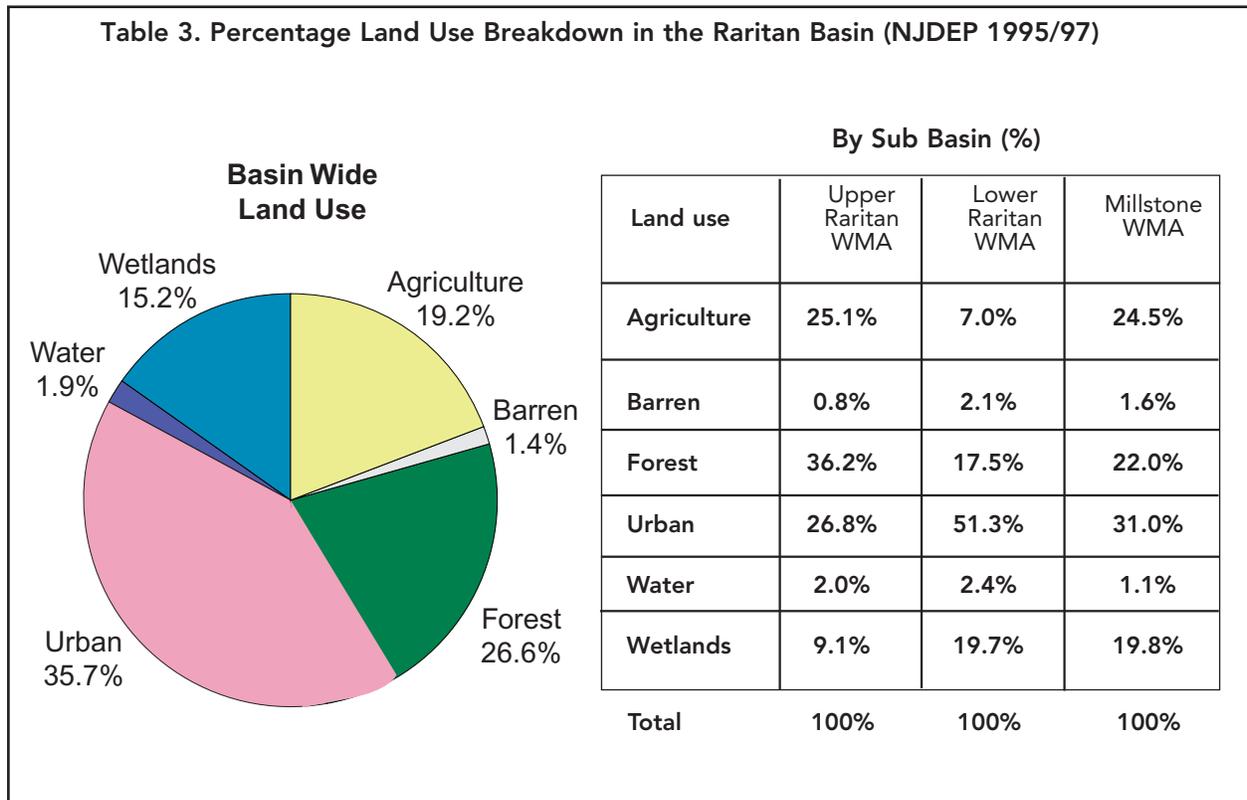
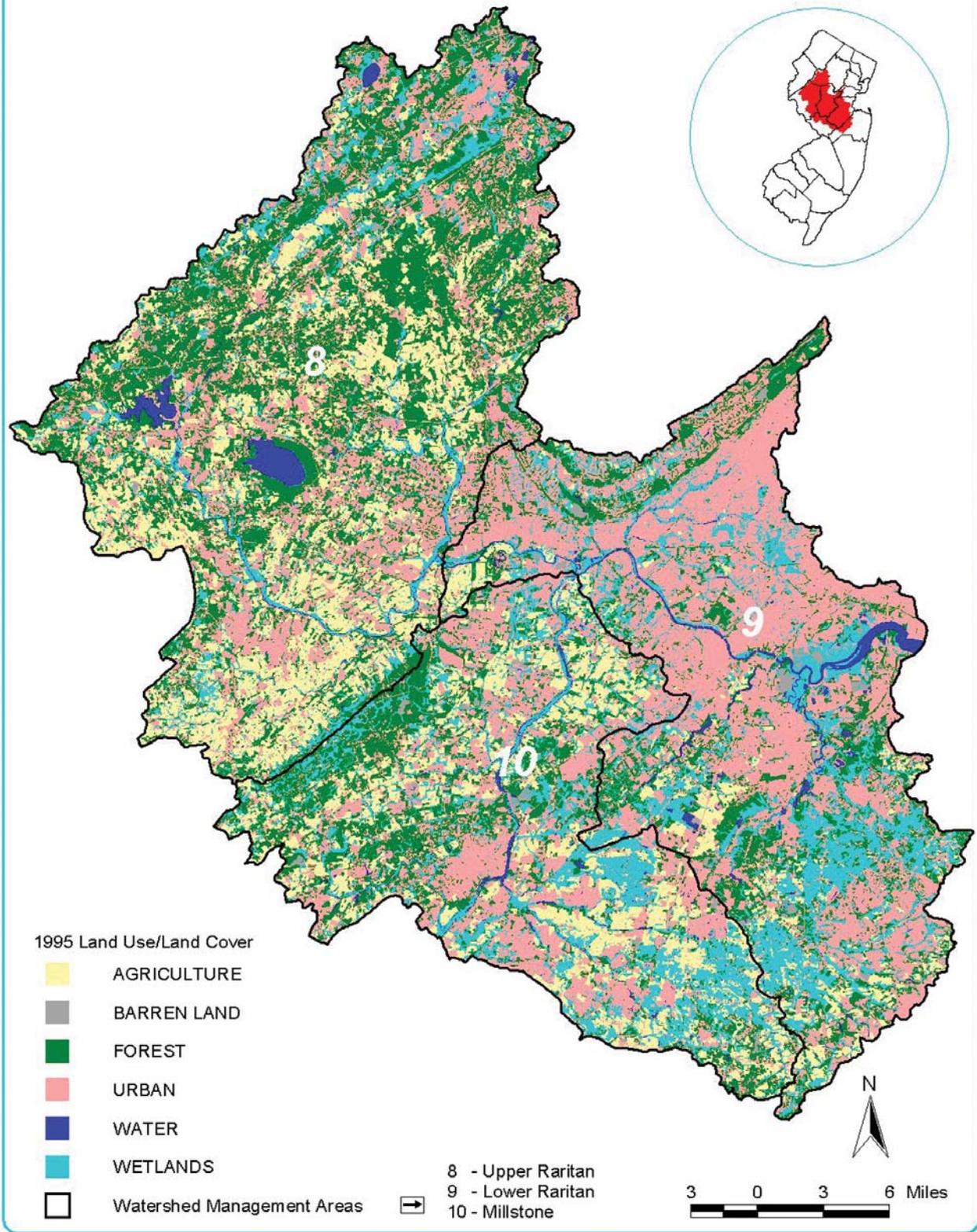


Figure 9



Land uses range from highly urbanized in the east to agricultural and forested in the North and West

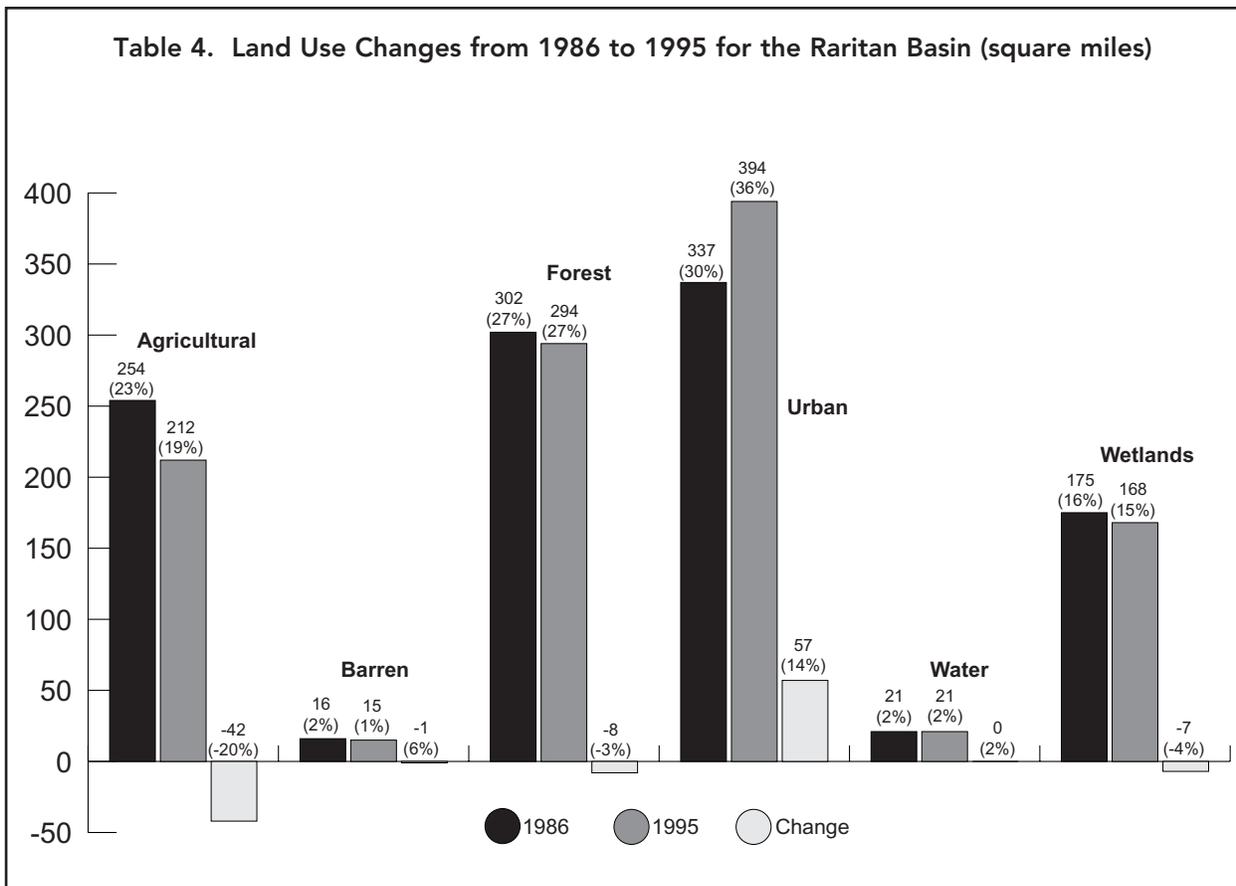
Raritan Basin: Portrait of a Watershed

How have land uses changed over time?

Prior to World War II, the Raritan Basin was primarily rural and agricultural, with development concentrated along the Raritan River and the Delaware Raritan Canal. In the 1950s and 1960s, single-family housing developments were built outside of traditional suburban limits. Communities such as Old Bridge, Bridgewater, Piscataway and Woodbridge experienced considerable growth at this time as families moved from the older urban centers.

Also, large-scale communities such as Kendall Park in South Brunswick Township were built adjacent to highways and public transportation systems.

However, most municipalities within the Basin experienced the majority of their housing development after 1980. Comparisons of 1986 and 1995 land use data indicate development has moved away from the traditional population centers and into more rural areas. In several areas, 25 percent or more of the total developed area in 1995 occurred between 1986 and 1995, such as along the Neshanic and the South Branch Raritan in the Upper Raritan WMA and along the Manalapan and Millstone (above Carnegie Lake) sub-watersheds of the Millstone WMA. Table 4 illustrates the change in land use in the Raritan Basin from 1986 to 1995.



How do land uses affect water quality in the Raritan Basin?

Land uses have different effects on water quality in the Raritan Basin. Forested land and wetland areas have a positive effect on both the volume and quality of water in the Basin. Both wetland and forest vegetation absorb water and prevent erosion from stormwater runoff.

Agricultural and urban land uses displace natural ecosystems and have a greater impact on the Basin than other land uses. Erosion from stormwater runoff.

Agricultural and urban land uses displace natural ecosystems and have a greater impact on the Basin than other land uses. The tillage of fields for crops exposes the soil, leading to erosion. Herbicides, pesticides and fertilizers, especially if used in excess, are washed off the land by stormwater runoff or into ground water by infiltration.

“Agricultural and urban land uses displace natural ecosystems and have a greater impact on the Basin than other land uses.”

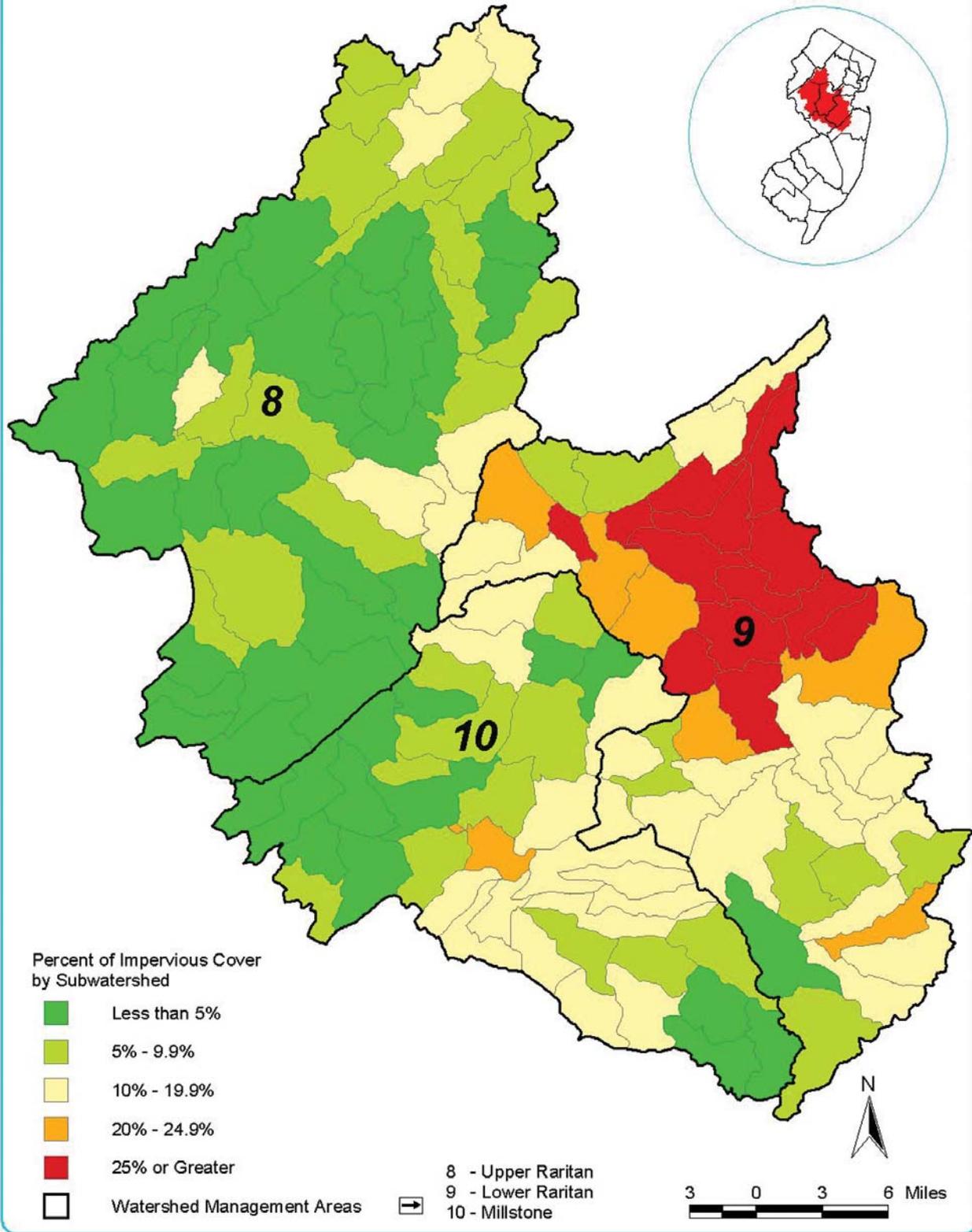
Urban areas also affect the quality and quantity of water in the Raritan Basin. Buildings, parking lots, roadways and expanses of lawn decrease both the infiltration and evapotranspiration of water and can greatly increase the quantity of stormwater runoff. Runoff is usually directed to streams and water bodies through man-made channels, delivering water more quickly than a natural channel. Stormwater flows from man-made channels have higher velocities, increasing the erosive forces at work in the waterways. In addition, the stormwater from urban areas can contain pollutants from lawn fertilizers and pesticides, roadways, parking lots, and commercial and industrial facilities.

How does impervious cover affect the Raritan Basin?

Impervious cover or surfaces prohibit the infiltration of water from the ground surface into the underlying soil. Buildings, sidewalks, roads and parking lots are all considered impervious surfaces. Bedrock close to the ground surface and very dense soil layers, which naturally restrict soil infiltration, are not considered impervious surfaces for this project; impervious surfaces are created by the actions of people. As would be expected, the highest levels of impervious surface are found in the most urban sections of the Basin, such as high-density residential, commercial, industrial and transportation land uses. The Lower Raritan WMA has the most

impervious cover with higher values in the heavily developed portions of Union and Middlesex Counties. Throughout the entire Basin, town centers, such as New Brunswick, Perth Amboy, Flemington and Somerville, have impervious surface values greater than 50 percent of their total area. Other high-density developments also have greater than 50 percent impervious surface values, such as the townhouse and apartment complexes in Plainsboro and East Windsor and the commercial corridors of Routes 1, 9, 18, 22 and 202. Figure 10 presents the percent impervious surfaces as calculated for each of the 136 sub-watersheds of the Raritan Basin.

Figure 10



Raritan Basin: Portrait of a Watershed

Generally, the amount of impervious cover in a watershed is predictive of the degradation within a stream. For watersheds between 10 and 20 square miles, impervious cover values greater than 10 percent indicate that a stream will experience degradation. Impervious cover values greater than 25 percent have been correlated to extensive and permanent stream damage. At levels lower than 10 percent, streams are usually healthier, although this may not necessarily be true in sub-watersheds with a large proportion of agricultural land use, damaged riparian area, or contaminated sites. While percent impervious cover can be used as a predictor of stream damage, hydrologic changes and ecosystem degradation are the true indicators of stream degradation.

“Generally, the amount of impervious cover in a watershed is predictive of the degradation within a stream.”

The percent total impervious cover for the entire Raritan Basin is approximately 11 percent. Most of the Basin’s 136 sub-watersheds fall within the 10-25 percent range. Fifteen subwatersheds have less than 10 percent impervious cover and are located along the Sourland and Watchung Mountains or where agricultural, wetlands and water features dominate. Fourteen sub-watersheds have percent impervious cover greater than 25 percent and all but one are located in a contiguous region in and near the Bound Brook/Green Brook watershed. The sub-watersheds containing Princeton, Bridgewater and Roxbury have impervious cover values between 20 and 25 percent.

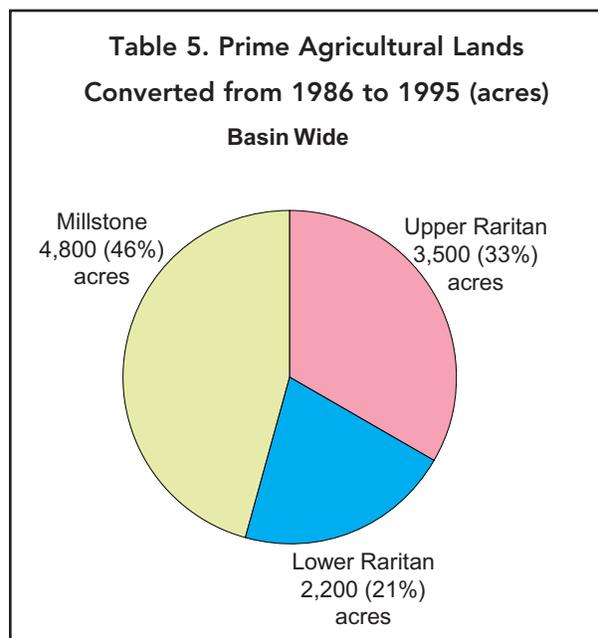
What soils are most restrictive to land uses?

Soil type plays a major role in restricting land uses unless extensive engineering practices are used to overcome the limitations of a particular soil. The physical, chemical and biological properties of soil types affect how they can be used. For example, a soil’s consistency affects cultivation, percolation and its ability to bear weight for a building foundation.

A soil’s suitability for development also can be rated based on the depth to a seasonal high ground water table, depth to bedrock, and slope. These soil characteristics

determine what type of building foundations are needed, if buildings can have basements, if septic tank leach fields are feasible, if lawns will grow, and if road foundations can be supported. Based on 1995 land use and land cover data, much of the development within the Raritan Basin has occurred on soils least suited for development. In the Upper Raritan WMA, the Lower Raritan WMA and the Millstone WMA, 47 percent, 38 percent and 36 percent, respectively, of development has occurred on soils least suited for development.

The United States Department of Agriculture's Natural Resources Conservation Service classifies a soil's suitability for agricultural uses based on fertility, erosion potential, drainage and ability to be tilled. Agricultural land uses are the most sensitive to soil type. However, soils appropriate for agricultural uses generally are appropriate for development. As a result, most of the agricultural lands lost to development between the 1986 and 1995 land use surveys were those of prime soils for agriculture. Table 5 presents the agricultural land losses by WMA.



What future land uses are anticipated for the Raritan Basin?

Future land uses in the Raritan Basin can be anticipated based in part on the State Development and Redevelopment Plan. This plan divides the State into planning areas that reflect the dominant and preferred intensity of development, while directing development to centers of population and developed areas and away from environmentally sensitive and natural resource areas. About two-thirds of existing urban land in the Raritan Basin is located in the Metropolitan (PA1) and Suburban (PA2) Planning Areas, but that percentage is declining as development

moves into rural areas. Of all agricultural land located in the Raritan Basin, over 19 percent is designated as Suburban Planning area. Accordingly, the State Development and Redevelopment Plan anticipates that these lands eventually will become fully developed, particularly since the majority of these agricultural lands are within approved sewer service areas. Thus, the State Plan sees these agricultural areas as under intense development pressure.

How important is the Raritan Basin for threatened or endangered plants and wildlife?

The Raritan Basin provides important habitat for many threatened and endangered species, especially in the Upper Raritan WMA. Critical wildlife habitats within the Raritan Basin include forested areas, forested wetlands, emergent wetlands and grasslands. The Basin as a whole is one quarter forested and slightly more than one-eighth wetlands. The most extensive tracts of undisturbed forest are located in the Upper Raritan Watershed Management Area in the Highlands region; the Cushetunk Mountain region around Round Valley Reservoir; the Sourland Mountains in both the Millstone and Upper Raritan WMAs; and, the Watchung Mountains in the Lower Raritan WMA. Grasslands are typically open agricultural areas that are either cultivated or fallow. They are an important habitat, providing nesting and over-winter locations for a variety of bird species including State-listed threatened species, State-listed endangered species, and declining species.

About one-third of endangered species in the United States are associated with wetlands habitat. The Raritan Basin contains seven areas of priority wetlands, identified as important and containing unique habitat and rare wetland vegetation. The wetlands are located in tributary areas to Spruce Run Reservoir, along the Lamington River; in the Dismal Swamp and in Raritan Center (Edison

Township); within Helmetta, in the Pigeon Swamp (South Brunswick); and around the Raritan Bay Estuary.

The Raritan Basin contains 19 NJDEP National Heritage Program Priority Sites, which are locations that provide the best habitat for rare plant and animal species and natural communities. Of these sites, two are of very high significance, three are of high significance, six are of moderate significance, and eight are of general biodiversity interest. The Raritan Basin also contains fifteen sites with priority plant species, eight in the Upper Raritan WMA and seven in the Lower Raritan WMA. The Upper Raritan sites include various types of woodlands and wetlands. The Lower Raritan sites also include various woodlands and wetlands, along with steep sloped traprock (basalt).



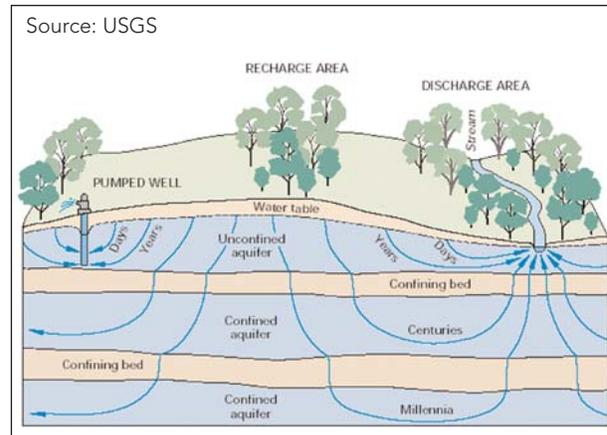
This Bog Turtle is an example of the endangered species found in the Raritan Basin

GROUND WATER AVAILABILITY AND QUALITY

Ground water availability and quality are important for the assessment of a watershed. Sources of ground water are replenished by infiltration of water into the ground from the land surface. Ground water affects both the quantity and quality of stream flow by moving into the stream as base flow. If ground water supplies are over-used or deprived of recharge, the base flow in streams is reduced. When ground water is contaminated, the pollutants can move into the stream through base flow and can impair wells.

What is an Aquifer?

Aquifers are porous and permeable geologic formations that store, transmit and yield economically significant amounts of ground water for human uses. All aquifers contain ground water, but not all ground water is located in aquifers. Aquifers store and pass water along to other aquifers or to surface waters. Geology plays a major role in determining aquifer function. An unconfined (water table) aquifer is defined as ground water that is in contact with the atmosphere via pores in the unsaturated soil above. Impermeable soil layers trap a confined aquifer; the water is under pressure within the aquifer. Confined aquifers are less prone to contamination.



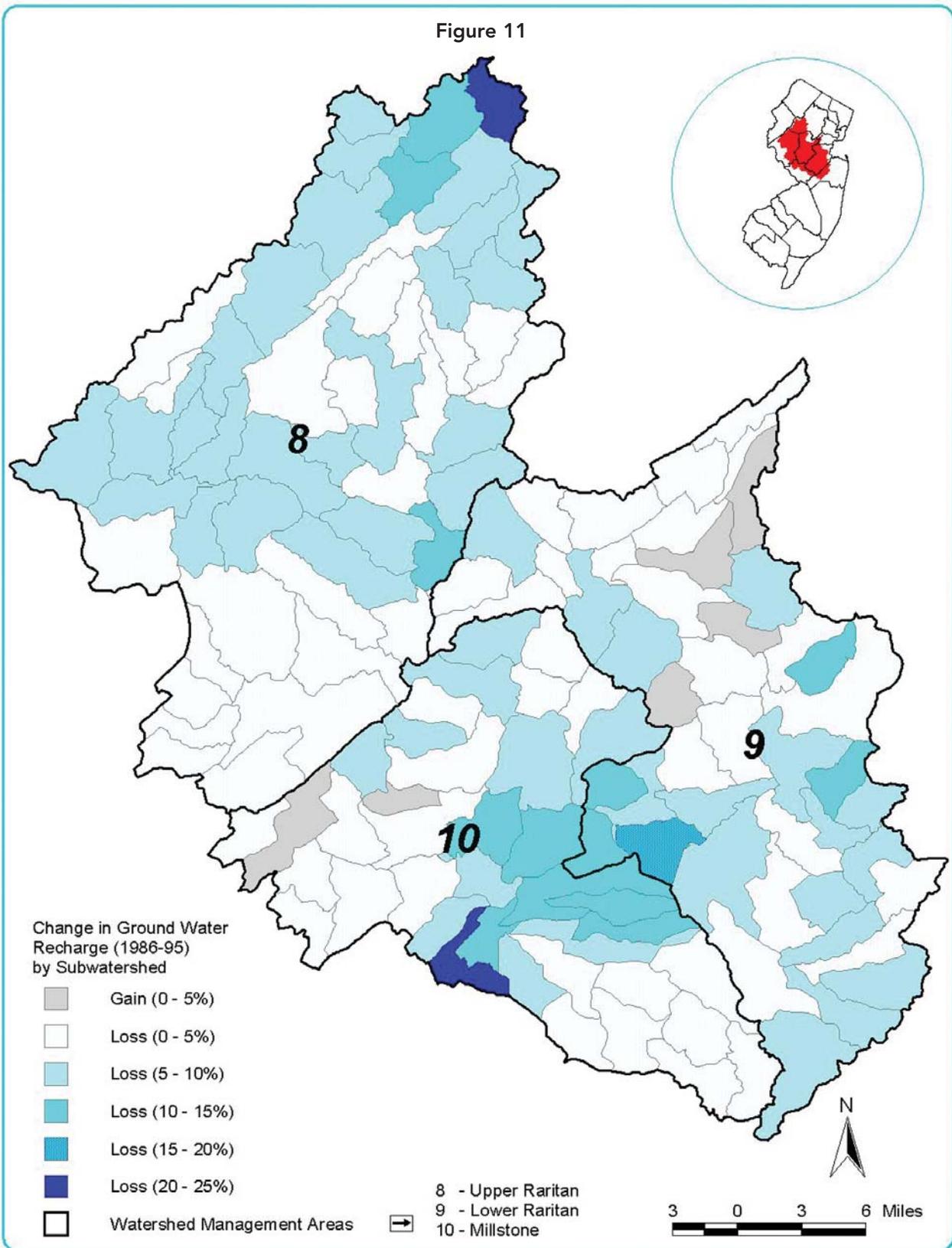
Aquifers contain ground water to discharge points with flow paths ranging from days to millenia.

Do the aquifers underlying the Raritan Basin have adequate recharge?

Ground water recharge, or infiltration, is a function of aquifers. For the Raritan Basin, ground water infiltration was estimated by sub-watershed using the New Jersey Geological Survey's method, which estimates long-term average infiltration based on annual rainfall, temperature, soil type and land use. Figure 11 presents a comparison of infiltration rates from 1986 to 1995. The results show that ground water infiltration declined in 130 of the 136 sub-watersheds of the Raritan Basin due to changes in land use. The loss of infiltration

is primarily due to the increase in impervious surface as land is developed. As a result, the dependable yields of aquifers and the amount of base flow in streams will be reduced. The remaining six sub-watersheds demonstrated a slight increase in recharge, perhaps due to natural reforestation of former farms or developed areas.

Figure 11



Much of the Raritan Basin lost ground water recharge between 1986 and 1995.

Raritan Basin: Portrait of a Watershed

What is the quality of ground water in the Raritan Basin?

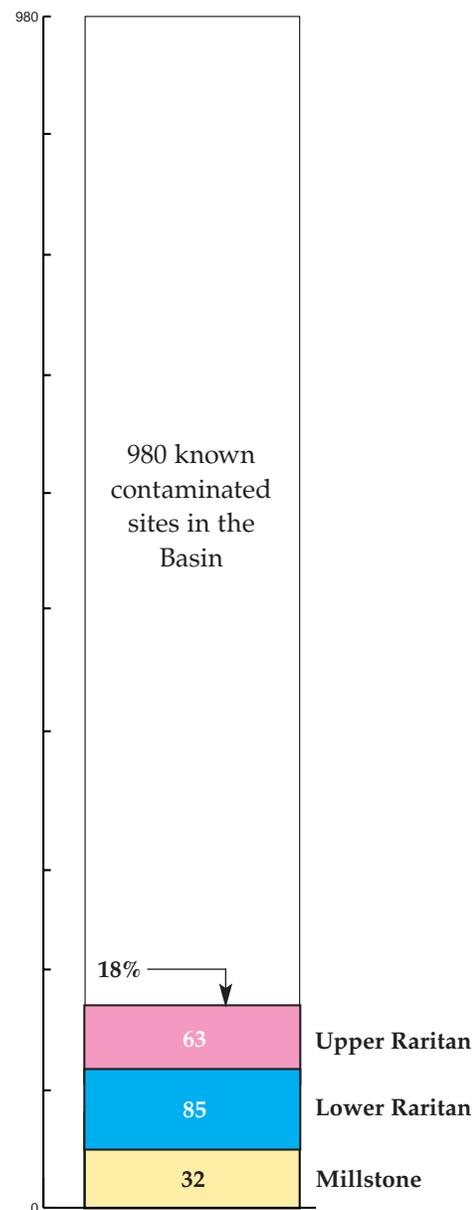
In general, the ground water quality in the Raritan Basin is good. However, ground water contamination is evident in urban areas. Urban areas have a legacy of contaminated sites from past and current activities. Such contamination may originate:

- on the land surface (from landfills, illegal dumping, accidental spills, fertilizers and pesticides),
- underground above the water table (from malfunctioning septic systems, underground storage tanks, leaking underground pipelines), or
- underground below the water table (from mines, waste disposal through injection wells, and ground water withdrawals).

Based 2002 data, NJDEP had identified 980 contaminated sites in the Raritan Basin, where ground water contamination exists. NJDEP also has identified well head protection areas (WHPA) for the 352 community water supply wells in the Raritan Basin. Basin wide, 18 percent of the contaminated sites are within a well head protection area. Table 6 presents the breakdown of known contaminated sites in well head protection areas by WMA. According to NJDEP estimates from 1992, 60 landfills were located within the Basin, of which only six remain in operation. Over 4,600 underground storage tanks are registered in the basin of which about 1,430 are still active as of April 2000. Salt-water intrusion from the Raritan Bay has occurred from over-pumping of ground water in the South River area (Water Supply Critical Area #1). Pesticides and

arsenic, a naturally occurring toxic substance, have been detected in the Piedmont Province in the western portion of the Raritan Basin.

Table 6. Known Contaminated Sites in Well head Protection areas



How many septic systems can the Basin handle?

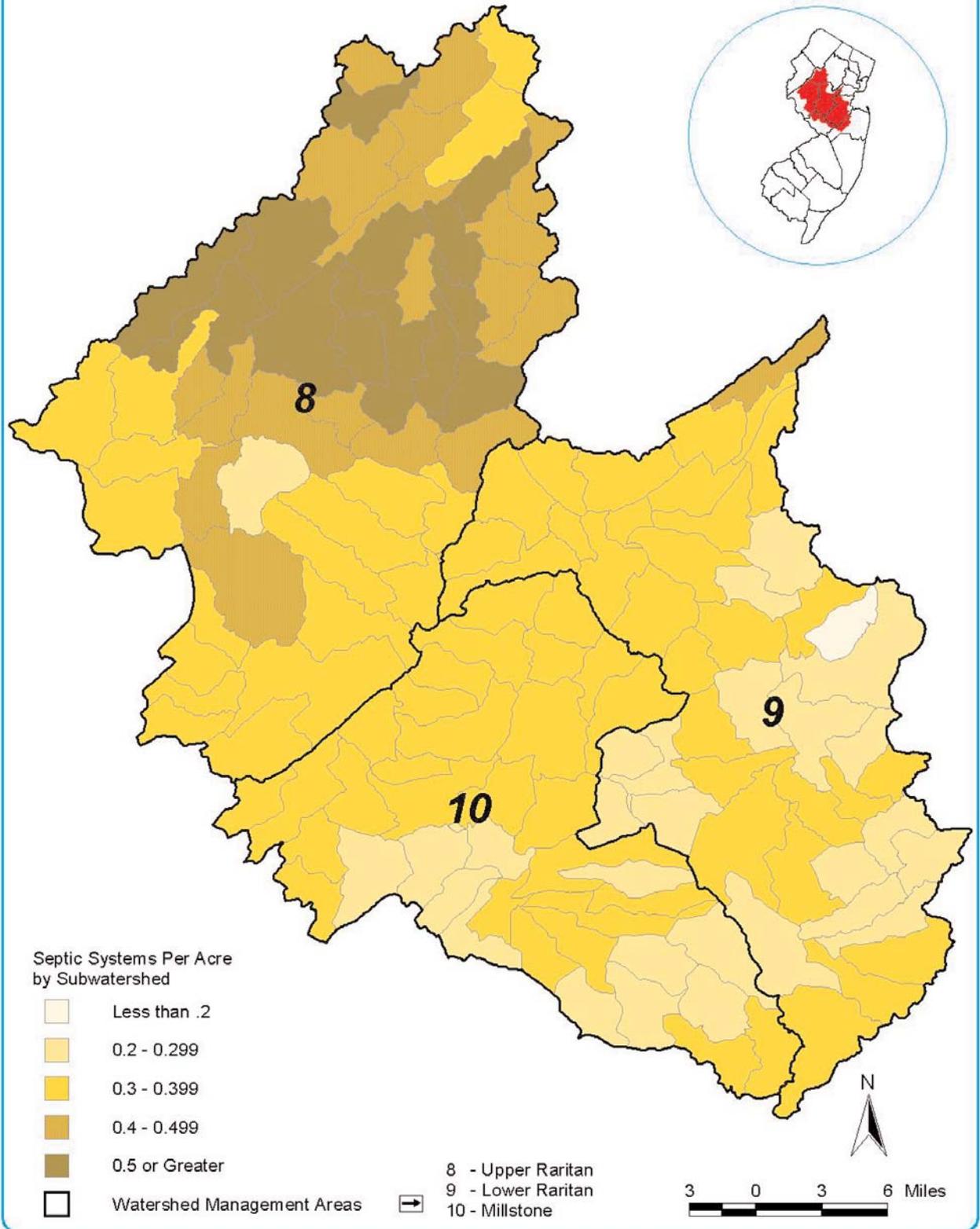
Much of the development in the Basin is occurring in areas without public sewer systems. Development of too many septic systems has the potential to contaminate surface and ground water resources.

The New Jersey Geological Survey developed a method for estimating the maximum number of septic systems that can be located in a specific watershed based on soil conditions, precipitation, ground water recharge, and average nitrogen loading rates from septic systems. Nitrate levels are used as the indicator pollutant, at 5.5 parts per million (the drinking water standard is 10). The results for Raritan Basin sub-watersheds are presented in Figure 12 as an average

number of septic systems per acre by sub-watershed. Estimates using more detailed local information or other water quality objectives will yield different results.

The highest carrying capacity for septic systems is found in the Upper Raritan WMA and is one system per 1.64 acres. This area has soils with relatively high recharge rates. Within the Lower Raritan WMA, the maximum carrying capacity is one system per 2.4 acres. In the Millstone WMA, the maximum carrying capacity is one system per 2.6 acres. In other sub-watersheds throughout the basin, the maximum carrying capacities are lower, requiring larger lot sizes to accommodate septic system.

Figure 12



Septic system capacity varies by soil type and precipitation - example is for 5.5 mg/L Nitrate target

Raritan Basin: Portrait of a Watershed

SURFACE WATER QUALITY AND POLLUTANT LOADS

Water quality is used to indicate the condition of a water body. The concentrations of compounds in water usually are compared against water quality standards to determine if a water body supports all of its intended uses. Some of the compounds used to indicate water quality include nutrients (nitrogen and phosphorus), bacteria (fecal coliform), toxic compounds (pesticides and heavy metals) and dissolved oxygen. Nutrients above certain concentrations predispose a water body to eutrophication, a process of excessive plant growth that harms other life. Fecal coliform bacteria indicate contamination with pathogenic (disease-causing) bacteria. The presence of toxic compounds indicates unhealthful water for drinking or aquatic life. Dissolved oxygen concentrations indicate the capacity of the water body to assimilate organic wastes and support aquatic life, particularly fish.

What are Water Quality Standards and Designated Uses?

Surface water quality standards are the means by which the NJDEP assesses a water body and include designated uses, numerical concentration criteria, and anti-degradation policies. A designated use is a classification of a water body by the State of its existing and potential uses. An example of a designated use is TP-Trout Production, which means that the surface water can support trout for spawning or nursery purposes during their first year. Another example is “primary contact recreation”, which means that the water is safe for activities with significant risk of ingestion, such as swimming, diving, surfing and water skiing.

Numerical concentration criteria are set to support the designated use, and are described generally in terms of a constituent (or pollutant) concentration, which is usually “not to be exceeded.” The criteria are compared with water sample concentrations to determine if a water body meets standards. Two unusual criteria are pH, which needs to remain within the range of 6.5 to 8.5 pH units, and dissolved oxygen, which needs to remain

above 4.0 mg/L in general and above 7.0 mg/L in trout waters.

Antidegradation policies protect water bodies from pollutant loads. The policies control the extent to which good-quality waters can be impacted by future increases in pollutant loads that do not exceed the standards. Specifically, existing uses shall be maintained and protected and no irreversible changes may be made to existing water quality that would impair or preclude attainment of the designated use by the water body.



Source: NJ Fish and Wildlife

Greg Young caught the state record trout in Round Valley on May 4, 2002 (32 pounds, 8 ounces)

What does impaired mean?

A stream or other water body (lake, pond) is considered impaired if surface water quality standards are not met for any reason. This includes non-compliance with water quality criteria and non-support of designated uses. A site also is considered impaired if the biological assessment

indicates that the expected aquatic life is not thriving in the waterway. The designated use (for example: maintenance, migration and propagation of natural established biota) may be considered impaired even if there are no chemical or physical water quality data.

What is the Impaired Water Bodies or 303(d) list?

What does it mean if a stream is on the list?

The Impaired Water Bodies List is named after Section 303(d) of the federal Clean Water Act that requires states to prepare a list or inventory of water bodies that are not attaining or are not expected to attain water quality standards despite existing regulatory programs (New Jersey Pollution Discharge Elimination System - NJPDES). In May 2002, the NJDEP released the draft impaired water bodies list with the Integrated list. Streams listed as category 5 waters are impaired waterbodies of the 303 (d) list and become part of the Statewide Water Quality Management Plan. The list essentially identifies water bodies that continue to have standards violations after point source dischargers have reduced (either voluntarily or through permit requirements) their contributions of pollutants to the water body.

If a stream or water body is on the Impaired Water Bodies list and impairment is confirmed, a surface water pollution control plan (known formally as a Total Maximum Daily Load or TMDL) must be developed for that stream. The surface water pollution control plan (or TMDL) determines the amount of pollutant that a stream can assimilate while still meeting standards. Then, the sources of those pollutants, including non-point sources, are examined to determine where reductions in pollutant loading can be achieved. The surface water quality control plan results in waste load allocations (WLAs) for point sources and load allocations (LAs) for non-point sources.

How is water quality assessed?

What are the results?

Water quality is assessed both chemically and ecologically. Tests of surface water samples for various compounds are used to compare instream water quality with water quality standards. Bioassessment techniques are used to evaluate the ecological health of a water body, which is part of the water quality assessment.

For the Raritan Basin, water quality data were evaluated from 21 sites of the cooperative ambient water quality monitoring network of the NJDEP and the United States Geological Survey (USGS). Figure 13 presents these sampling locations. Sampling data from the 1990s were evaluated for compliance with water quality standards. These data covered a

broad range of pollutants including pesticides and industrial chemicals. Water quality samples from the same location were compared over time, during different seasons, and under various flow conditions to determine trends in concentrations.

Bioassessment generally involves the counting of bottom-dwelling insects, looking for indications that the insect communities show changes from their natural levels. These insects are good indicators of localized conditions because they maintain their position in flowing water by living on the streambed or attaching to fixed objects. Ecological changes can be observed quickly due to the relatively short life cycles of the insects, and can be monitored with relative ease over time. The Raritan Basin has 152 stations in the Ambient Biomonitoring Network (AMNET), managed and

sampled by NJDEP. The locations of the AMNET stations and their bioassessment ratings are presented in Figure 13. In 1999, the bioassessment ratings for the Basin indicated that about 37 percent of the AMNET sites were non-impaired, 55 percent were moderately impaired, and 8 percent were severely impaired. In comparison with the 1993—1994 bioassessment, the percentage of non-impaired sites remained about the same. The percentage of severely impaired sites changed from 5.6 percent in 1994 to 8.0 percent in 1999; however, 1999 was a drought year and the bioassessment results may have been temporarily affected. The percentage of moderately impaired sites was reduced from 1994 to 1999 with these sites becoming severely impaired. Table 7 presents the breakdown of the bioassessment ratings by Watershed Management Area.

What trends exist in water quality?

A trend is a shift or tendency towards a particular direction. Trends in water quality are determined by evaluating water quality sampling data over time, and can be used to indicate happenings in the Basin. In the Raritan Basin, concentrations of total dissolved solids, chloride and sodium exhibited an increasing trend. Increased road salting for deicing roadways in the winter is the probable cause. While these three pollutants are not of immediate concern, their increasing trends are a warning signal that they may become a concern in the future. Conversely, ammonia and organic nitrogen concentrations have decreased with time throughout the Basin, as point sources reduced the concentrations in their effluent through improved treatment.

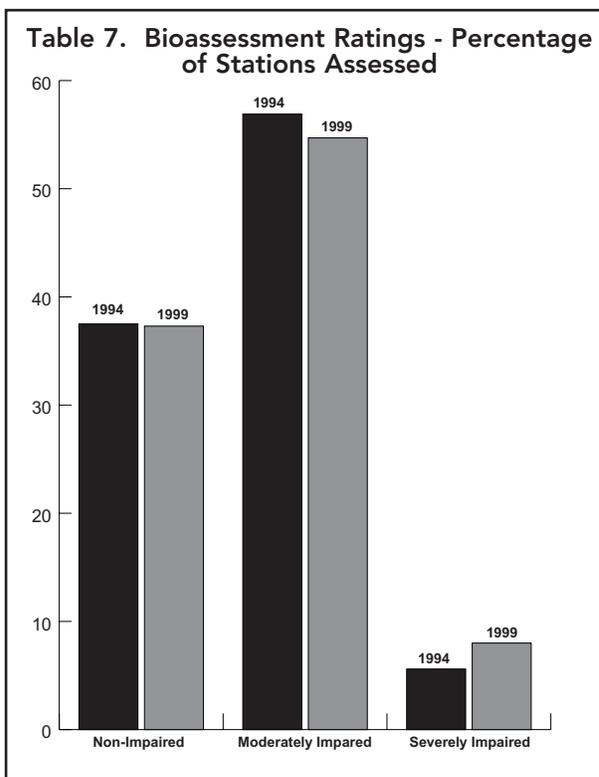
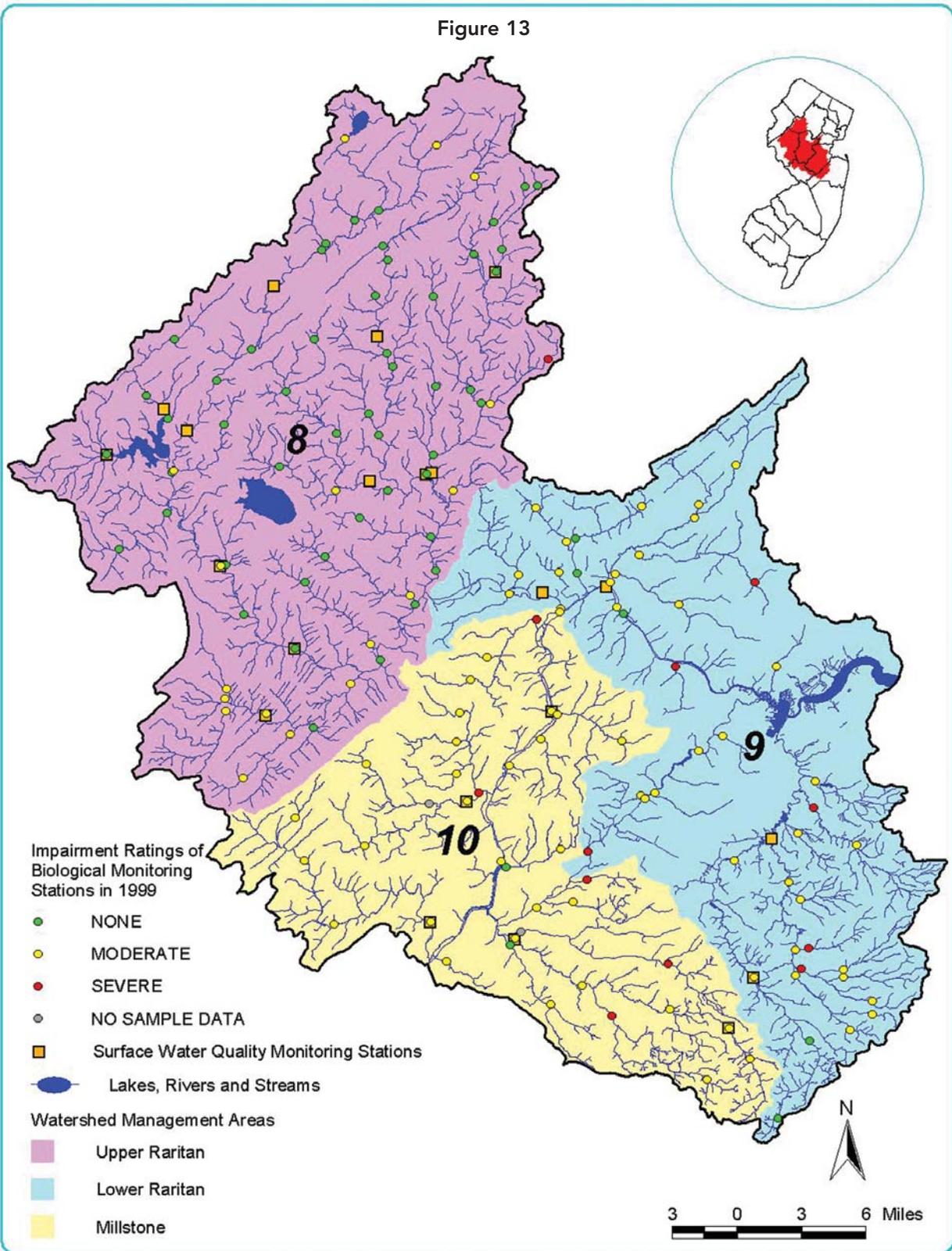


Figure 13



The Raritan Basin contains 152 biological monitoring sites (AMNET) and 21 water quality monitoring locations (NJDEP / USES)

Raritan Basin: Portrait of a Watershed

How do people in the Raritan Basin affect water quality?

People in the Raritan Basin affect its water quality through the activities of everyday life. The water that we use every day to shower or flush the toilet is disposed via a septic system or public sewer system. If the wastewater is sent to a septic system, the solids and grease are removed in the septic tank and the effluent is sent through an underground leachate field where the water infiltrates to ground water. Wastewater sent to a public sewer system is conveyed to a municipal wastewater treatment plant where the wastewater is treated, disinfected, and then usually discharged to a surface water body.

People also may affect the water quality in the Basin by over-fertilizing their lawns, improperly disposing of pet waste, driving vehicles that leak antifreeze or oil, and improperly storing household chemicals outside. Stormwater washes lawn and agricultural fertilizers and pesticides, pet wastes, and deposits on roads and driveways into the stormwater drainage system and conveys them to a nearby water body.

What are the water quality issues in the Raritan Basin?

In the Raritan Basin, the pollutants of most frequent concern are phosphorus and fecal coliform. Phosphorus stimulates excessive growth of aquatic plants and algae, causing eutrophication of water bodies. While phosphorus occurs naturally from the weathering of some rocks and sediments, major sources include agricultural and lawn fertilizers and treated wastewater effluent. Fecal coliform bacteria signify contamination and the potential presence of waterborne disease-causing bacteria and viruses from the digestive tracts of mammals. Fecal coliform in water may be from untreated wastewater such as failing septic systems or sewer breaks, wildlife, farm animals and pets. When fecal coliform concentrations exceed the water quality standards, the water is unsuitable for swimming and other primary contact recreation.

Besides total phosphorus and fecal coliform, other water quality problems were discovered in localized areas of the Basin. At some sampling sites, pH was either too high (basic) or too low (acidic), some of which may be natural. In the Upper Raritan WMA, some trout waters exceeded acceptable temperature levels. A few pesticides were detected above human health criteria in the Stony Brook, Neshanic River and the Raritan River at Bound Brook. Fish tissue samples in lakes indicate bioaccumulation of mercury. NJDEP is doing further analysis of heavy metals levels, including mercury, in the Basin.



Waterfowl add to the fecal coliform found in our waterways

How many surface water bodies in the Raritan Basin are impaired and by what?

A total of 121 water body segments in the Basin are listed as impaired on the Impaired Water Bodies list (category 5 of NJDEP's 2002 Integrated list). The use impairments are non-support of primary contact recreation, non-support of aquatic life, vegetation interference with boating, and fish and shellfish consumption advisories. The pollutants of concern are temperature (in trout waters), dissolved oxygen, total phosphorus, fecal coliform, pH, excessive macrophyte growth, sedimentation, and mercury in fish tissue.

In addition, NJDEP has issued a schedule of TMDLS and other responses they intend to complete by 2004. For the Raritan Basin seven TMDLS will be developed for fecal coliform. At 13 sites in the Raritan Basin, additional monitoring for up to 9 different metals will be performed to confirm impairments.

THE WATERSHED MANAGEMENT PLAN

The Raritan Basin Watershed Management Project has completed its initial characterization and assessment of the Basin. With this knowledge, the stakeholders and project team can begin working to improve conditions throughout the Basin through the development and implementation of the watershed management process and plan.

What is Watershed Management?

You may have heard a new term when people talk about the environment—that term is “watershed management.” “Watershed management” is:

- An assessment of watershed characteristics to determine the condition (the health) of the network of streams and water bodies within a watershed, including both ground and surface waters;
- The development of watershed goals and objectives to meet public priorities;
- The examination of human activities in the watershed to determine if behaviors and activities need to change to improve watershed health;
- The inventory and current management of all the uses of the watershed and its resources, and the identification of necessary management changes;
- The education of stakeholders about the importance of watersheds and management activities to preserve and protect water resources; and
- The implementation of strategies and activities to affect positive change in the watershed.

To determine the condition of the watershed and its water bodies, we evaluate water quality, aquatic life (such as

insects, fish, amphibians), stream channels, soil properties, land uses within the watershed, land uses along streams and water bodies, wildlife, habitat, population density, impervious (impermeable) surfaces, quantity and quality of wetlands, and other types of information. To balance and manage the uses of the watershed and its resources, we determine what the uses are by developing an inventory of watershed uses (such as a water budget), assessing habitat and defining what uses are most important to society.

Effective watershed management must be planned, not random or ad hoc. This process, which includes the development of a watershed management plan, is currently underway and is called the Raritan Basin Watershed Management Project. The process encompasses activities and projects that improve the condition or prevent further degradation of the watershed and its associated water bodies, such as:

- Development of watershed goals and objectives;
- Development of strategies to ensure achievement of watershed goals;
- Development of projects to enhance or restore the watershed.



Raritan Basin: Portrait of a Watershed