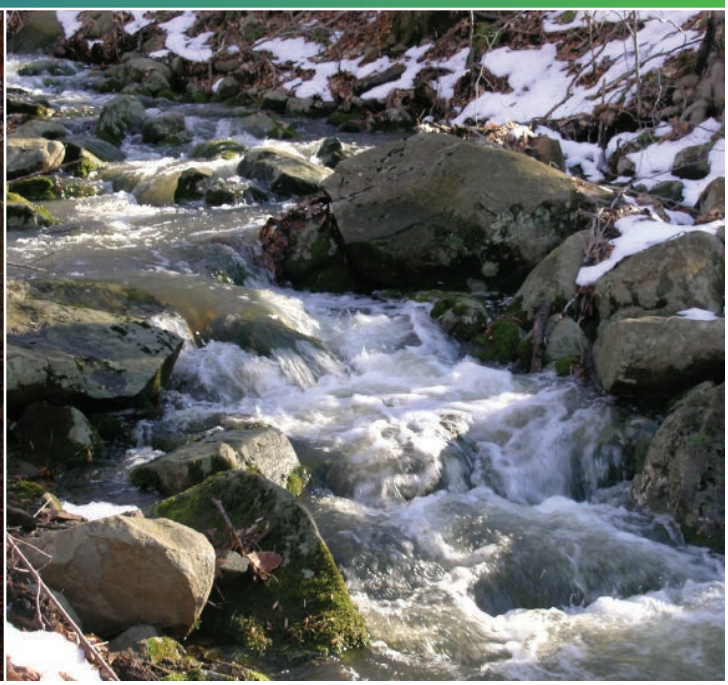
2008 NATURAL RESOURCE INVENTORY

UPDATED 2012 & 2015

West Amwell Township

HUNTERDON CO
NEW JERSEY



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DEDICATIONS

TO THE NATURAL ENVIRONMENT OF WEST AMWELL TOWNSHIP
for providing unique beauty and healthful resources for our community

TO THE RESIDENTS OF WEST AMWELL TOWNSHIP
who depend on and enjoy these precious resources

ACKNOWLEDGEMENTS

TO THE HUNTERDON COUNTY PLANNING BOARD
for assistance with maps and data interpretation

TO THE STONYBROOK MILLSTONE WATERSHED ASSOCIATION
for review of the Natural Resource Inventory and assistance with maps

TO THE DELAWARE TOWNSHIP ENVIRONMENTAL COMMISSION
for permission to use their Natural Resource Inventory

TO THE ASSOCIATION OF NEW JERSEY ENVIRONMENTAL COMMISSIONS — ANJEC
for providing model Natural Resource Inventories

TO THE MEMBERS OF THE WEST AMWELL TOWNSHIP ENVIRONMENTAL COMMISSION
who have volunteered hundreds of hours to research,
write and assemble this document

Original NRI July 2008, updated December 2012 and July 2015

2008 NATURAL RESOURCE INVENTORY

UPDATED 2012 & 2015

West Amwell Township

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SECTION 1

Introduction

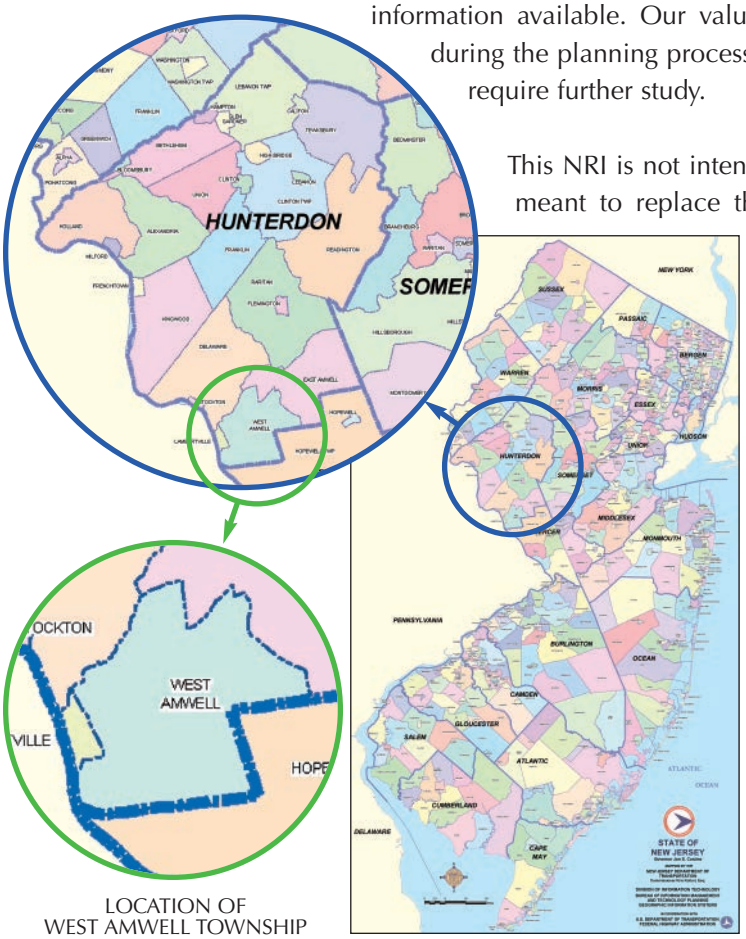
"We are starting to see that our energy and environmental ills stem, essentially, from the same source: from patterns of growth and development that waste our energy resources just as liberally as they lay waste our natural environment.

We no longer live in a time when we were few and the land was wide and waiting for us.

We have reached a point where we can no longer insulate ourselves from the punishment and pollution we visit upon the earth and the atmosphere, and where the natural resources we once regarded as so endlessly available and expendable are becoming increasingly hard to get."

— EXCERPTED FROM 1977 NATURAL RESOURCE INVENTORY OF WEST AMWELL TOWNSHIP

This Natural Resource Inventory documents the natural resource base of West Amwell Township and presents considerations for public policy and land use. All maps and data presented here represent the most up-to-date information available. Our valuable natural resources merit consideration during the planning process and may be indicators of larger issues that require further study.



LOCATION OF WEST AMWELL TOWNSHIP

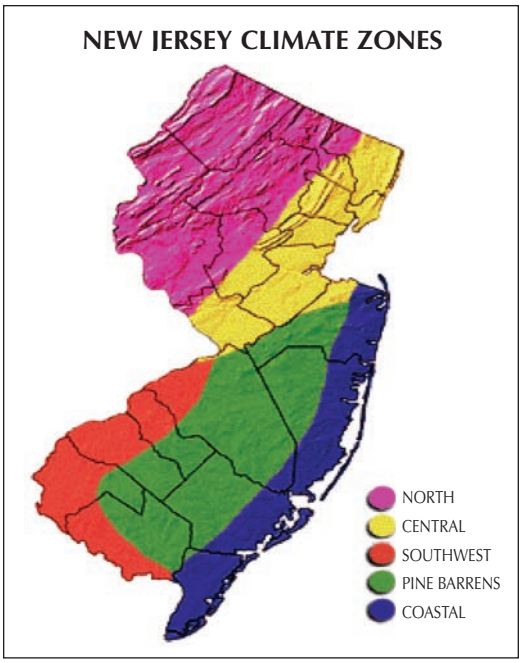
This NRI is not intended to produce original research and is not meant to replace the primary data sources upon which it is based. It is intended for preliminary assessments of projects and cannot substitute for on-site testing and evaluations.

Some components of the environment have been studied or presented in detail, while other important factors may have been minimally addressed. When new or updated information becomes available or new issues emerge, updates will be appended to the NRI.

Existing map sources provided the basis for establishing the location of natural resources presented in this NRI. Since the maps were not field verified, the resource mapping is intended for general planning purposes and should not substitute for site-specific surveys.

SECTION 2

Climate

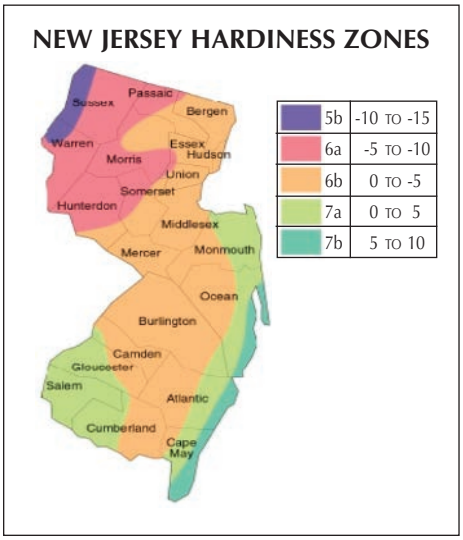


Viewed on a global scale, West Amwell Township is situated in the North Temperate Zone, the part of the Earth's surface between the Arctic Circle and the Tropic of Cancer. Temperate forested areas occur in eastern North America and central Europe. This forest biome has well-defined seasons with distinct winters but also has a moderate climate and a growing season of 140-200 days during four to six frost-free months. Fertile soils support temperate forests and moderately dense forest canopy, which allows light penetration and promotes well-developed and richly diversified understory and animal life.

At the local level, West Amwell Township is in the northern climate zone of New Jersey. Hunterdon County is generally not influenced by the Atlantic Ocean and therefore has a continental type of climate. Prevailing winds are from the southwest in summer and from the northwest in winter. The average low temperature is 32 degrees and the average high temperature is 78 degrees. The annual average temperature is 53 degrees.

Compared with central and southern New Jersey, West Amwell Township generally has colder temperatures and greater snowfall in winter, with a greater average annual precipitation overall. Precipitation amounts (rainfall and rainfall equivalent of snowfall) average 48.8 inches annually. Spring and summer months tend to experience temperatures consistent with those found in the rest of the state, averaging between 51 and 73 degrees Fahrenheit.

The difference between the continental and coastal climate types has a profound effect on length of growing season, characterized by the dates of first and last killing frost. Varying within the region as well as from year to year, the growing season averages 155 days. The average date of the last killing frost is May 4 and the average date of the first killing frost is October 7. Areas within the northern climate zone have, however, experienced killing frosts as early as mid-September and as late as mid-June. Another climate indicator is the hardiness zones established by the United States Department of Agriculture.



As depicted on the adjacent map, West Amwell Township falls within Zone 6b, with an average annual minimum temperature range of 0 to -5 degrees Fahrenheit. The Indicator Plant Examples for Zone 6b that are native to the region include:

- Red Maple (*Acer rubrum*)
- Tulip Tree *(Liriodendron tulipifera)*
- Dogwood *(Cornus spp.)*
- Red Oak *(Quercus rubra)*
- Spicebush *(Lindera benzoin)*
- Viburnum *(Viburnum spp.)*

Hardiness zones are critical for successful cultivation or maintenance of landscape plant material. Landscape plants are rated by the minimum zone that can be tolerated. As an example, if a shrub is rated as hardy in Zone 7a, it will tolerate an average annual min-

imum temperature of 0 to 5 degrees Fahrenheit and can survive in any Zone above 7a. It would likely not survive winters in West Amwell, however, as the Township is rated within Zone 6b. Aside from cold hardiness, a number of other factors affect plant growth, including soil pH, sun exposure, rainfall and artificial micro-climate. Artificial micro-climates are those which can be altered by the nature of the built environment. The proximity of buildings, artificial landform (severe grading), adjacency to a highway or parking lot and/or planting of material in planters or other elevated structures can all affect plant growth.

Some of the information contained in this section has been adapted from the Delaware Township NRI.

SECTION 3

Land Use / Land Cover

Land Cover

According to a 1995 New Jersey Department of Environmental Protection (NJDEP) Land Use/Land Cover analysis, forested lands were the most prevalent land cover, composing 45.36 percent of the Township (6,333 acres). Agricultural lands composed 32.85 percent of the Township (4,587 acres). The remaining land cover was: urban, 12.34 percent (1,724 acres), wetlands, 8.30 percent (1,159 acres), water, 1.01 percent (141 acres) and barren land, 0.13 percent (18 acres). Figure 1 depicts the 1995 NJDEP data.

WEST AMWELL'S ALEXAUKEN CREEK WILDLIFE MANAGEMENT AREA

According to a 2007 NJDEP Land Use/Land Cover analysis, forested land was still the most prevalent land cover, composing 44.43 percent of the Township (6,212 acres). Agricultural lands composed 28.76 percent (4,021 acres). The remaining land cover was: urban, 17.25 percent (2,411 acres), wetlands, 8.19 percent (1,146 acres), water, 1.23 percent (171 acres) and barren land, 0.14 percent (19 acres) for a total of 13,980 acres. Figure 2 depicts the 2007 NJDEP data.

The Sourland Mountain is West Amwell's largest forested area, but wooded areas are also widely distributed throughout the Township. The areas that flank both sides of the mountain are well suited for agricultural purposes. Agricultural lands are fairly dispersed throughout these areas with a larger proportion located north of the Sourland Ridge. Urban land uses are present as residential properties located throughout the Township, and are also concentrated in the newer, denser residential developments located in the northwest and north central parts of the Township.

Wetlands, water and barren lands make up a majority of the remaining land cover found in the Township. While the majority of the wetlands are found in the Sourland Ridge, many wetland areas are found adjacent to stream corridors. The water cover (as streams) in West Amwell is comprised of the Alexauken Creek, Moore's Creek, Swan Creek, Peter's Brook and Back Brook. The Township is dotted with small ponds and lakes in addition to the United Water Company reservoir.

Between 1995 and 2002, 563 acres of land in agricultural production was converted to other land uses, a loss of 4 percent. Urban areas increased by 2.4 percent (335 acres) and wetlands decreased slightly by 0.07 percent (9.28 acres). Although forested land increased slightly by 0.97 percent (135.5 acres), this change is likely due to improved data quality and land cover classification methods rather than physical change of the landscape. Barren lands increased by 0.55 percent (76.74 acres). Barren lands within the Township, as classified in the NJDEP Land Use/Land Cover data, primarily comprise transition areas under development when the data was interpreted.

Population Change 1970-2000

West Amwell's population increased 11.3 percent between 1970 and 2000, from 2,142 to 2,383. See Table 1.

According to the NJ Department of Consumer Affairs, the estimated population for 2008 was 2,944 which means that the change in the population from 2000 to 2008 increased 23.5 percent.

Table 1: *West Amwell Population Change, 1970-2000*

YEAR	1970	1980	1990	2000	CHANGE 1970 - 2000	% CHANGE 1970 - 2000
POPULATION	2,142	2,299	2,251	2,383	+241	+11.3%

West Amwell Demographics

- 2,383 people based upon the 2000 census
- 2,944 people based upon an estimate in 2010 from the NJ Department of Consumer Affairs (This number is taken from the 2010 census which is being challenged by the Township)
- 21.9 square miles (5.1 percent of Hunterdon County)
- 984 housing units (2.2 percent of Hunterdon County)

Land Use Build-Out Analysis

West Amwell Township completed a land use build-out analysis in accordance with the requirements of N.J.A.C. 7:8-4.2. This analysis involved the use of data from multiple sources including the NJDEP Geographic Information System (GIS) Office, the Hunterdon County GIS Department and information obtained from the Township of West Amwell. Four steps were undertaken to complete this analysis:

1. The first step was to evaluate the total land area in each of the HUC14s within the Township. Six different HUC14s (Section 8 contains a description of HUCs or Hydrologic Unit Codes) and 11 zoning designations are present in the Township.
2. The second step in the process was to determine all lands in the Township that are constrained from future development. Constrained lands included areas within 300 feet of Category 1 designated streams, areas identified as Freshwater Wetlands by NJDEP, areas with slopes greater than 25 percent, properties that are designated as preserved farmland and other open space.
3. Next, the Township's zoning ordinance was reviewed to determine the maximum allowable impervious cover for each zoning designation. This was included in the analysis to determine the maximum potential impervious cover in each HUC14 under full build-out

conditions.

4. Finally, pollutant loads generated under full build-out were analyzed and then compared to existing conditions. This was done using a unit real loading model as specified by the New Jersey Stormwater Best Management Practices Manual. The parameters that were evaluated by HUC14 were Total Phosphorus (TP), Total Nitrogen (TN), and Total Suspended Solids (TSS).

Appendix 1 contains the complete build-out analysis prepared for West Amwell.

SECTION 4

Hydrogeology

Geology

West Amwell Township sits atop three primary geologic formations: the Lockatong, Passaic and Diabase.

- The Lockatong Formation lies along the southern portion of the Township. This formation is the oldest in West Amwell. It is composed of grayish-red, dark brown, and grayish-purple mudstones, argillaceous sandstones and siltstones.
- The Passaic Formation is encountered beneath West Amwell Township in three bands oriented southwest to northeast. This formation is typically red–brown, brownish-purple and grayish–red shales, siltstones, silty mudstones and argillaceous very fine-grained sandstones.
- The Diabase Formation is the youngest formation in West Amwell and is found primarily underlying the Sourland Mountain. Diabase was formed by magmas (molten rock) and is dense and hard.

Groundwater

Groundwater exists in cracks, faults and other openings in bedrock or between the grains of rock. Rock that has many open spaces between grains is said to have primary porosity. Rock with little or no opening between grains is considered non-porous. Non-porous formations do not allow groundwater to travel through—groundwater is accessible only in fractures. The number, distribution and interconnectivity of fractures control the availability of groundwater for use and consumption. Wells must be able to connect to fractures in order to bear water.

- The Lockatong Formation has limited fractures, and where they do exist, they tend to be narrow and intermittent.
- The Passaic Formation, although equally non-porous, is somewhat more heavily fractured. The conditions found in this formation can vary significantly. Some portions, covered by thick sand and gravel deposits, are generally good sources of groundwater. Other areas, although well-fractured, are overlain by a “baked” shale, typically located on either side of the Diabase Formation. These areas provide very poor groundwater access.
- The Diabase Formation is the poorest source of groundwater. The rock has virtually no permeability. Because this formation is relatively young compared to other formations, it

has not been subjected to folding and faulting that allow groundwater to move toward the surface. In addition, surface water generated by snow and rainfall runs off rapidly with virtually no opportunity for infiltration. Conditions created by the Diabase Formation have also metamorphosed portions of the adjacent geologic formations, resulting in similar conditions in these areas.

All of the geologic formations lying beneath West Amwell consist of non-porous material. Because of the limitations of non-porous material, access to groundwater and septic suitability are severely limited. Future development must reflect land use considerations that preserve the quality and availability of West Amwell's limited groundwater resources.

Local Aquifer System

Aquifer boundaries, which are defined and designated by the NJDEP and U.S. Environmental Protection Agency (USEPA), are indicated in Figure 3. The eastern portion of the Township near the borders with East Amwell and Hopewell townships is located within the Northwest New Jersey Sole Source Aquifer. According to NJDEP, sole source aquifers contribute more than 50 percent of the drinking water to a specific area and the water would be impossible to replace if the aquifer were contaminated. The western portion of the Township and the City of Lambertville near the Delaware River are located within the New Jersey Coastal Plain Aquifer System. The central portion of the Township is not located within a designated sole source aquifer; however, the bedrock beneath this section of the Township is the only source of drinking water.

The hydrogeologic characteristics of these aquifers depend on the type of bedrock and nature of the fractures and other openings. Rocks such as those encountered beneath West Amwell Township generally have no intergranular openings and, therefore, no primary porosity for transmitting water. In these types of rocks, groundwater storage and transmittal depend on the secondary porosity or the openings between blocks of impermeable rock. In shales, sandstones, argillites, siltstones, mudstones, and diabase sills, these openings are typically associated with fractures from faults or found near joints or along bedding planes.

OLD ROCK ROAD

Since groundwater in bedrock aquifer systems is stored and transmitted along fractures, joints, and bedding planes, water availability depends on the separation between fractures, the degree to which these fractures are interconnected, and weathering of the materials between fracture planes. In some rocks, fractures are separated by a few inches of competent, unweathered, and impermeable bedrock. In other rocks, the distance between fracture openings may be several feet. In some areas such as near major regional faults, fractures form highly connected networks; therefore, more water can be stored and transmitted. In areas where a single or few fractures are available there is little storage or transmission capability.

The extent of fracturing depends on rock type and the amount of weathering. In some rock types, silts and clays are the predominant residual soils developed from weathering. In other rocks, sands, gravels, cobbles and boulder-sized particles will result. Weathering increases fracture size and may result in increased fracture interconnection. Weathering is typically more pronounced within 75 feet of ground surface and generally

decreases with depth. Therefore, the greatest groundwater yield can often be obtained from the shallower portion of the aquifer. Individual formations vary in available yield owing to differences in rock type and weathering patterns. These differences should be considered when a well is installed.

Stockton Formation

The Stockton Formation has a median yield ranging from 15 to 18 gallons per minute (gpm) and is considered to be a good bedrock aquifer capable of meeting most water-supply needs. However, it is only mapped in the southeastern corner of the Township and encompasses fewer than three acres, or 0.02 percent of total area. Given the limited extent of the Stockton Formation in West Amwell, it is not considered to be a significant groundwater resource for the Township.

Lockatong Formation

The Lockatong Formation is encountered in the southern portion of West Amwell and encompasses approximately 3.4 square miles, or 15.5 percent of the Township. Thin bedded shales are the primary water-bearing layers and are often confined by thick-bedded siltstones. The Lockatong is a poorly yielding aquifer with a median yield ranging from 4 to 7 gpm, or less than half the median yield of the Stockton Formation. It has a significantly lower capacity to transmit water than the Stockton Formation. Available data also indicates that the Lockatong Formation beneath West Amwell has less potential to transmit water than the same formation beneath the Stony Brook, Bedens Brook, and Jacob's Creek basins in nearby Hopewell Township.

Passaic Formation

Regionally, the Passaic Formation is considered a good aquifer with characteristics similar to the Stockton Formation. It is encountered beneath West Amwell Township in three bands oriented southwest to northeast. A small band encompassing approximately 3.9 square miles is located southeast of the Sourland Mountain. A second band, encompassing approximately 0.4 square miles, is located immediately northwest of the Sourland Mountain between the primary diabase sill that forms the mountain and an interconnected sill further north. The third band underlies the northern portion of the Township and encompasses approximately 8.3 square miles. The Passaic underlies 56 percent of the Township in total.

The Passaic is usually capable of meeting most water-supply needs except in areas adjacent to diabase intrusion. The metamorphic effects of the intrusion significantly reduce the ability of the Passaic Formation to transmit and store water. As the formation is often found adjacent to Diabase intrusions in West Amwell, it has been observed that the Passaic is significantly less capable of transmitting or storing water in the Township than elsewhere in Hunterdon or nearby Mercer County. The Passaic has a regional yield of 10 to 15 gpm; however, the median yield in West Amwell is 5 to 6 gpm.

Diabase Formation

Diabase intrusions are highly resistant to erosion and as a result are found at the highest elevations in West Amwell Township. The largest diabase sills are encountered beneath the Sourland Mountain. Two large linear sills are directly connected to the Sourland Mountain. One of these sills parallels and is directly north of Rocktown-Lambertville Road and the second one trends to the southwest from Wilson Road to Mount Airy-Harbourton Road. Two smaller sills have also been mapped north of West Amwell Elementary School and intersecting the border with Lambertville. These intrusions encompass approximately 5.9 square miles, or 27 percent of West Amwell Township.

Diabase is generally a poor aquifer system. It has few fractures and distances of more than 1 foot often separate these fractures. Wells completed in Diabase exhibit a median yield of 5 gpm. Diabase also has a lower capacity to transmit water at depth.

Figure 4 shows the locations of the formations underlying West Amwell Township.

Appendix 2 contains a detailed description of each formation.

Summary

The bedrock aquifers beneath West Amwell Township are significantly less capable of yielding or transmitting water than those measured elsewhere in Hunterdon or Mercer counties. This is a concern for the residents of West Amwell who largely depend on individual groundwater supply wells for potable water. The density of housing and application of surface and subsurface improvements can reduce aquifer recharge and yields, and increase interference and degradation of groundwater quality. In areas of the Township where aquifer yields and recharge are limited or strained, additional development may degrade groundwater.

ABOVE-GROUND DIABASE FORMATION

In addition, the eastern portion of West Amwell Township is within New Jersey Regional Water Resource Planning Area (RWRPA) 10, which is the third most-populated RWRPA in the state and continues to grow. West Amwell has some of the highest elevations within the southwestern portion of RWRPA 10 and is an upland recharge area for the Raritan River Watershed. The westernmost portions of the Township are located within RWRPA 9, which is the Trenton Delaware Tributaries. This area encompasses the portion of the Township that drains toward the Delaware River.

The protection of the quality and availability of groundwater resources is a priority for West Amwell Township, for current and future residents and businesses, and for downstream consumers in RWRPAs 9 and 10.

SECTION 5

Well Head Protection Areas

The 1986 Federal Safe Drinking Water Act Amendments (Section 1428, P.L. 93-523, and 42 USC 300 et. seq.) direct all states to develop a Well Head Protection Program (WHPP) Plan for public community and public non-community water-supply wells. New Jersey's WHPP Plan was approved by the USEPA in December 1991. A goal of the WHPP Plan is to prevent contamination of groundwater resources, which provide drinking water to roughly 42 percent of New Jersey's population.

The delineation of Well Head Protection Areas (WHPAs)—areas from which wells draw their water within a specified time—is one component of the WHPP. Once delineated, these areas become a priority for efforts to

prevent and clean up groundwater contamination. Existing and potential pollution sources may be managed in relation to their location within the WHPA and proximity to the public well. Other components of the WHPP Plan include pollution-source inventories, development and implementation of best management practices to protect groundwater, land-use planning, and education to promote public awareness of each person's role in protecting our groundwater resources.

A Public Community Well (PCW) is defined as a well that supplies public community water systems serving at least 15 service connections used by year-round residents, or used by at least 25 year-round residents. No Public Community Well Head Protection Areas exist in West Amwell Township.

A Public Non-Community Well (PNCW) is a well that serves as either one of the following:

- A public non-transient non-community water system – a public water system that is not a public community water system and that regularly serves at least 25 of the same persons for more than six months in any given calendar year (schools, hospitals, businesses, etc.)
- A public transient non-community water system – a public water system that is not a public community or a public non-transient non-community water system and that serves at least 25 transient individuals for at least 60 days in any given calendar year (restaurants, etc.)

According to NJDEP, there are currently 12 PNCW Well Head Protection Areas within West Amwell Township or on the border with neighboring towns. Figure 5 shows their locations. These include, but are not limited to, schools, restaurants, convenience stores and other small businesses.

The West Amwell Board of Health is developing an ordinance for protection of drinking water. This ordinance will address concerns specific to the Township regarding groundwater protection and will implement policies to manage protected well head areas and prevent negative impacts to our groundwater supplies.

Some information contained in this section has been adapted from NJDEP Guidelines for Delineation of Well Head Protection Areas in New Jersey.

SECTION 6

Soils

Soils provide the basis for the potential land uses within West Amwell. They determine the types of vegetation or crops that can be grown and influence the way development can take place. Soils are a non-renewable resource and must be appropriately managed. The loss of farms to residential and commercial development carries a cost in terms of losses to cultural and aesthetic aspects of a community's character—and in terms of losses of quality soils.

Development converts soils from their historic agricultural or open space uses into permanent non-use. Considering significant soils in the planning process is vital to maintaining the Township's rural character and achieving Master Plan goals and objectives.

Soils are formed by forces of the environment acting on material deposited or accumulated by geologic processes. The characteristics of a soil at any given location are determined by the climate in which the soils' material has accumulated; the climate in which it has existed since accumulation; the physical and mineralogical composition of the parent material; the relief or slope of the land that influences drainage, moisture

content, aeration, susceptibility to erosion, and exposure to the sun and elements; the biological forces (plants and animals) acting upon the soil; and the length of time the climate and biological forces have had to act on the soil.

Erosion can be a concern and the erodability of a soil type is determined by the soil infiltration capacity and the ease with which particles dislodge in precipitation or under flow conditions. Silty and fine sandy soil particles tend to detach easily resulting in highly erodable conditions. These soils are less erodable when particles with binding properties such as clay or organic matter increase in the soil's composition. Coarse sandy or gravelly soils are not typically erodable because they are highly permeable and tend to be easily infiltrated by surface water, slowing runoff. Soils with low erodability show significant signs of erosion when occurring on steep slopes. Figure 6a depicts highly erodable soils in the Township. West Amwell has very few areas which are not highly erodable or potentially highly erodable.

The U.S. Department of Agriculture Soil Conservation Service has mapped soils throughout New Jersey. These maps have been included in the New Jersey Geological Survey (NJGS). Based on the Soil Conservation Service mapping, 35 general soil types have been delineated within West Amwell Township. Figure 6b shows these general soil classifications. Some of these classifications were further subdivided based on the steep gradient of slopes and/or potential limitations for subsurface wastewater disposal systems.

Table 2 provides a summary of the slope ranges, approximate areas encompassed, and the potential septic system limitations as described by the Soil Conservation Service for the various soil types within the Township (Jablonski 1988). Chalfont silt loam, Lehigh silt loam, Mt. Lucas-Watchung very stony silt loam, Penn shaly silt loam, Neshaminy-Mt. Lucas very stony silt loam, and Lawrenceville silt loam are the most common soils beneath the Township. These soils and associated variants underlie more than 63 percent of West Amwell Township.

Chalfont soils are deep, fairly flat to steeply sloping, poorly drained soils, typically with a shallow water table and fragipan derived from weathering of the underlying dark gray shale bedrock.

Lehigh soils are characterized as deep, gentle to moderately sloping, well drained to poorly drained derived from weathering of the underlying shale bedrock.

Mt. Lucas-Watching soils are composed primarily of Mt. Lucas soils with minor percentages of Watchung soils. Both of these soils are derived from the underlying diabase bedrock and are described as deep, nearly level to gently sloping, moderately well drained to poorly drained.

Penn shaly soils are moderately deep, gently to moderately steeply sloping, well-drained loam derived from weathering of the underlying red shale bedrock.

Neshaminy-Mt. Lucas very stony loam soils are composed primarily of well-drained Neshaminy soils and moderately wet Mt. Lucas soils, both of which are derived from weathering of the underlying diabase bedrock.

Lawrenceville silt loam is derived from weathering of the underlying shale and is considered deep, gently to steeply sloping, well-drained soil.

The Klinesville shaly loam and rough broken land shale materials may be considered a second tier of commonly found soils beneath West Amwell Township. The areas mapped as rough broken land shale and Klinesville soil each comprise nearly 5 percent of Township soils. The Klinesville soils are shallow, well-drained materials that form gentle to steep slopes. The areas mapped as rough broken land shale are gen-

erally composed of rock outcroppings and are often steeply sloping.
The Soil Conservation Service indicates that the following soils in West Amwell Township have severe limitations for the disposal of septic system effluent: Abbottstown, Bowmansville, Chalfont, Croton, Klinesville, Lehigh, Mt. Lucas, Norton, Pattenburg, Penn, Reaville, rough broken land shale, Rowland, and Watchung. In addition, the steep sloping areas underlain by the Hazleton, Legore, Neshaminy and Quakertown series are also considered to have severe limitations for septic systems. These soils, in conjunction with the two gravel pits, underlie nearly 84 percent of West Amwell Township. One of the former gravel pits is beneath Mount Airy-Harbourton Road and the second is adjacent to Old River Road and is primarily composed of bedrock and disturbed soils. If soils with moderate restrictions are included, more than 97 percent of the Township is underlain by soils with limited capability for septic discharges.

Refer to Appendix 2 for an in-depth analysis.

General Soil Type	Slope Range (percent)	Approximate Area (acres)	Septic Limitations
Abbottstown silt loam	0 to 6	38.5	Severe-seasonal high water at 0.5 to 1.5 feet
Bowmansville silt loam		51.2	Severe-flooding
Bucks silt loam	2 to 12	228.6	Moderate-bedrock 4 to 6 feet
Chalfont silt loam	0 to 12	2202.2	Severe-seasonal high water at 0.5 to 1.5 feet
Chalfont very stony silt loam	2 to 12	136.1	Severe-seasonal high water at 0.5 to 1.5 feet
Chalfont-Lehigh very stony silt loam	2 to 12	92.2	Severe-seasonal high water at 0.5 to 1.5 feet
Chalfont-Quakertown silt loam	0 to 6	26.5	Severe-seasonal high water at 0.5 to 1.5 feet
Croton silt loam	0 to 6	32.5	Severe-seasonal high water at 0 to 1 foot
Croton very stony silt loam	0 to 6	16.3	Severe-seasonal high water at 0 to 1 foot
Gravel Pit		6.9	
Hazleton channery loam	2 to 12	113.6	Moderate-bedrock 4 to 6 feet
Hazleton channery loam	12 to 18	67.9	Severe-moderately steep slopes
Hazleton very stony loam	18 to 40	53.3	Severe-steep slopes, excessive stones
Klinesville shaly loam	4 to 18	656.2	Severe-shallow pervious shale bedrock at 1 to 1.5 feet
Lawrenceville silt loam	2 to 12	859.5	Moderate-seasonal high water perched at 1.5 to 3 feet, bedrock at 4 to 6 feet
Legore gravelly loam	2 to 6	5.5	Slight
Legore gravelly loam	6 to 12	135.7	Moderate-bedrock 5 to 6 feet
Legore gravelly loam	12 to 18	63.6	Severe-moderately steep slopes
Lehigh silt loam	2 to 18	1741.2	Severe-bedrock at 3.5 to 5 feet, seasonal high water at 0.5 to 2 feet
Lehigh very stony silt loam	2 to 18	215.6	Severe-bedrock at 3.5 to 5 feet, seasonal high water at 0.5 to 2 feet, very stony
Mt Lucas silt loam	0 to 6	132.0	Severe-seasonal high water at 0 to 2.5 feet, hard bedrock at 4 to 8 feet
Mt Lucas-Watchung very stony silt loam	0 to 6	1657.0	Severe-seasonal high water at 0 to 2.5 feet, hard bedrock at 4 to 8 feet
Neshaminy silt loam	2 to 6	360.1	Slight
Neshaminy silt loam	6 to 12	224.5	Moderate-bedrock 4 to 6 feet
Neshaminy very stony silt loam	2 to 40	558.9	Severe-very stony to steep slopes
Neshaminy-Mount Lucas very stony silt loam	2 to 12	927.3	Severe-very stony, seasonal high water 0.5 to 2.5 feet, hard bedrock 4 to 8 feet
Norton loam	2 to 6	16.1	Severe-slow permeability
Pattenburg gravelly loam	18 to 40	2.4	Severe-steep slopes
Penn shaly silt loam	2 to 18	1454.2	Severe-shallow shale bedrock at 1.5 to 3.5 feet
Penn-Bucks complex	2 to 12	124.8	Penn-severe to Bucks-moderate
Pope fine sandy loam		20.0	Slight-if no flooding, severe where subject to flooding, groundwater pollution likely
Quakertown silt loam	2 to 12	248.0	Moderate-bedrock 4 to 6 feet
Quakertown silt loam	12 to 18	41.7	Severe-moderately steep slopes
Readington silt loam	6 to 12	23.5	Moderate-seasonal high water at 1.5 to 3 feet and bedrock at 3.5 to 5 feet
Reaville silt loam	2 to 12	248.5	Severe-seasonal high water at 1 to 2.5 feet, bedrock at 1.5 to 2.5 feet
Reaville silt loam-wet variant	0 to 6	118.2	Severe-seasonal high water at 0 to 1 foot, bedrock at 1.5 to 2.5 feet
Riverhead gravelly sandy loam	6 to 18	6.6	Moderate-groundwater pollution hazard
Rough broken land shale		610.5	Severe-very steep, shallow bedrock
Rowland silt loam		275.0	Severe-very steep, shallow bedrock
Watchung silt loam		127.8	Severe-seasonal high water at 0 to 1 foot

Table 2: *Septic Limitations*

Some information in this section has been adapted from the Cranbury Environmental Resource Inventory.

SECTION 7

Known Contaminated Sites

The Known Contaminated Sites in New Jersey (KCS-NJ) report is prepared by NJDEP's Site Remediation and Waste Management (SRWM) Program. The report contains basic information on approximately 14,000 contaminated sites in New Jersey and provides a list of sites where contaminated soil and/or groundwater has

have been confirmed. This list includes sites with confirmed on-site sources of contamination, and sites with unknown sources of contamination. In addition, the report lists sites where the completed remediation requires engineering and/or institutional controls. Engineering controls involve the placement of physical barriers as a means of preventing exposure, such as placement of a cap. Institutional controls involve formal documentation of steps that must be taken to ensure the contamination is contained, such as maintenance and/or monitoring activity. An institutional control can also place limits on the future use of a site, such as a deed notice.

The KCS-NJ report is updated periodically. As new sites are identified and others are remediated, the number of contaminated sites in New Jersey and their status constantly change. Consequently, the KCS-NJ is a dynamic list and should always be thought of as a "snapshot" in time. Based on the listings and data files of May 9, 2008 of the KCS-NJ report, 10 active contaminated sites have been identified in West Amwell Township. (Township sites that have been previously investigated and closed by SRWM are not included.) The active site information is summarized in Table 3.

SITE ID	PI NUMBER	PI NAME	LINE 1 ADDRESS
353232	435985	100 PLEASANT VALLEY HARBOURTON ROAD	100 PLEASANT VALLEY HARBOURTON ROAD
147093	194455	1351 ROUTE 179	1351 RT 179
363419	449061	1442 HIGHWAY 179	1442 RT 179
372871	461922	322 ROCK ROAD EAST	322 ROCK RD E
80426	G000043596	329 EAST ROCK RD	329 ROCK RD E
356845	440637	337 ROCK ROAD EAST	337 ROCK RD E
6682	165762	CHRIS AUTO BODY	1409 OLD YORK RD
6680	023496	LEHIGH FLUID POWER	1413 RT 179
56659	031528	MOUNT AIRY GULF	1337 RT 179
	012380	NJDOT WEST AMWELL MAINTENANCE YARD	1406 RT 179

Table 3: *Known Contaminated Sites*

Figure 7 reflects the NJ-KCS data from Spring 2006. The NJDEP i-map GIS database had not yet been updated with the May 2008 data as of the publication of this NRI. The following sites, present on the 2006 data figure, were removed in 2008: 16 Mill Road, Algonquin Pipeline, 1490A Route 179, 219 Rock Road West, 228 Rock Road West, 26 Barry Road and 74 Barry Road. The following sites were added in 2008: 100 Pleasant Valley Harbourton Road, 1442 Route 179, 322 Rock Road East and 337 Rock Road East.

Some of the information contained in this section has been adapted from NJDEP, Site Remediation Program, Known Contaminated Sites.

SECTION 8

Streams and Subwatersheds

Streams

UNITED WATER COMPANY RESERVOIR

The physiography (look of the land) of West Amwell can be described as rolling hills, with ridges and valleys extending in the same direction as the trend of the bedrock. Thus, the valleys and ridges run northeast to southwest, as do most of the streams. Most of the streams are tributaries of the Delaware River, which is part of the western boundary of West Amwell. The Township is an extension of the Sourland Mountain that starts at Hillsborough in Somerset County and continues southeast to West Amwell. At the lower eastern corner of the Township, the Stony Brook Valley receives some of West Amwell's drainage from the area between Linvale and Route 518. The area along the southern side of the Township is the Moore's Creek basin, which flows through Hopewell Township and Pleasant Valley and then to the Delaware River. The area on the southwest side is an area of significant relief and has some short but steep unnamed tributaries that flow down over Goat Hill to the Delaware River. These small intermittent streams can be seen under the bridges and culverts where they pass under the highway along the stretch of Rt. 29 between Belle Mountain and the Wing Dam on the Delaware River. The area north of the steep Goat Hill unnamed intermittent streams is Swan Creek, which begins in the flat area at the top of the Sourland Mountain and flows into the United Water Company reservoir, which is the source of water for Lambertville. Unnamed tributaries of Swan Creek exist between Route 179 and Rocktown Lambertville Road and flow into the Delaware River. Finally, the Alexauken Creek encompasses the entire northern part of the Township. This creek begins on the northern side of the Sourland Mountain and as far up as the area near Mt. Airy and Rocktown and drains a wide area near the northern border of the Township where it contacts Delaware Township.

SWAN CREEK IN WINTER

Most of the streams generally follow the southeast trend of the rock formations and are tributaries of the Delaware River. A small area on the eastern part of the Township flows into Stony Brook and is part of the Raritan-Millstone River drainage system, and another small area in the northeast flows into the South Branch of the Raritan River system.

Alexauken Creek is the principal surface water body in West Amwell, draining 15.12 square miles and including 28.64 stream miles and 52.31 lake acres. The Alexauken runs southwest from its headwaters in West

Amwell (and East Amwell and Delaware Townships), running through the city of Lambertville and crossing under the Delaware and Raritan Canal into the Delaware River. The creek drains nearly 10 percent of the largely forested Sourland Mountain region and flows through a region facing growing development pressures.

In 2004, the NJDEP reclassified the Alexauken Creek as a Category 1 waterbody based on its connection to the federally protected Delaware River, its value as habitat for Threatened and Endangered species and the relatively undeveloped nature of its watershed.

Peter's Brook, Back Brook and Swan Creek are classified by the NJDEP as FW2-NT, which means these streams are considered general classification fresh waters, not suitable for trout; however, they may be suitable for other species. Moore's Creek is classified as FW2-TM, indicating that water quality conditions are sufficient for trout maintenance.

Figure 8a depicts the streams and waterbodies in West Amwell.

Subwatersheds

A watershed, or drainage basin, is defined as the entire land that drains water, sediment and dissolved substances to a body of water. Watershed boundaries are delineated by topography. In New Jersey, watersheds are referred to as the name of the water body to which the land area drains and the corresponding Hydrologic Unit Code (HUC). The HUC can range from 2 to 16 digits long – the longer the numeric code, the smaller the watershed area. NJDEP also has divided the state into 20 Watershed Management Areas (WMA) based on large scale drainage patterns and to address water quality and supply issues. Subwatersheds are smaller drainage basins within larger hydrological units.

Water quality is affected in various ways:

- Any pollution that occurs upstream degrades water quality downstream,
- As floodplains are altered or filled, floodwaters cause more damage, and
- New development within a watershed causes the amount of impervious surface area to increase, which results in increased runoff.

LAKE IN ALEXAUKEN SUBWATERSHED IN WEST AMWELL

For these reasons, it is best to manage natural resources using a watershed-based approach. Water quality impacts are often easier to track in subwatersheds, especially those related to non-point source pollution.* Because subwatersheds are small, it is easier to assess the location of potential pollution sources and determine effects they may have on water quality.

*Non-point source (NPS) pollution is water pollution caused by runoff from diffuse sources such as stormwater, road surfaces, agriculture, fertilizers and lawn chemicals.

According to data from NJDEP, six individual subwatersheds exist within West Amwell, four of these draining to the Delaware River and two draining to the Raritan River. None of these subwatersheds have their boundaries completely within the Township and some have only a small portion within West Amwell's boundaries. Figure 8b and Table 4 depicts the subwatersheds and their HUC codes within the Township's boundaries.

Table 4: *Subwatersheds*

WATERSHED	SUBWATERSHED	HUC 14 NUMBER	ACRES
Neshanic River	Back Brook	02030105030050	447.520
Alexauken Ck / Moore's Ck / Jacob's Ck	Alexauken Creek (below 74d 55m to 11BA06)	02040105210020	1,337.703
Alexauken Ck / Moore's Ck / Jacob's Ck	Alexauken Creek (above 74d 55m)	02040105210030	4,585.653
Stony Brook	Peter's Brook (above 74d 49m 15s)	02030105090010	1,411.68
Alexauken Ck / Moore's Ck / Jacob's Ck	Swan Creek (Moore's Creek to Alexauken Creek)	02040105210030	2,890.326
Alexauken Ck / Moore's Ck / Jacob's Ck	Moore's Creek	02040105210040	3,289.60

SECTION 9

Surface Water Quality

Preserving and enhancing surface water quality is of great importance for preserving the quality of drinking water, aquatic habitats, and visual and recreational opportunities that the Township's streams, rivers and lakes provide. The primary method of classifying water quality for streams and rivers in New Jersey is offered in the NJDEP's Division of Environmental Planning *Surface Water Quality Standards* (N.J.A.C 7:9B). These statewide standards establish a regulatory framework and management policies based on the designation of streams as FW1 and FW2, Category 1 and 2 and either trout producing (TP), trout-maintenance (TM) or non-trout waters (NT). West Amwell does not contain any trout-producing waters.

A TRIBUTARY OF SWAN CREEK

According to NJDEP, all surface waters within West Amwell are classified as FW2, which is the general surface water classification applied to those fresh waters that are not designated as FW1 or Pinelands Waters. As a frame of reference, "FW1" means those fresh waters, as designated in N.J.A.C. 7:9B-1.15(h) that are to be maintained in their natural state of quality (set aside for posterity) and not subjected to any man-made wastewater discharges or increases in runoff from anthropogenic activities. These FW1 waters are set aside for posterity because of their clarity, color, scenic setting, other characteristic or aesthetic value, unique ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources.

Possible uses described for FW2 waters include:

- Maintenance, migration and propagation of the natural and established biota,
- Primary and secondary contact recreation,
- Industrial and agricultural water supply,
- Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation, and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfections, and
- Any other reasonable uses.

In addition to the above classification and for purposes of implementing regulatory policy, surface waters are further categorized by NJDEP as either "Category 1" (C-1) or "Category 2" (C-2). Category 1 waters are those waters designated in the tables in N.J.A.C. 7:9B- 1.15(c) through (h), for purposes of implementing the anti-degradation policies set forth at N.J.A.C. 7:9B-1.5(d), for protection from measurable changes in water quality characteristics because of their clarity, color, scenic setting, other characteristics of aesthetic value, exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources. These waters may include, but are not limited to:

HISTORIC STONE BRIDGE ON OLD ROCK ROAD

- Waters originating wholly within Federal, interstate, state, county, or municipal parks, forests, fish and wildlife lands, and other special holdings that have not been designated as FW1 at N.J.A.C. 7:9B-1.15(h) Table 6,
- Waters classified at N.J.A.C. 7:9B-1.15(c) through (g) as FW2 trout production waters and their tributaries,
- Surface waters classified as FW2 trout maintenance or FW2 nontrout that are upstream of waters classified as FW1 trout production,

STREAM ON THE SOURLAND RIDGE IN WEST AMWELL

- Shellfish waters of exceptional resource value, and
- Other waters and their tributaries that flow through, or border, Federal, state, county, or municipal parks, forests, fish and wildlife lands, and other special holdings.

Category 2 waters are those waters not designated as Outstanding National Resource Waters or Category 1 at N.J.A.C. 7:9B-1.15 for purposes of implementing the anti-degradation policies set forth at N.J.A.C. 7:9B-1.5(d).

According to NJDEP, the surface waters within West Amwell are classified as:

- Category 1 waters – Alexauken Creek (FW2-TMC1)
- Category 2 waters – Moore's Creek (FW2-TM), Swan Creek, Peter's Brook and Back Brook (FW2-NT)

Figure 9 illustrates these classifications.

Alexauken Creek falls under the antidegradation policies set forth in N.J.A.C. 7:9B-1.5(d). The remaining streams in West Amwell fall under the general anti-degradation policies of the regulations as well as those specified for Category 2 waters. General anti-degradation policies seek to protect waterways from decline in quality while protecting the designated uses set forth. In addition to general policies, where water quality exceeds levels necessary to support the designated uses, that level shall be maintained unless deterioration would accomplish important social or economic goals.

The Surface Water Quality Standards adopted by NJDEP in 1998 also established strict guidelines for the presence of numerous contaminants, both man-made and naturally occurring. Included in these categories are items such as fecal coliform, enterococci, dissolved oxygen, floating colloidal solids, petroleum hydrocarbons, phosphorus, suspended solids, total dissolved solids, sulfates and taste and odor producing substances. Also important, especially to future potential areas of Category 1 waters, are alterations to temperature and the addition of toxic substances.

On January 24, 2008, Lisa P. Jackson, Commissioner, NJDEP, signed Administrative Order No. 2008-02. This order updated guidance for the functional assessment of the Special Water Resource Protection area for Category 1 streams. Appendix 3 describes this order.

Some of the information contained in this section has been adapted from the Delaware Township NRI.

SECTION 10

Special Protection Waters Designation for the Lower Delaware River

The Delaware River is the last major free-flowing river in the East. It flows for 330 miles through four states, 42 counties and 838 municipalities. Rather than serving as a dividing line among these communities, the Delaware River is a unifying element in the landscape. Throughout history and present day, communities throughout the region, regardless of political boundaries, have been drawn together by this river recognizing it as a living resource that supports their lives.

The Lower Delaware River (from the Delaware Water Gap to Trenton) is a unique and vulnerable natural system that supports a remarkable variety of flora and fauna. For example, the restoration of shad to the Delaware River is a national success story. In the mid-20th century the Delaware River had become so polluted that it prevented migration of the historically important shad. Implementation of environmental laws and concerted action by concerned citizens and communities restored the river's water quality and ecosystems and supported the return of the shad to the Delaware River. In fact, the shad spawning area has now expanded into the Lower Delaware because river protection efforts have been so successful.

The rich ecological resources of the Lower Delaware include the endangered shortnosed sturgeon that is in need of critical protection. Many other species of fish, aquatic life, birds, and other wildlife are dependent on the river and its flowing tributaries. A remarkably well-established green riparian buffer provides important wildlife habitat and cooling. The streams, wetlands and floodplain that are part of the Lower Delaware natural system define the river in terms of its natural inventory and the quality of its resources. Much appreciated by residents and tourists alike, these ecological assets and the unique cliff formations overlooking the river, its rapids, islands and other special features, all combine to make this part of the river worthy of its Wild and Scenic designation. This Congressional action was the first step in providing essential protection to the historic, economically important and ecologically unique Lower Delaware River.

In 2000, the 106th Congress enacted Public Law 106-418 cited as the *Lower Delaware River Wild and Scenic Rivers Act.* This law incorporates most of the Lower Delaware River into the National Wild and Scenic Rivers System. The Delaware Riverkeeper Network petitioned the Delaware River Basin Commission (DRBC) in 2001 to designate these portions of the Lower Delaware River (RM 133.4-209.5) as Special Protection Waters. The petition also asked the DRBC to fulfill the requirements for prioritization of the Upper and Middle Delaware Wild and Scenic River segments, which were granted Special Protection Waters status by the DRBC in 1992 in response to a petition filed by the Delaware Riverkeeper.

The designation of the Lower Delaware River as Wild and Scenic has provided the recognition the river and its watershed need in order to protect its natural resources. The Lower Delaware River Management Plan, worked out by an interstate committee, is the foundation of the designation. Goal 1 of the plan is to protect and improve existing water quality in the river.

Special Protection Waters designation provides the mechanism by which this goal can be achieved through the requirement that all new and expanded discharges and withdrawals in the Lower Delaware River's contributing watershed meet the highest standards – standards that will protect and, where needed, improve the water quality of this part of the river. Water quality standards will be maintained through the requirements for high level sewage treatment and a non-point pollution control plan employing stormwater best management practices for the project area to be served by any new or expanded connection. Protection efforts need this kind of coordination due to the difference in regulations in the states and due to the unique resources and uses the river supports.

The DRBC has collected water quality data for the main stem river and tributary streams for several years. A resolution was adopted by the DRBC with broad public support on January 19, 2005 and renewed in September 2005, 2006, and 2007, which temporarily put in place some requirements of Special Protection Waters for the Lower Delaware River. The designation was made permanent on July 16, 2008.

The information contained in this section is courtesy of Tracy Carluccio, Deputy Director, Delaware River Basin Commission.

SECTION 11

AMNET Biological Monitoring and Water Quality

To determine the health of the streams that compose the watersheds, NJDEP uses a program monitoring benthic macroinvertebrates populations using the Environmental Protection Agency's Rapid Bioassessment Protocols – Level II procedure. Using this method, aquatic communities are examined for pollution tolerant and intolerant life forms, and the results are used to compute a New Jersey Impairment Score and Biological Condition. Biological condition of a stream sample is based on 100 organism samples taken at designated sampling sites. The benthic macroinvertebrate samples examined include representatives of various taxonomic families of insects and insect larvae, mollusks such as mussels, clams and snails, and crustaceans such as crayfish. Benthic populations are those that live in the bottom part of the water.

Ratings of the stream condition are based on the level of pollution tolerance of the families collected, the ratio of pollution tolerant to pollution intolerant families, and the biodiversity of the system (percentage of single species dominance). In New Jersey, more than 800 locations are sampled on a five-year rotating schedule. Biological impairment of streams may be caused by several major factors including non-point source pollution, point source pollution and/or a lack of stream corridor (riparian) buffers.

NJDEP's Ambient Biological Monitoring Network (AMNET) monitoring program focuses on populations of macroinvertebrates present in freshwaters. These biotic communities, which are mainly stationary and cost effective to monitor, integrate the effects of changes in water quality into their life cycle, providing effective indicators of change over time. AMNET has three monitoring stations for waterways in West Amwell providing data from 1997 and 2003. Figure 10 depicts the location of these monitoring stations, with two along Alexauken Creek and one along Moore's Creek.

The 1997 AMNET data for West Amwell shows that three of the three sites depicted on Table 5 had non-impaired benthic communities. This was not the case in 2003 (Table 6) when station AN0097 showed moderate impairment, a decrease in water quality from 24 to 21. Benthic communities present in this stretch of waterway indicate rapid decline in water quality. Station AN0100 showed an improvement in water quality from 1997 to 2003, with the rating increasing from 24 to 30. However, station AN0096 showed a slight decrease in water quality from 27 to 24.

Table 5: *AMNET Monitoring, 1997*

STATION	WATERBODY	LOCATION	MUNICIPALITY	COUNTY	SAMPLE DATE	NJIS	IMPAIRMENT	HABITAT SCORE	HABITAT RATING
AN0096	Alexauken Creek	Rocktown-Lambertville Road	West Amwell Township	Hunterdon	7-14-97	27	Non-impaired	166	Optimal
AN0097	UNT to Alexauken Creek	Queen Road to Alexauken Road	West Amwell Township	Hunterdon	7-14-97	24	Non-impaired	166	Optimal
AN0100	Moore's Creek	Barry Road	West Amwell Township	Hunterdon	7-8-97	24	Non-impaired	162	Optimal

Table 6: *AMNET Monitoring, 2003*

STATION	WATERBODY	LOCATION	MUNICIPALITY	COUNTY	SAMPLE DATE	NJIS	IMPAIRMENT	HABITAT SCORE	HABITAT RATING
AN0096	Alexauken Creek	Rocktown-Lambertville Road	West Amwell Township	Hunterdon	5-8-2000	24	Non-impaired	138	Sub-optimal
AN0097	UNT to Alexauken Creek	Queen Road to Alexauken Road	West Amwell Township	Hunterdon	5-8-2000	21	Moderate	116	Optimal
AN0100	Moore's Creek	Barry Road	West Amwell Township	Hunterdon	5-8-2000	30	Non-impaired	116	Sub-optimal

Additionally, an NJDEP 319(h) grant to study the Alexauken Creek watershed established monitoring sites along the Alexauken Creek during 2007. This study confirmed that the Alexauken Creek and its watershed are exhibiting signs of deteriorating water quality.

Some of the information contained in this section has been adapted from NJDEP, AMNET.

SECTION 12

Vernal Pools

The New Jersey Division of Fish and Wildlife defines vernal pools as confined wetland depressions, either natural or man-made, that hold water for at least two consecutive months out of the year and are devoid of breeding fish populations. These are temporary features that either dry out completely or draw down to very shallow levels unsuitable for sustaining fish. Vernal pools can be found in isolated depressions within upland forests, seasonally flooded meadows, floodplain swamps, abandoned gravel pits or quarries.

ONE OF WEST AMWELL'S VERNAL POOLS

Because of the absence of predatory fish, vernal pools are unique aquatic ecosystems that provide habitat for a variety of amphibians, insects, reptiles, plants, and other wildlife. Many of these species are classified as Threatened and Endangered or species of special concern and rely on fish-free vernal pools for successful reproduction. Amphibians that depend on vernal pools are known as "obligate vernal pool breeders." In New Jersey, seven species—two frogs and five salamanders—fit this category. Another 14 of New Jersey's amphibians also use vernal pools for breeding, but unlike the "obligate" species, these species—known as "facultative vernal pool breeders"—can also successfully reproduce in habitats that contain fish.

The Endangered and Nongame Species Program (ENSP) initiated the Vernal Pool Survey Project in November 2000 to map and inventory vernal pools statewide and determine the status, range and distribution of obligate vernal pool amphibians. Possible locations of vernal pools are identified using computer-aided analysis

techniques and field surveys. ENSP staff and volunteers then conducted more detailed field surveys of animal and plant species. Vernal pools that provide documented habitat for certain amphibian and reptile species are designated as "certified." As data is collected on vernal pools, the information will be integrated into NJDEP's land use regulatory databases. NJDEP is moving vernal pool data from an older database compiled by the Center for Remote Sensing and Spatial Analysis (CRSSA) at Rutgers University. The CRSSA data, along with any new information, will be added as a layer to the DEP's Landscape Project sometime in 2008.

According to the CRSSA database, West Amwell has 24 potential vernal pools that require survey. Three vernal pools have been surveyed and officially certified. Four potential sites were surveyed and determined to not be vernal pools. A map of the NJDEP data is not available at this time; however, a map and updated data will be included in the next revision of this NRI. Also, a 319h grant to study the Alexauken Creek watershed has identified many potential vernal pools. This information will be added to the NRI as it becomes available.

In September 2001, New Jersey adopted legislation to protect vernal pools. Although the NJ Freshwater Wetlands Protection Act has been in place since 1989, it has done little to protect vernal pools because wetlands less than 1 acre (many vernal pools in NJ are less than 0.25 acre) are exempt from regulatory protection. Thus before the rule vernal pools could be filled, drained, or modified with a general permit. The new vernal pool (or "vernal habitat," as it is known in regulatory language) regulations protect vernal pools that are known to meet the following certification criteria:

- Occurs in a confined basin depression without a permanently flowing outlet,
- Provides documented habitat for obligate or facultative vernal habitat species,
- Maintains ponded water for at least two continuous months between March and September of a normal rainfall year, and
- Remains free of fish populations throughout the year or dries up at some time during a normal rainfall year.

The primary way in which NJDEP's Land Use Regulation Program is implementing vernal pool protection is through cross-referencing land use permit applications with mapping of certified vernal pools. Projects proposed directly within vernal pools may need to be redesigned to avoid adversely affecting them or the permit may potentially be denied. However, this protection can only be applied to vernal pools that have been previously certified.

Some of the information contained in this section has been adapted from NJDEP: New Jersey's Vernal Pools.

SECTION 13

Wetlands

Wetlands serve many important purposes. They are aquifer recharge areas and areas that trap and filter pollutants through natural bio-chemical processes. The filtering capabilities of wetlands are particularly useful along waterways where protection of existing water quality is desirable. Wetlands in these areas may serve as a buffer to harmful non-point source pollutants.

Wetlands play a particularly important role on the Sourland Mountain Ridge and are a valuable part of the ecosystem. In addition to acting as headwaters, wetland systems capture and retain precipitation, slowly releasing it into the ground and recharging aquifers. This is critical as recharge on the Mountain is extremely low.

Wetland habitats generally occur between well-drained upland areas that rarely receive floodwater and low-lying, permanently flooded waters of lakes or streams. Wetlands characteristically include swamps, bogs, marshes and bottomland areas. Although they usually lie along rivers and lakes, wetlands may occur on slopes where they are associated with groundwater seeps or in areas of a perched water table. Wetlands depicted on Figure 2 are taken from the NJDEP Land Use/Land Cover information from 2007.

NJDEP wetland mapping indicates that 1,146 acres of wetlands exist in West Amwell Township. The predominant wetland type is deciduous/mixed forest, composing 90.02 percent of the total acreage of wetlands at 1,042.13 acres. They are located primarily along stream corridors and in isolated pockets throughout the Township. Agricultural wetlands represent the second largest type of wetlands, composing 4.33 percent (49.75 acres) of all wetland areas. Agricultural wetlands are wetland areas that have been modified for crop production, generally by the installation of drainage features such as ditches. When drainage features are removed and the land is allowed to fall into succession, these areas will generally revert to wetlands. Agricultural wetlands are typically located at the edge of existing wetland areas, which abut field fringes. They are located throughout the Township. Table 7 lists the wetland types.

PERCHED WETLANDS

Herbaceous wetlands represent .84 percent (9.7 acres) of the wetlands areas in the Township. Herbaceous wetlands are typically emergent habitats located along stream corridors where vegetation can be frequently flooded and run down by moving water. In late summer, vegetation is typically stable and hardy, maintaining a vegetative state below shrub/scrub status.

Deciduous shrub/scrub wetlands comprise 1.04 percent (11.94 acres), mixed shrub/scrub 1.06 percent (12.14 acres).

The remaining wetlands in the Township are coniferous shrub/scrub (3.94 acres), coniferous wooded (2.7 acres), former agricultural wetland reverting to scrub (4 acres) and disturbed areas (4.5 acres) all together comprising .96 percent of the wetlands. There are also 5.2 acres of wetland right of ways, comprising .45 percent of the total wetlands.

Although state regulations afford some protection for wetlands, they do not prevent destruction or disturbance per se, and it is prudent to consider additional environmental protection strategies that can build upon these state protections. Recent history highlights the importance of wetlands in flood control. The need for careful management of wetlands and their environs became obvious during recent damaging storms and floods along the Delaware River. Careful planning and location of development can avoid loss from such disasters in the future.

Table 7: *Wetland Types*

WETLAND TYPE	ACRES	PERCENT
Deciduous/mixed forest	1042.13	90.02
Agricultural	49.75	4.33
Mixed shrub/scrub	12.14	1.06
Deciduous shrub/scrub	11.94	1.04
Herbaceous	9.70	.84
Rights of Way	5.20	.45
Disturbed areas	4.50	.39
Former agricultural	4.00	.35
Shrub/scrub	3.94	.34
Coniferous wooded	2.70	.23

Some of the information contained in this section has been adapted from the Delaware Township NRI.

SECTION 14

Floodplains

Floodplains are areas subject to inundation by flood waters and the watercourse that creates them. Floodplains are made up of two distinct areas: the floodway and the flood fringe. The floodway is the channel of a watercourse and portions of the floodplain adjoining the channel that are required to carry and discharge floodwaters. The flood fringe is the remaining portion of the flood plain outside the floodway. The width of a floodplain depends on the drainage area of the watercourse, the type and amount of development in the watershed, duration and amount of rainfall, and the topography adjacent to the watercourse. Floodplains are mapped by the state and the federal governments.

DELAWARE RIVER FLOODING

Floodplains that are relatively undisturbed (or have been restored to a nearly natural state) provide a wide range of benefits to humans and natural systems. These benefits take many forms. Some are static conditons (like aesthetic pleasure) and others are active processes (like storing stormwater during a flood). These benefits can be grouped into two categories.

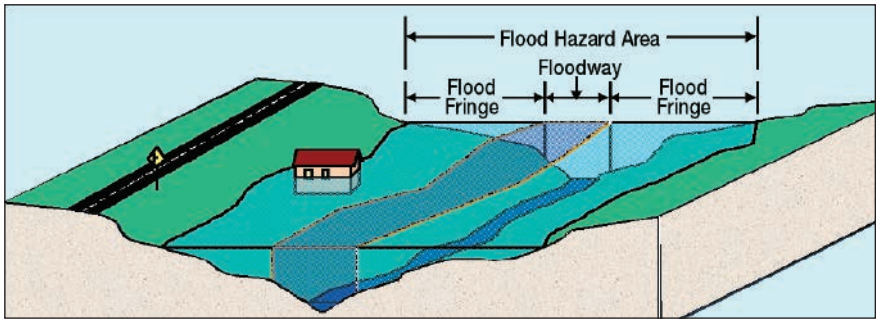
1. Water Resources
    a. Natural Flood and Erosion Control
        - Flood storage and conveyance, reduce flood velocities and peaks, reduce sedimentation
    b. Water Quality Maintenance
        - Filter nutrients and impurities, process organic waste, moderate temperature changes
    c. Groundwater Recharge
        - Facilitate infiltration and aquifer recharge, reduce low surface flows

2. Biologic Resources
    a. Biological Productivity
        - Support high rate of plant growth, maintain biodiversity and integrity of the ecosystem
    b. Fish and Wildlife Habitats
        - Provide breeding and feeding grounds, create and enhance waterfowl habitat, protect habitats for Threatened and Endangered species

The Federal Emergency Management Agency (FEMA) has prepared maps of the 100-year floodplain found along a majority of the streams and rivers in the Township. This mapping is prepared to provide information to homeowners, floodplain managers, engineers and flood insurance providers on the flooding risks associated with the location of dwellings and structures. Note that the digital floodplain data that FEMA provides was created by digitizing the existing Flood Insurance Rate Maps, which have varying scales. In most cases, the data is distorted to varying degrees and are useful only for generalized floodplain location and magnitude. Because of its elevation, flooding has not been a concern in West Amwell Township except in one or two

locations. Flooding is a Township concern, however, to the extent that excess runoff into a stream contributes to flooding along the Delaware River.

The state has mapped the larger watercourses in the Township including the Delaware River, Swan Creek, Moore's Creek and Alexauken Creek. Floodplains of these watercourses have been delineated and officially adopted by rule. These maps delineate the Floodway and Flood Hazard Area and are used for regulatory purposes by NJDEP. For delineated watercourses the design flood elevations have been established and are readily available at the West Amwell Township Office and from the Flood Plain Management Bureau in NJDEP. Other floodplains and the watercourses that create them are considered "non-delineated" and to determine the extent of the floodplain one must use standard computational methods established by NJDEP.



THE FLOOD HAZARD AREA COMPRISES THE FLOODWAY AND THE FLOOD FRINGE

It is important to know the extent of the floodplain on a given property to minimize the potential for damage to structures and to protect residents from the hazards of flood waters. During floods, materials and structures can be swept downstream and threaten lives and property. Development in the floodplain may also adversely affect the floods' carrying capacity in these areas and may subject new structures to increased damage from flood waters by displacing natural flood storage that the floodplain provides. Development in the floodplain may also degrade water quality of the receiving watercourse by introducing additional stormwater runoff and sedimentation.

For these reasons and others, the Township and the state regulate any construction activities, placement of fill or obstructions in the floodplain. The Township's requirements for construction in the floodplain can be found in the municipal code at Chapter 90 Floodplain Management. The Flood Hazard Area Control Act Rules at NJAC 7:13 codifies the state's requirements.

FEMA requires all persons with improved property within a special flood hazard area certified by a Township Flood Search Official and shown on the Flood Insurance Rate Maps to purchase flood insurance. FEMA recommends that even those not directly in a flood hazard area purchase insurance, as flood damage can occur outside the flood hazard areas as well.

The mapping of floodplains provided by FEMA carries a number of different designations. The 100-year floodplain is delineated for most streams, though some do not have base flood elevations determined. Streams that do not have base flood elevations determined have not been subject to detailed hydraulic study to determine potential flood extent, and water levels during the 100-year storm have not been determined.

Figure 11 depicts FEMA floodplain mapping for Hunterdon County.

Refer to Appendix 4 for FEMA critical area and floodplain mapping for West Amwell.

Some of the information in this section has been adapted from North Carolina Floodplain Resources and the Delaware Township NRI.

SECTION 15

Steep Slopes

West Amwell Township is characterized by two general landforms: the flat to gently rolling expanses of the flanks of the Sourland Mountain and the Sourland Mountain Ridge. The Sourland Mountain Ridge, which bisects the Township, has the highest elevation and represents the most prominent topographic features in West Amwell.

Steep slopes, depicted on Figure 12, represent transitional areas in the landscape from higher terrain to lower terrain into stream corridors. The latter are often created by the erosion from water scouring the landscape. The most extensive areas of steep slopes are found along the Alexauken Creek, Moore's Creek and Swan Creek. These creeks are bordered by slopes greater than 25 percent, which is the most critical value required for protection.

STEEP SLOPE ON THE SOURLAND RIDGE IN WEST AMWELL

Steep slopes have a number of implications for community development and the environment. Slopes in excess of 25 percent present serious limitations for development, often requiring extensive and costly engineering and construction. Development on slopes in excess of 15 percent can degrade the environment. Since most slopes occur in and around the banks of streams and rivers, disturbance in these areas creates the potential for erosion and stream sedimentation. The clearing of trees and vegetation also reduces shading which increases water temperatures in streams and rivers, thus degrading aquatic habitat.

Agricultural operations near steep slopes and stream courses raise additional concerns. Livestock grazing along steep stream banks can cause serious degradation and destabilization. Pesticides and fertilizers used on steep slopes along watercourses are more likely to reach the water without being infiltrated into the ground.

Some of the information contained in this section has been adapted from the Delaware Township NRI.

SECTION 16

Forested Areas

Including wooded wetlands (1,072.85 acres), West Amwell Township has about 7,285 acres of forested area. This represents 52.11 percent of the total acreage (13,980 acres) of the Township, a significant portion of land cover. Forested areas are depicted in the 2007 NJDEP Land Use/Land Cover analysis (Figure 2). Table 8 lists the forest types.

The Sourland Mountain wooded ridge is the most significant contiguous forest stand in the Township. This area is characterized primarily by deciduous forest, with deciduous wooded wetlands, vernal pools, Swan Creek

and its tributaries and the United Water Company reservoir. The Sourland Mountain is an environmentally sensitive area, home to Threatened and Endangered species, and is important for its role as a summer residence for neo-tropical birds.

There are other areas of contiguous forest in the northern portion of the Township, although they are not as significant as those on the Sourland Mountain.

Table 8: *Forest Types*

FOREST TYPE	ACRES	PERCENT
Deciduous	4343	69.91
Mixed deciduous/ coniferous shrub/scrub	446	7.17
Coniferous	325	5.23
Mixed >50% coniferous shrub/scrub	251	4.04
Coniferous shrub/scrub	218	3.50
Rights of Way	173	2.78
Deciduous shrub/scrub	161	2.59
Orchards, nurseries	150	2.41
Mixed >50% deciduous	145	2.33

The forested areas of West Amwell play a vital role in many ecosystem functions, including:

- Habitat for Threatened and Endangered species,
- Regulation of stream temperatures to support stability of streams and rivers,
- Provision of nutrients and woody debris to streams and rivers,
- Stabilization of steep slopes and reduction of erosion and sedimentation,
- Wooded wetlands that act as headwaters to tributary streams,
- Conversion of carbon dioxide to oxygen,
- Dissipation of heat and provision of shade,
- Provision of riparian buffers,
- Regulation of building temperatures and reduction of reliance on heating and cooling systems,
- Reduction of groundwater pollution,

DECIDUOUS FOREST IN WEST AMWELL

- Reduction of noise and air pollution,
- Provision of privacy and screening,
- Enhancement of groundwater recharge capacities,
- Vernal pools, and
- Biodiversity.

Deciduous Forests

Deciduous forests represent the major forest type in West Amwell consisting of 4,343 acres.

The mature deciduous forests of the Township are primarily forests of:

- American Beech *(Fagus grandifolia)*
- Basswood *(Tilia Americana)*
- Black Birch *(Betula lenta)*
- Black Oak/Red Oak *(Quercus species)*
- Black Walnut *(Juglans nigra)*
- Common Catalpa *(Catalpa bignonioides)*
- Crab Apple *(Pyrus species)*
- Eastern Red Cedar *(Juniperus virginiana)*
- Flowering Dogwood *(Cornus florida)*
- Gray Birch *(Betula populifolia)*
- Ironwood *(Carpinus caroliniana)*
- Mockernut Hickory *(Carya tomentosa)*
- Osage Orange *(Maclura pomifera)*
- Pin Oak *(Quercus paulistris)*
- Red Maple *(Acer rubrum)*
- Red Mulberry *(Morus rubra)*
- Sassafras *(Sassafras albidum)*
- Shagbark Hickory *(Carya ovata)*
- Silver Maple *(Acer saccharinum)*
- Slippery Elm *(Ulmus rubra)*
- Staghorn Sumac *(Rhus typhina)*
- Sugar Maple *(Acer saccharum)*
- Swamp Chestnut Oak *(Quercus michauxii)*
- Swamp White Oak *(Quercus bicolor)*
- Sycamore *(Platanus occidentalis)*
- Tuliptree *(Liriodendron tulipifera)*
- White Ash *(Fraxinus Americana)*
- White Oak *(Quercus alba)*

The typical forest understory species present in the deciduous forests of West Amwell are:

- Amur Honeysuckle *(Lonicera Maackii)*
- Arrowwood *(Viburnum dentatum)*
- Japanese Barberry *(Berberis thunbergii)*
- Japanese Silverberry *(Autumn Elaeagnus Elaeagnus umbellate)*
- Morrow Honeysuckle *(Lonicera morrowi)*
- Nannyberry *(Viburnum lentago)*
- Northern Bayberry *(Myrica pensylvanicum)*
- Northern Spicebush *(Lindera benzoin)*
- Panicled Dogwood *(Cornus foemina ssp. Racemosa)*
- Privit *(Ligustrum vulgare)*
- Red Chokeberry *(Pyrus arbutifolia)*
- Shadbush *(Amelanchier arborea)*
- Silky Dogwood *(Cornus amomum)*
- Staghorn Sumac *(Rhus typhina)*
- Steeple Bush *(Spirea tomentosa)*
- Winged Euonymus *(Euonymus alata)*
- Winterberry *(Ilex verticillata)*

Shrub/Scrub Forests

About 630 acres of land in West Amwell are mapped as shrub/scrub forest. Upland shrub forests mapped within the region would typically be represented by successional lots, old fields or other previously disturbed areas. These forests may be old agricultural areas abandoned or left fallow or portions of open canopy within a forest. Opportunistic “pioneer species” initially colonize these areas. In old field communities, annual, biennial, and eventually perennial herbaceous plants are the pioneer species.

Some early succession herbaceous plants found in West Amwell include:

- Asters *(Aster spp.)*
- Broomsedge *(Andropogon spp.)*
- Foxtails *(Setaria spp.)*
- Goldenrods *(Solidago spp.)*
- Horseweed *(Conyza canadensis)*
- Oxeye daisy *(Chrysanthemum leucanthemum)*
- Panic grasses *(Panicum spp.)*
- Ragweed *(Ambrosia artemisiifolia)*
- Thistle *(Cirsium spp.)*
- Wild carrot *(Daucus carota)*
- Wild garlic *(Allium vineale)*

Forest Fragmentation and Corridors

Fragmentation of forested areas by development isolates stands from the main forest complex, increasing the amount of edge habitat and decreasing the amount of forest interior habitat. Negative effects of forest habitat fragmentation are well documented for breeding birds. Large tracts of contiguous forested areas are necessary to support breeding populations of migratory songbirds as well as forest dwelling raptors. Most forest interior species will only nest within a forest "core" that is at least 295 feet from the nearest forest edge. In addition the forest core must be a minimum of about 25 acres in size.

Fragmented forests are characterized by high levels of edge-related nest predation, brood parasitism, or both and prove undesirable for many area sensitive species. In addition, forest fragmentation facilitates the spread of exotic and invasive plants and animals that can dramatically change the forest habitat.

Demographic data suggest that populations of many forest-breeding species in severely fragmented landscapes may be "sinks" that produce too few young to compensate for adult mortality. The loss of habitat is the primary reason for the decline in species and affects plants, mammals, birds, reptiles, amphibians, fish and invertebrates. Immigration and recolonization then become critical for long-term regional survival of local populations, particularly for imperiled species.

UNFRAGMENTED FOREST IN WEST AMWELL

Habitat corridors are linear landscapes that provide wildlife the ability to move between habitat patches. The best corridors are those that are the widest possible and those that connect the largest patches of habitat. The wider the corridor the more likely it will be used by forest interior species including neo-tropical migrant birds. Most imperiled species are habitat specialists, meaning that they only survive within a specific type of habitat. In addition, they only occur in limited numbers, so it is critical that areas of suitable habitat are connected via adequate corridors. This allows individuals to migrate between habitats and interbreed with subpopulations. This concept is particularly important for many small mammals, reptiles, amphibians and some invertebrates. Many of these creatures will be entirely prohibited from dispersing if impeded by barriers such as roads or unsuitable habitat. Dispersion is critical to maintaing a healthy genetic mix within a species.

Corridors between natural communities help to mitigate the impacts of habitat fragmentation and species isolation. Corridors allow species with limited dispersal capabilities an effective means to disperse.

Many larger forested areas within West Amwell are mapped as wetlands and have limited development potential. The forested corridor can be broadened or improved by allowing preserved lands to revert to their natural state or through planting of native species to "jump start" the process. Establishing connectivity between the forested patches and expanding the width of existing forested riparian corridors can improve the overallhabitat quality of the Township's forests.

Forest fragmentation and connectivity should always be considered during development review. Projects should be designed to limit forest fragmentation and the destruction of the interior forest by protecting critical environmental resources, including air quality, water quality, soil cover, animal and plant habitat and viewsheds. These resources provide great benefits to West Amwell's quality of life.

Retention of woodlands has a number of benefits. Woodlands help to control the velocity and amount of stormwater runoff, thereby reducing flooding. They also filter sediments and pollutants before they reach streams, promote groundwater recharge, stabilize the soil and reduce soil erosion and improve air quality by filtering pollutants from the air. Woodlands also offer a stable habitat for associated plant species and for animal wildlife, provide shade and windbreaks that help moderate the effects of climate conditions and preserve scenic views that residents often come to cherish.

Protection of woodlands along a stream corridor is essential to the maintenance of stream biota, and protection of woodlands on steep slopes is essential to soil stabilization. The retention of woodlands is essential to the scenic quality of West Amwell and helps to preserve the diversity of native plant and animal species. The protection of woodlands is consistent with New Jersey's Stormwater Management Rules and Best Management Practices.

The benefits of trees are well documented. Trees foster a healthier environment for humans and animals while simultaneously providing economic benefits. A publication of the NJDEP *Valuing New Jersey's Natural Capital* reinforces the economic value of the state's natural resources. It is therefore important to continue to encourage the preservation and wise management of forest resources within the Township. This can be aided through the development review process, establishing strong limits on clearing and making tree and forest preservation a known priority. The Township adopted a Woodland Protection Ordinance to help address this. For more detailed information on the Woodland Ordinance, refer to Appendix 5.

One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people.

— U.S. DEPARTMENT OF AGRICULTURE

Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20 to 50 percent in energy used for heating.

— USDA FOREST SERVICE

Healthy, mature trees add an average of 10 percent to a property's value.

— USDA FOREST SERVICE

The planting of trees means improved water quality, resulting in less runoff and erosion. This allows more recharging of the ground water supply. Wooded areas help prevent the transport of sediment and chemicals into streams.

— USDA FOREST SERVICE

Some of the information in this section has been adapted from the Delaware Township NRI.

SECTION 17

Riparian Areas

The health of surface waters within the Township depends on the health of the buffer areas that surround them. These riparian areas or stream corridors protect water resources from non-point source pollution and provide bank stabilization and aquatic and wildlife habitat. The formal definition of riparian buffer is diverse and depends on the individual or group defining the term.

The USDA Forest Service defines a riparian buffer as follows:

> *The aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, and bays and their adjacent side channels, floodplain, and wetlands. In specific cases, the riparian buffer may also include a portion of the hillslope that directly serves as streamside habitats for wildlife.*

Leading experts (Lowrance, Leonard, and Sherida, 1985) on riparian buffers define them as follows:

> *A complex assemblage of plants and other organisms in an environment adjacent to water. Without definitive boundaries, it may include stream banks, floodplain, and wetlands, as well as sub-irrigated sites forming a transitional zone between upland and aquatic habitat. Mainly linear in shape and extent, they are characterized by laterally flowing water that rises and falls at least once within a growing season.*

Riparian areas are a diverse and important part of the ecosystem. Due to their position in the landscape, they convey a great amount of energy and nutrients. But this position also makes them most vulnerable, subject to a combination of effects that can be related directly to human activities.

Natural riparian buffers are composed of grasses, trees, or both types of vegetation. If riparian buffers are maintained or re-established, they can exist under most land uses: natural, agricultural, forested, suburban, and urban.

RIPARIAN AREA FUNCTIONS

- Maintenance of biodiversity
- Provision of forage and other food sources
- Protection of water quality
- Regulation of stream temperature
- Flood storage and release
- Provision of wildlife corridors
- Aquifer recharge and baseflow maintenance
- Terrestial and amphibian habitat
- Recreation sites
- Stream bank stabilization
- Habitat for Threatened and Endangered species

Riparian buffers are important for good water quality. Riparian zones help to prevent sediment excess, nitrogen and phosphorus, pesticides and other pollutants from reaching a stream. Riparian buffers most effectively improve water quality when they include native grasses or other vegetative filters along with deep-rooted trees and shrubs along the stream. Riparian vegetation is a major source of energy and nutrients for stream communities. In-stream woody debris provides areas for fish and amphibians to reproduce and provides critical nutrients and substrate. This is especially important in small, headwater streams where up to 99 percent of the energy input may be from woody debris and leaf litter. Overhanging riparian vegetation keeps streams cool. Riparian buffers provide valuable habitat for wildlife. In addition to providing food and cover they are an important corridor or travel way for a variety of wildlife. Streamsides benefit game species such as deer, rabbit, quail and nongame species like migratory songbirds.

Riparian vegetation slows floodwaters, thereby helping to maintain stable streambanks and protect downstream property. By slowing floodwaters and stormwater runoff, the riparian vegetation allows water to soak into the ground and recharge groundwater. Slowing floodwaters allows the riparian zone to function as a site of sediment deposition, trapping sediments that build stream banks and would otherwise degrade our streams and rivers. Riparian areas serve a multitude of functions for surface waters, the most critical of which is to provide a transition area from surrounding land uses.

ALEXAUKEN CREEK RIPARIAN BUFFER IN WEST AMWELL

Careful delineation of riparian areas and implementation of appropriate management strategies can ensure continued maintenance and potential enhancement of existing water quality. This is critical in more developed portions of the Township, where water quality will continue to decline if riparian areas are not protected. Riparian buffers are also important to protect headwaters in undeveloped but not naturally buffered areas.

Development and subsequent loss of riparian areas can have a number of negative effects on surface waters. The loss of riparian areas eliminates filtration of sediment and non-point source pollution, greatly affecting water quality. In addition to sediment that enters the stream from off-site sources, deterioration and elimination of streamside and stream bank vegetation lends to scouring, which causes bank deterioration and contributes to further erosion and sedimentation. Additionally, streams lacking forested or even vegetative riparian areas also lack habitat provided by woody debris. Road crossings, which include bridges and culverts degrade riparian areas and stream channels. Crossings create breaks in an otherwise uninterrupted corridor, making wildlife migration difficult. Bridges are also prime sources of non-point pollution that often washes directly into the stream from the bridge deck.

Riparian areas also make intrinsic social and economic contributions. They provide passive recreation sites, which can be enjoyed by the Township residents. An interconnected stream network and its associated riparian areas present the opportunity for habitat corridors that can span a large area.

West Amwell Township's Stream Corridor Ordinance protects riparian areas as follows:

1) For Category 1 waters, the stream corridor shall be measured as defined at N.J.A.C. 7:8-5.5(h) or as defined by this ordinance, whichever is more restrictive.
2) For all other streams, the stream corridor shall be measured from the top of the bank of an intermittent or perennial stream, or centerline if the bank is not defined.
3) For developed residential properties in existence as of the adoption of this ordinance, the delineated stream corridor shall extend 75 feet perpendicular to and parallel with both sides of the stream.
4) For undeveloped residential properties of six acres or less in existence as of the adoption of this ordinance, where construction of a single-family home would be permitted pending issuance of a building permit, the delineated stream corridor shall extend 75 feet perpendicular to and parallel with both sides of the stream.
5) For undeveloped residential properties greater than six acres in existence as of the adoption of this ordinance, where construction of a single-family home would be permitted pending issuance of a building permit, the delineated stream corridor shall extend 100 feet perpendicular to and parallel with both sides of the stream.

6) For all other properties, the delineated stream corridor shall extend 150 feet perpendicular to and parallel with both sides of the stream.
7) Where steep slopes (in excess of 15 percent) are located within the designated widths, those slopes will only count for 50 percent of the dimensional criteria of the stream corridor buffer.
8) Where there is a 100-year flood plain delineated, the stream corridor shall encompass the flood plain.
9) Where a stream's origin is identified, this being its headwaters, and where this location comprises a groundwater source that encompasses groundwater formations commonly known by names such as wet soils, seeps and springs, and where this area is not under the jurisdiction of state wetlands laws and regulations, the area of stream corridor protection for this headwaters origin point shall be a 150-foot radius from that point except for existing developed residential properties where the radius shall be 75 feet.

In November, 2007, new Flood Area Control Act Rules were adopted by the NJDEP (N.J.A.C. 7:13). According to N.J.A.C. 7:13-4.1(c)2, the width of the riparian zone is 150 feet for trout maintenance waters. Moore's Creek is classified as FW2-TM and the stream corrider buffer is 150 feet for the entire length, including all upstream waters (including tributaries) within one linear mile as measured along the length of the stream.

Refer to Appendix 6 for detailed information on the Stream Corridor Ordinance.

Figure 8a depicts riparian (streams and waterbodies) areas in West Amwell.

Some of the information contained in this section has been adapted from North Carolina State University, Riparian Buffers and North Carolina State University, Stream Notes:Riparian Buffers.

SECTION 18

Agriculture

According to the Hunterdon County Agricultural Development Board, 56.6 percent of West Amwell is "farmland assessed" (Figure 14). Forty-five percent of this "farmland assessed" area is woodlot management. However, cordwood production is not considered by NJDEP to be consistent with an agricultural designation for land use.

ONE OF WEST AMWELL'S LARGE FARMS

As depicted in the 2007 NJDEP Land Use/Land Cover Analysis (Figure 2), West Amwell Township has 4,021 acres of lands that can be categorized as agricultural. This represents about 28.76 percent of the Township's total land area. These lands are categorized as crop land (71.55 percent) and pasture land (28.45 percent).

Hay, corn, soybeans, wheat, rye, sorghum and vegetables compose the majority of the crop lands, with minor production of nursery stock, honey, apples, herbs and sunflowers. Beef cattle, dairy cow, poultry, horse, game bird, alpaca, sheep and pig operations make up the pastured lands.

Farmlands are classified by the importance of their underlying soils. The Natural Resource Conservation Service (NRCS) has identified soils based on their agricultural significance, or Land Capability Classification. The best quality soils are termed "Prime Farmlands," which are followed by "Soils of Statewide Importance."

- **Prime Farmlands** include all those soils in Land Capability Class I and selected soils from Land Capability Class II. Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when treated and managed according to acceptable farming methods. Prime Farmlands are not excessively erodable or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

- **Soils of Statewide Importance** include those soils in land capability Class II and III that do not meet the criteria as Prime Farmlands, but nonetheless support agricultural production, with some limitations. These soils may be suited to certain crops or require special conservation practices to maintain their productivity. Figure 15 identifies the soils that are considered Prime Farmland or Soils of Statewide Importance in West Amwell.

Except for the Sourland Ridge (because of the limited water supply and the shallow nature of the soils, limiting the ability to sustain crops) and smaller portions in the northeast, northwest and southwest portions of the Township, West Amwell has a large percentage of soils that are Prime Farmlands and Soils of Statewide Importance. These soils represent areas that are most suitable for retention as agricultural lands. The preservation of these high quality agricultural lands is considered vital to retaining the agricultural component of West Amwell's community character.

WEST AMWELL FARM FIELD WITH HAY BALES IN SPRING

Highly productive soils are a finite resource. Once developed, they are unlikely to return to agricultural uses. In addition, agricultural soils form the backbone of farming, a prized part of the Township's agrarian history. With only roughly 29 percent of the Township's land remaining in some form of agricultural production, protection of remaining undeveloped fertile lands is paramount to the continuation of agriculture in West Amwell.

Some of the information contained in this section has been adapted from the Delaware Township NRI.

SECTION 19

Wildlife and Critical Habitat

In 1994, NJDEP's Endangered and Non-game Species Program (ENSP) initiated the Landscape Project. With suburbanization and development occurring in all areas of the state, an increasing amount of habitat that could potentially support Threatened and Endangered species was being lost daily.

Many imperiled species require large contiguous tracts of habitat for survival. The consequence of the rapid spread of suburban sprawl is the loss and fragmentation of important wildlife habitat and the isolation and degradation of the smaller habitat patches that remain. Small patches of fields, forests and wetlands interspersed with development provide habitat for common species that do well living near humans, but they do not provide the necessary habitat for most of our imperiled wildlife. Large, contiguous blocks of forest, grassland and wetlands need to be protected to assure the survival of imperiled species over the longterm.

To address habitat loss and assess the extent and suitability of remaining resources in the state, ENSP partnered with the Center for Remote Sensing and Spatial Analysis (CRSSA) at Cook College, Rutgers University. Using LandSat Thematic Mapper satellite imagery, CRSSA mapped land cover for the entire state, broken down into 20 different habitat/land cover types. After generalized cover types were classified, detailed methodologies were developed to address the habitat suitability issues for each focus category, including beaches and dunes, emergent landscapes, forested wetlands, forested areas and grasslands.

Landscape Project data provide scientifically sound, peer-reviewed information on the location of critical habitat based on the conservation status of the species that are present. The data is intended to aid municipalities, county and state governments, conservation agencies and citizens in determining the extent of critical habitat within their respective jurisdictions and communities. After identifying critical habitat, a variety of means can be employed to protect it, including the following:

- Prioritizing open space acquisitions based on the presence of habitat for Threatened and Endangered species,
- Adopting regulations aimed at protecting critical habitat,
- Adopting management policies for open space that are consistent with protection of critical habitat,
- Permitting flexibility in development techniques that can accommodate the protection of critical habitat, and
- Promoting land stewardship practices that are consistent with the protection of critical habitat.

The Landscape Project was revised and updated in May 2008.

Forested uplands and forested wetlands make up the majority of the critical habitat in West Amwell, with most of these areas containing Threatened and Endangered species. Refer to Figure 16 for the delineation of this critical habitat. Appendix 7 lists the New Jersey Threatened and Endangered Wildlife.

The highest concentrations of critical forested habitat are along the Sourland Ridge, although the southwest and north central portions of the Township are rich in critical Threatened and Endangered species habitat. Refer to Appendix 8 for an in-depth analysis of the Sourland Mountain.

Grasslands supporting populations of state species of special concern are present throughout the Township, especially the northern and central portions. Most of these grassland habitats are associated with agricultural operations which likely involve the production of hay or other grass-like crops. These lands are uniquely suited to reproducing populations of neo-tropical migrating birds.

West Amwell also has emergent wetland habitat for species of special concern scattered throughout the Township. These habitats are not as high ranking and expansive as the forest and grassland habitats, yet are nonetheless worthy of noting. Emergent habitats are critical to the reproductive cycles of many amphibian species that rely on both emergent wetlands and vernal pools for this process.

In 2004, Washington Crossing Audubon and residents of West Amwell identified the following Threatened and Endangered populations at the Alexauken Creek Wildlife Management area:

- Northern Harrier *(Circus cyaneus)*
- Cooper's hawk *(Accipiter cooperli)*
- Red Shouldered Hawk *(Buteo lineatus)*

Appendix 9 contains the complete Alexauken Creek Wildlife Management Area Biological Inventory report.

While the Landscape Project documents and identifies only Threatened and Endangered animal species, it is worth noting that the Goat Hill Natural Heritage Priority Site (Section 21) has populations of three state endangered plant species and the Alexauken Wildlife Management Area has populations of two Threatened and Endangered plant species.

Invasive Plant Species

While identifying and protecting Threatened and Endangered species' habitat is critical, it is also important to identify and control alien invasive species that can create an imbalance in the ecosystem and replace native plants, thus contributing to species extinction.

In 2004, Governor James McGreevey issued Executive Order No. 97 and established a New Jersey Invasive Species Council. Governor McGreevey stated, in part: "Harmful non-indigenous species of plants, animals, and other organisms, commonly referred to as invasive species, pose a threat to New Jersey's native vegetation and natural resources by invading healthy ecosystems where they displace, impair or destroy indigenous species and impair ecosystem function."

New Jersey has more than one thousand invasive species, many of which have made a home in West Amwell. Introduced non-native species often form dense stands that crowd out and alter the structure of natural plant communities, creating habitat loss. Wildlife dependent on the displaced native species as a food source are also affected. In order to preserve native habitat, non-native plant species must be identified and eradicated.

LESSER CELANDINE

The following are some of the more common invasive species of West Amwell:

- Norway maple *(Acer platanoides)*
- Garlic mustard *(Alliaria petiolata, Bieb.)*
- Canadian thistle *(Cirsium arvense)*
- Wild teasel *(Dipsacus fullonum)*
- Russian olive *(Elaeagnus angustifolia)*
- Ground ivy *(Glechoma hederacea)*
- Purple loosestrife *(Lythrum salicaria)*
- Japanese honeysuckle *(Lonicera japonica)*
- English plantain *(Plantago lanceolata)*
- Lesser celandine *(Ranunculus ficaria)*
- Multiflora rose *(Rosa multiflora)*
- Wineberry *(Rubus phoenicolasius)*

Refer to Appendix 10 and 11 for more complete information about exotic, invasive and native plants.

Some of the information contained in this section has been adapted from the Delaware Township NRI.

SECTION 20

The Sourland Region

The Sourland Region, comprising the Sourland Mountain Ridge and adjacent areas, spans 87 square miles (55,731 acres) and includes the largest unbroken forest in the heart of central New Jersey. The Mountain formed more than 150 million years ago, during the Triassic and Jurassic periods, and was the result of continental separation or rift. It extends through three counties, seven municipalities, and three major regional watersheds. Set amid productive agricultural valleys to the north and south, the Sourlands are between New York and Philadelphia, in a region which has been dramatically altered by development. A place rich in history, the lower elevations of the Sourland Region were first settled by the Lenape Indians, whose Unami tribes farmed the agricultural valleys that flank the mountain. However, the hostile environment of hard rock and scarce water limited their exploitation of the ridge.

Unlike much of central New Jersey, the Sourland Region, especially the Ridge, has remained largely undeveloped. Unique geology and water resources, deep forests, wetlands, history, and culture all define the Sourland Region. The Sourland forest, transitional areas and grasslands make up a high-quality woodland habitat, especially for forest interior nesting birds. The region is a critical stopover point for birds migrating along the Atlantic Flyway and is one of New Jersey's top fall migration stopover sites essential for long-distance migrants.

The Ridge features impressive boulder fields that make plowing for crops impractical or impossible. Below the surface, the hard rock has few cracks where water can percolate downward, so rainfall tends to form perched wetlands even at the highest elevations. Wells are difficult to drill and often run dry. As a result of the relative difficulty of developing the Mountain, the region has remained largely forested and the fact that the Mountain was never cleared for farming has permitted many of the plant and animal species that were present hundreds of years ago to persist.

This inhospitable environment discouraged significant settlement by the Europeans who migrated to the area in the 18th century and had a similar effect during the 19th century. The latter part of the 20th century, however, brought technological advances that aided human settlement of areas previously deemed too harsh. These new or improved technologies, which provided new techniques for wastewater disposal and devices to extract the limited available potable water, now pose a significant threat to the overall ecological health of the Mountain. Today the Sourland Region faces unprecedented pressures that threaten to deplete and degrade the water that maintains this delicate ecology and the lifestyles of residents of the Mountain.

In addition to the local importance of adequate volumes of high quality water, the Sourland Region performs an important regional water quality function. Water that flows within headwaters that originate on the Mountain travels downstream, diluting the effects of non-point and other downstream pollution and maintaining stream flow and the biotic communities supported by these streams. Having less water in the Sourland aquifers increases the likelihood of well pollution from septic systems, and there is no cure for over-pumping limited potable water supplies, except imported water. Exceeding the water supply capabilities of the region could have irreversible consequences.

Protection of groundwater resources requires, in part, that development impacts to aquifers, such as impervious surface coverage, are managed in ways that protect recharge areas. Recharge areas, where permeable soils and natural drainage patterns permit the infiltration of surface runoff to replenish the underlying geologic structure, need to be protected from impervious coverage to keep them open to infiltration. Protecting aquifer recharge also requires adequate functioning of on-site septic systems.

SOURLAND RIDGE WOODLAND/RIPARIAN AREA IN WEST AMWELL

Since about 90 percent of West Amwell lies within the Sourland Region and in response to an increase in development pressure, West Amwell has been working in cooperation with a coalition of environmental and municipal government organizations formed to preserve and protect the Mountain habitat and the surrounding area. The coalition includes the Sourland Planning Council, the Delaware and Raritan Greenway, Stony Brook Millstone Watershed Association, Friends of Hopewell Valley Open Space, West Amwell Township, East Amwell Township and Hopewell Township. In 2005, the *Sourland Mountain Smart Growth Planning Project* was produced as a result of a State Smart Growth grant (Phase I). This project was the joint effort of Banisch Associates, Demicco and Associates, M2 Associates, the Sourland Planning Council, and the townships of East Amwell, Hillsborough, Hopewell, Montgomery and West Amwell. Ultimately, a natural resource inventory, a groundwater evaluation, a build-out analysis and a conservation/open space plan for the Sourland Region was produced. Phase II of the project began in 2007 with the ultimate goal of producing a Regional Management Plan for the Sourland Region. Figure 17 depicts the Sourland Region.

Refer to Appendix 8 for the Sourland Smart Growth Project.

In addition, a Watershed Management Protection Plan for the Sourland Region was adopted in 2008 and accepted by NJDEP. The lead planning agency for the plan was the Township of East Amwell.

SECTION 21

Natural Heritage Priority Site

Goat Hill

Through its Natural Heritage Database, the Office of Lands Management identifies critically important areas to conserve New Jersey's biological diversity. The database provides detailed, up-to-date information on rare species and natural communities to planners, developers and conservation agencies for use in resource management, environmental impact assessment and both public and private land protection efforts.

VIEW OF GOAT HILL FROM THE DELAWARE RIVER

The database has identified Natural Heritage Priority Sites that represent some of the best remaining habitat for rare species and exemplary natural communities in the state. These areas should be considered to be top priorities for the preservation of biological diversity in New Jersey. If these sites become degraded or destroyed, we may lose some of the unique components of our natural heritage.

Goat Hill has been designated as a Natural Heritage Priority Site (Figure 19). Goat Hill is the westernmost boundary of the Sourlands. It is a steep, woody diabase hillside and the site contains three state endangered plant species.

This site was preserved in its entirety by the New Jersey Department of Environmental Protection, Green Acres in 2008. It is now known as Goat Hill Overlook.

Some of the information contained in this section has been adapted from NJDEP, Frequently Asked Questions About Natural Heritage Priority Sites.

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